From: James Reese
To: Ullrich, Elizabeth
Cc: Gaskins, Farrah
Subject: [External_Sender] RE: License Status Docket No. 03039153
Date: Thursday, July 11, 2019 10:31:49 AM
Attachments: 20160420_GKP OU1_Final SAP_v0.docx
RS-012.0 Respiratory Protection NRC.pdf
UCB Giannini Hall RSSP 010919.pdf
RS-005 0 Radiation Work Permits NRC.pdf
RS-006 0 Contamination Control NRC.pdf
RS-010 1 Radiation and Contamination Surveys Rev NRC.pdf
RS-016 0 Radiation Safety Incident Reports Rev NRC.pdf
RS-015 0 Internal Dosimetry Rev NRC.pdf
RS-008 0 Air Monitoring Rev NRC.pdf

Betsy

Attached are procedures and examples of project documents that cover the requested information. The GKP OU1 SAP covers core sampling, water sampling, core scanning. The UCB Giannini Hall RSSP provides discussion on the aggressive decontamination work. The other procedures I believe are self explanatory. I did add procedures that support the decom work such as contamination control.

If you have any questions please let me know.

James Reese, CHP, RRPT
Vice President Radiological Services Division
Tidewater, Inc
1804 Tribute Road
Suite B
Sacramento, CA 95816
916-717-0529

From: Ullrich, Elizabeth <Elizabeth.Ullrich@nrc.gov>
Sent: Thursday, July 11, 2019 4:17 AM
To: James Reese <james.reese@tideh2o.net>
Cc: Gaskins, Farrah <Farrah.Gaskins@nrc.gov>
Subject: RE: License Status Docket No. 03039153

I do not have an answer in writing at this time. The staff paper is in management concurrence, and I am waiting to see if it will be signed or sent back for modification.

Also, I need some additional procedures for activities that involve the following activities: procedures for aggressive decommissioning (or a sample procedure from a project where scabbling, grinding, soil sampling at depth etc was performed); bioassay; respiratory protection or an agreement to meet Part 20 Appendix H requirements; air sampling; coil and water sampling; emergency/incident response at TJS; survey procedures; and your criteria for development of RWP.

Normally, I would put this into a more formal letter, but I would like to keep this moving so that as soon as I have a signed response from the program office, we can issue the license.

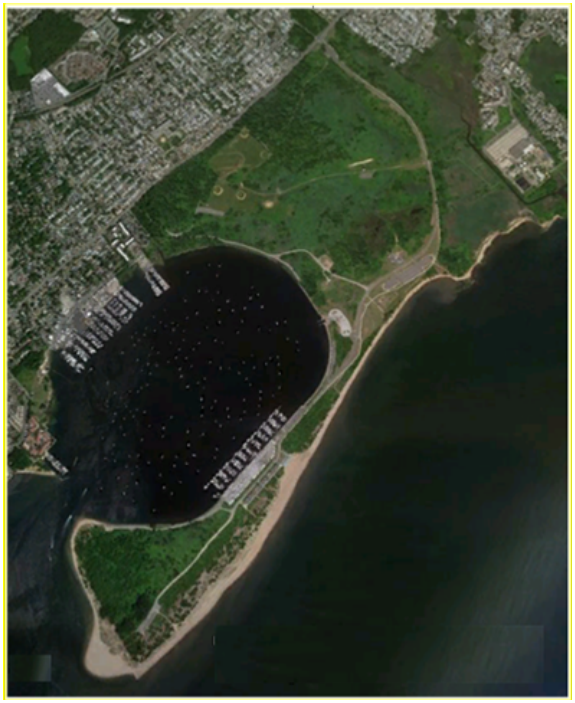
Betsy

From: James Reese [mailto:james.reese@tideh2o.net]
Sent: Wednesday, July 10, 2019 7:20 PM
To: Ullrich, Elizabeth <Elizabeth.Ullrich@nrc.gov>
Subject: [External_Sender] License Status Docket No. 03039153

Betsy

What is the status of the decision regarding the EA and our license submittal?

James Reese, CHP, RRPT
Vice President Radiological Services Division
Tidewater, Inc
1804 Tribute Road
Suite B
Sacramento, CA 95816
916-717-0529



Sampling and Analysis Plan (Final)

Gateway National Recreation Area, New York

Great Kills Park Site - Operable Unit 1
Remedial Investigation

EDL #5NER1580

Prepared by

AECOM-Tidewater Joint Venture

4/22/2016

Revision Log:

Revision #	Revision Date	Revision Description

NPS Project Manager Name

Signature, Date

By signing above, the signatories verify that they understand and concur with the information, procedures, and recommendations presented herein

Sampling and Analysis Plan (Final)

Great Kills Park Site, Operable Unit 1 Remedial Investigation
Gateway National Recreation Area, New York
National Park Service

Document Date: April 22, 2016

Prepared by: AECOM-TIDEWATER INC. JOINT VENTURE (AECOM-TIDEWATER JV)
3101 Wilson Blvd, Suite 900
Arlington, Virginia 22201

Preparation Date: April 22, 2016

AECOM-TIDEWATER JV Project Manager: Mark MacEwan
Mark MacEwan, P.E. — 22 April 2016 Date

AECOM-TIDEWATER JV Project Scientist:
Kurt VanGelder — 22 April 2016 Date

AECOM-TIDEWATER JV Technical QC: Ankit Gupta
Ankit Gupta — 22 April 2016 Date

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List of Abbreviations and Acronyms

˚C	degrees centigrade
%R	percent recovery
µCi/ml	microcuries per milliliter
µg/L	micrograms per liter
ADR	Automated Data Review
ANSI	American National Standard Institute
APP	Accident Prevention Plan
ARS	ARS International, LLC
ATSDR	Agency for Toxic Substance and Disease Registry
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CD	compact disk
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CoC	Chain-of-Custody
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
cpm	counts per minute
CQCP	Contractor Quality Control Plan
CSM	Conceptual Site Model
DoD	Department of Defense
DOHMH	New York City Department of Health and Mental Hygiene
DPT	direct push technology
DQI	data quality indicator
DQO	data quality objective
DSNY	New York City Department of Sanitation
DU	Decision Unit
EE/CA	Engineering Evaluation and Cost Analysis
ELAP	Environmental Laboratory Accreditation Program
EPC	exposure point concentration
EPD	exposure pathway diagram
ERAGS	Ecological Risk Assessment Guidance for Superfund

ERV	Ecological Risk Values
ESV	Ecological Screening Value
FS	Feasibility Study
FSP	Field Sampling Plan
Gateway	Gateway National Recreation Area
GIS	Geographic Information System
GKP	Great Kills Park
GWS	Gamma Walkover Survey
HASL	Health and Safety Laboratory
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHRA	Human Health Risk Assessment
HSA	Historical Site Assessment
ID	Sample Identification
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigative-derived waste
ISM	Incremental Sampling Methodology
IRA	Interim Response Action
IRMA	Integrated Resource Management Application
JV	Joint Venture
LCS	Laboratory Control Samples
LOAEL	lowest-observed-adverse-effect-level
LOP	line of protection
LOQ	Level of Quantitation
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
m	meter
mg/L	milligrams per liter
mrem	millirem
mR/hr	Milliroentgens per hour
mS/cm	milliSiemens per centimeter
m/s	meter/second
MS/MSD	matrix spike / matrix spike duplicate
mV	millivolts
NaI	sodium iodide

NCP	National Oil and Hazardous Substances Pollution Contingency Plan (AKA, National Contingency Plan)
NOAEL	no-observed-adverse-effect-level
NPS	National Park Service
NRC	Nuclear Regulatory Commission
NTU	nephelometric turbidity unit
NYCDEP	New York City Department of Environmental Protection
NYPD	New York City Police Department
OU	Operable Unit
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
PCE	tetrachloroethene
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PID	photoionization detector
PM	Project Manager
PPE	Personal Protective Equipment
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
^{226}Ra	Radium-226
RAP	Radiological Assistance Program
RI	Remedial Investigation
RAGS	Risk Assessment Guidance for Superfund
RI/FS	Remedial Investigation/Feasibility Study
ROPC	Radionuclide of Potential Concern
ROPEC	Radionuclide of Potential Ecological Concern
RPD	relative percent difference
RPP	Radiation Protection Plan
RS	Records Search
RSD	relative standard deviation
RSL	Regional Screening Level

RWP	Radiation Work Permit
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SEDD	Staged Electronic Data Deliverable
SOP	standard operating procedure
SRSL	Site Radiation Safety Lead
SSHO	Site Safety and Health Officer
SSHP	Site-Specific Safety and Health Plan
SSUPT	Site Superintendent
SU	Sampling Unit
SUF	Site Use Factor
SVOC	semi-volatile organic compound
TCRA	Time-Critical Removal Action
TOC	total organic carbon
^{232}Th	Thorium-232
U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
U_{nat}	Natural uranium
^{234}U	Uranium-234
^{235}U	Uranium-235
^{238}U	Uranium-238
VOC	volatile organic compound
WP	Work Plan
WPCP	Water Pollution Control Plant

1 Introduction

This Sampling and Analysis Plan (SAP) has been developed for the Remedial Investigation (RI) of Operable Unit 1 (OU1) comprising approximately 43 acres within the larger 523-acre Great Kills Park (GKP) located on Staten Island, NY. GKP is managed by the National Park Service (NPS) as a part of the Staten Island Unit of Gateway National Recreation Area (Gateway) (Figure 1-1). Radionuclides of potential concern (ROPCs) and contaminants of potential concern (COPCs) may be present, as indicated by the results from the 2015 Time Critical Response Action (TCRA) undertaken by the NPS, within a 265-acre waste filled area of GKP, known as the GKP Site. Waste fill at the GKP Site includes: sanitation fill, hydraulic fill, sewage sludge, and digested sludge. The potential contamination may be a result of the historical disposal of sanitation fill (incinerator residue, wood, glass, metal, food refuse, street sweepings and excavation and construction materials) from 1944 – 1948 by the New York City Department of Sanitation (DSNY) at the 265-acre GKP Site.

Parts of the 265-acre GKP Site also contain hydraulic fill from sediment dredged from Great Kills Harbor anchorage area and channel and placed historically by DSNY within the larger 523-acre GKP to provide firm foundations for park improvements including beach, boardwalk, bathhouse, game areas, parking fields, picnic groves, roadways, walks and landscaped areas. The 265-acre GKP Site also contains sludge reclaimed from New York City (City) sewage, which was historically mixed with clay and used within the larger 523-acre GKP to amend the surface areas underlain by hydraulic and sanitation fill to create artificial top soil. Lastly, a part of the 265-acre GKP Site also contains sludge impoundments historically used to dispose digested sludge by the adjacent Oakwood Beach Water Pollution Control Plant (WPCP).

On behalf of the NPS, AECOM-TIDEWATER INC. JOINT VENTURE (AECOM-TIDEWATER JV) has been contracted by the United States (U.S.) Army Corps of Engineers (USACE), under Contract No. W912DR-13-D-0016, Delivery Order 0003, to conduct the Remedial Investigation/Feasibility Study (RI/FS) of the GKP Site, which includes both OU1 and OU2, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). NPS is exercising its authority as lead agency under CERCLA to undertake the OU1 RI. AECOM-TIDEWATER JV is providing support for the development of planning documents to support the RI/FS at OU1.

OU1 is a 43-acre parcel situated within and along the northeastern perimeter of the 265-acre GKP Site and contains native soils and sediments in addition to: sanitation fill, hydraulic fill, sewage sludge and the digested sludge impoundments. OU1 is being investigated to provide information related to releases or threats of releases of hazardous substances that may pose a risk to human health or the environment and to assess possible contamination associated with the waste filled area at OU1 prior to construction of the Civil Works buried seawall LOP. The OU1 RI will determine the nature and extent of the hazardous substances released, at or from the waste filled area and that are present within OU1. In addition, the OU1 RI will assess risk to human and ecological receptors from the exposure to identified contaminants. The OU1 RI will also be used to make decisions regarding potential response actions.

With respect to potential contamination at the GKP Site, an aerial radiological survey of the City and surrounding areas was conducted in 2005 by the U.S Department of Energy at the request of the New York City Police Department (NYPD) for the purposes of developing a background radiation survey to assist in identifying areas with elevated radioactivity (GAO, 2006). During the survey, elevated radiation readings

were identified at the GKP Site, which resulted in a series of CERCLA response actions conducted by NPS over the past 10 years (2005–2015). These are summarized in Section 2.2. Based on the recently completed Time Critical Removal Action (TCRA), several ROPCs were identified in discrete locations in the waste fill at the GKP Site (TCRA, 2015). The identified ROPCs included radium-226 (^{226}Ra), thorium-232 (^{232}Th), and U_{nat}, consisting of uranium-238 (^{238}U), uranium-235 (^{235}U), and uranium-234 (^{234}U), including their progeny. To date, the U_{nat} appears to be from natural ore (based upon the isotopic ratios of previous samples) and thus, is assumed to be in equilibrium with its progeny. The identified radiological sources have included radioluminescent markers (e.g., personal and deck markers), radiotherapy medical devices (e.g., needles), a paint jar with radium paint residue, radium in incinerator ash, and uranium in soil/fill.

The primary objectives of the OU1 RI are to:

- Conduct activities including: gathering and reviewing existing GKP Site data and identifying the vertical and horizontal extent of the waste filled area within OU1 and to the north-northeast, if necessary. Information obtained from the Historical Site Assessment/Records Search (HSA/RS) being conducted as part of the investigation activities for the GKP Site will support the OU1 RI.
- Prepare project work plans including this sampling and analysis plan consisting of a field sampling plan (FSP) and a quality assurance project plan (QAPP). In addition to this SAP, Site-Wide health and safety plans have been prepared to support the field investigations for the GKP Site, including OU1. These Site-Wide plans include the Accident Prevention Plan (APP), Site-Specific Health and Safety Plan (SSHP), and Radiation Protection Plan (RPP).
- Conduct field investigation to determine the nature and extent of the hazardous substances released at or from OU1and assess risk to human and ecological receptors from exposure to contaminants.
- Ensure the public has appropriate opportunities to learn about the GKP Site and involvement in GKP Site-related decisions including selection of a remedy.

1.1 CERCLA and National Park Service Authority

This SAP was generated in accordance with the NPS SAP template (NPS 2014a), United States Environmental Protection Agency's (USEPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA 2006a), *Guidance for Quality Assurance Project Plans* (USEPA 2002a), *EPA Requirements for Quality Assurance Project Plans* (USEPA 2001), and the *Intergovernmental Data Quality Task Force's (IDQTF) Uniform Federal Policy for Quality Assurance Project Plans* (IDQTF 2005). NPS is authorized under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §§ 9601 *et seq.*, to respond as the Lead Agency to a release or threatened release of hazardous substances and/or a release or threatened release of any pollutant or contaminant that may present an imminent and substantial danger to public health or welfare on NPS-managed land.

CERCLA's implementing regulations, codified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Title 40 of the Code of Federal Regulations (CFR) Part 300, establish the framework for responding to releases and threatened releases of hazardous substances. The NCP prescribes two processes for responding to releases: removal actions and remedial actions (See NCP Sections 300.400 through 300.440). If environmental samples are to be collected under either process, a SAP is required (See

NCP Sections 300.415 and 300.430). This NPS SAP is comprised of multiple sections which include the Field Sampling Plan (FSP - Section 5) and the Quality Assurance Project Plan (QAPP - Sections 2, 3, 4, 6, and 7). The FSP describes the number, types, and locations of samples as well as the types of analyses that will be conducted on the samples. The QAPP describes the project's policy, organization, and functional activities as well as the DQOs and measures necessary to achieve the goals of the study.

In addition, the NPS has a number of regulations that apply to the release of hazardous substances on NPS-managed land (see NPS 2014b), including the NPS Organic Act of 1916 (16 U.S.C. §1, et seq. 36 CFR Part 1), which requires that the NPS manage parks to conserve the scenery, natural and historic objects, and wildlife and to provide for their enjoyment by such means as will leave them unimpaired for the enjoyment of future generations. Therefore, whether the GKP Site poses risks to the interaction of organisms and the environment is especially relevant to the NPS responsibility to protect park resources.

To the extent practicable, all work will be conducted in accordance with the USEPA guidance, *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites* (USEPA 2008).

1.2 Purpose of Field Sampling

The purpose of this sampling event is to determine the nature and extent of the hazardous substances released at or from OU1. The NPS will use data collected during this field investigation to support potential response actions that may be undertaken by the NPS in OU1. This SAP presents the following steps,

- Step 1: Delineate/verify the vertical and horizontal extent of the waste filled area in OU1.
- Step 2: Identify the presence of ROPCs and COPCs within OU1 through the collection and analysis of environmental data from surface soil, subsurface soil, sediment, groundwater, and surface water.
- Step 3: Identify the extent of surface and subsurface contamination for use in the human health and ecological risk assessment.
- Step 4: Collect and analyze shallow and deep groundwater samples for inputs into the RI risk assessments.

1.3 Site Location

GKP is located at the intersection of Buffalo Street and Hylan Boulevard, Staten Island, NY 10306 and was included within Gateway in 1972. Site coordinates are approximately 40º33'01.66"N and 74º07'37.67"W for the center of the park and 40º33'23.97"N and 74º08'36.37"W for the entrance to the park at Buffalo Street and Hylan Boulevard. OU1 is comprised of a 43-acre parcel of GKP located along the northeastern perimeter of the GKP Site (Figure 2-1).

2 Site Description, Previous Investigations, and Conceptual Site Model

This section presents background information regarding the GKP Site and OU1 location and history; summary of GKP Site and OU1 features, including geology and hydrogeology; summary of previous environmental investigations and associated activities conducted at the GKP Site from 2005 to June 2015; the supporting regulatory guidance; and the purpose and objectives of this OU1 RI. The GKP Site features, including the OU1 location and features are illustrated on **Figure 2-1**.

2.1 Key Site Features

This section includes a detailed discussion relating to the GKP Site and OU1's geographical, historical, and geological setting.

2.1.1 Site Description

GKP consists of approximately 523 acres in the vicinity of the Raritan and Lower New York Bays and the Great Kills Harbor, in the borough of Staten Island (**Figure 1-1**). GKP is part of the Staten Island Unit, which is one of three park Units—the Jamaica Bay Unit in Brooklyn and Queens Counties, the Staten Island Unit, and the Sandy Hook Unit (northern shore of New Jersey)—that comprise the Gateway National Recreation Area, a 26,607-acre National Recreation Area in the New York and New Jersey metropolitan area. The Staten Island Unit, which is located on the southeast shore of Staten Island within Lower New York Bay and Raritan Bay, includes five National Park areas: 1) GKP, 2) Fort Wadsworth, 3) Miller Field, 4) Hoffman Island (no public access) and 5) Swinburne Island (no public access).

ROPCs and COPCs may be present within a 265-acre waste filled area of GKP, known as the GKP Site, as a result of the historical placement of sanitation fill (incinerator residue, wood, glass, metal, food refuse, street sweepings and excavation and construction materials). Parts of GKP Site also contain hydraulic fill (sediment dredged from Great Kills Harbor anchorage area and channel), sludge from City sewage and digested sludge from adjacent Oakwood Beach WPCP. Based on the recently completed TCRA, several ROPCs including radium-226 (^{226}Ra), thorium-232, (^{232}Th) and U_{nat}, consisting of uranium-238 (^{238}U), uranium-235 (^{235}U), and uranium-234 (^{234}U), including their progeny were identified in discrete locations at the 265-acre GKP Site (TCRA, 2015).

OU1 encompasses 43 acres and is located along the northeastern perimeter of the GKP Site. OU1 is bounded by: the GKP and Buffalo Street to the south; Hylan Boulevard to the west; residential properties to the north, (located on Chersterton Avenue, Greyson Street, and Brook Avenue); residential properties (located on Lynn Street, Aviston Street, Riga Street, and Mill Road), the Oakwood Beach WPCP and Raritan Bay to the east. OU1 location and site features are illustrated on **Figure 2-2**.

OU1 is located within the lower portion of Oakwood Beach Watershed, which covers approximately 1,329 acres (Ney York City Department of Environmental Protection [NYCDEP], 2013). The Oakwood Beach Watershed includes the NYCDEP Bluebelt property, which consists of two similarly sized parcels of which one is almost entirely located to the east of OU1. OU1 has a consistently low elevation, within 5 feet or less of sea level (NYCDEP, 2013).

2.1.2 Operational History

The plan for the Marine Park (a.k.a. GKP)[1] originated in 1925 and was amended several times (over the next 10 years) while City acquired the GKP property including the upland and land under water. In 1927-28, New York State conveyed to the City approximately 529 acres of land under water, which would be assigned to the City once it acquired the adjacent upland. Between 1929 and 1930, the City acquired 18 parcels involving over 290 acres of upland. In 1936, the City acquired an additional 94 acres of privately owned land (upland) on Oakwood Point. The 94 acres acquisition was necessary to close the water gap between Crookes Point and Oakwood Point on the mainland (New York City Department of Parks, 1936). A portion of the acquired property by City includes the 47 acres parcel owned by the City and the Oakwood Beach WPCP, which are part of, and adjacent to the OU1.

In 1926, the City constructed an incinerator, known as the Bay Terrace Incinerator, on an approximately 14-acre parcel located in the central portion of the GKP Site. The former access road for the Bay Terrace Incinerator intersected Hylan Boulevard (from the east) at approximately the same location where Bay Terrace Avenue intersects (today) Hylan Boulevard from the west. The incinerator was formerly described as being located east of Hylan Boulevard and south of Baldwin Avenue (Block 5065 Lots 98 and 100) on an irregularly shaped area consisting of 14.9 acres (New York City, 1948). The Bay Terrace Incinerator consisted of two buildings, a "Private Garage" and "Burner House" (Sanborn Fire Insurance Map, 1937). The Private Garage consisted of a one to two story-building with several areas including truck storage (20 trucks), locker room, auto-repair, and boiler room areas. A coal boiler provided steam for heating the garage. A stove provided heat for the auto repair area. There was also a gasoline tank associated with the garage. The Burner House consisted of a three story building with ramp to a second story entryway and circular brick chimney. An April 28, 1941 Press Release from the New York City Department of Parks indicates that the City had a plan for filling the park including the area occupied by the abandoned incinerator. This suggests the incinerator was not in operation in 1941. On October 11, 1946, the DSNY surrendered the incinerator property as it was no longer required for sanitation purposes and on March 24, 1948 the New York City Planning Commission recommended the assignment of the property to the New York City Department of Parks (New York City, 1948).

In 1933, under the direction and administration of the Commissioner of the New York City Department of Parks, the City initiated the Marine Park Project to develop the Great Kills Harbor and vicinity as a shorefront recreation area. In conjunction with the Marine Park Project, the DSNY disposed over 15 million cubic yards of sanitation fill in GKP Site (a.k.a. waste filled area) between November of 1944 and July of 1948 (New York City Department of Parks, 1949). The sanitation fill included a heterogeneous mixture of ashes (incinerator waste), wood, paper, glass, metal, food refuse, sand, straw, street sweepings (e.g., leaves, branches, dust and soil), and excavation and construction materials (DSNY, 1941). Note there was no distinction between hazardous waste or solid waste at the time. The sanitation fill was then capped with clay and sludge reclaimed from City sewage (Wrenn, Tony, P., 1975; Michael Baker, 2007; and Tidewater, 2015). The sanitation fill extends into the 47-acre City Property and up to the boundary of the City property, which are part of the OU1.

[1] Starting in the May 3, 1943 press release, the Marine Park name changes to Great Kills Park. The name Great Kills Park is referenced with Marine Park in parentheses apparently to avoid confusion with the Marine Park in Brooklyn, New York.

In addition to the sanitation fill, DSNY placed over 5.0 million cubic yards of hydraulic fill from 1934 through 1951 in the area from Crookes Point towards the northeast parallel and along what is today GKP beach and bulkhead. The hydraulic fill consisted of sediment (graded sand) dredged by the City and USACE from Great Kills Harbor anchorage area and channel. The placement of hydraulic fill expanded into the GKP Site as the bulkhead curves to the northwest approximately 2,000 feet and extended parallel along the beach to the City property boundary to the northeast (Dallas, 2013 and New York City Department of Parks, 1947d). A portion of the hydraulic fill was placed in a "curvilinear" narrow band beneath, what is today, the GKP utility corridor along Buffalo Street up to Hylan Boulevard (New York City, 1947a, b, c). The City and USACE dredged the hydraulic fill from Great Kills Harbor anchorage area and channel (New York City, 1943 a, b, c). The hydraulic fill extends into OU1 near Buffalo Road and in the tidal marsh area south-west of the Oakwood Beach WPCP.

After completing landfill operations at the waste filled area, the City opened GKP in 1949 (New York City Department of Parks, 1949) (1949 was a limited opening – fully opened in 1952 [New York City Department of Park, 1952]). City operated GKP as a city park until the property was transferred to the United States in 1972 and became part of the Staten Island Unit of Gateway under the jurisdiction of NPS. The records search concerning operational history subsequent to 1972 is ongoing and will be provided in a separate document (Historical Site Assessment/Records Search/Preliminary Assessment). A summary of these findings will be included in the RI Report.

Currently, GKP maintains and operates several recreational facilities for members of the public, including but not limited to, a beach house, hiking and biking trails, fishing areas, boat launch ramp, and associated parking areas. Swimming beaches are located along the southeastern and southwestern portions of GKP. A marina is located at the western side of GKP. Overall, annual visitation at GKP had been approximately 155,000 visitors prior to the discovery of radiological contamination. Great Kills' NPS Park Rangers led an average of 120 programs including 55 school groups for 6,550 participants (3,360 children).

As a part of a previous CERCLA response action, NPS installed 4-foot tall fencing along roadways along the perimeter of the waste filled area and installed three gates at various access points to preclude entry. Warning signs stating "Danger Hazardous Area" were posted every 25 feet on the fence line to notify the public of potential risks associated with GKP Site.

Approximately 330 species of birds have been observed throughout Gateway. The location of GKP along the Atlantic flyway at the base of the Hudson corridor makes it a significant site for migratory species in particular. A number of other animal species inhabit Gateway as well, including approximately 27 species of mammals, and 25 species of reptiles and amphibians.

The Oakwood Beach WPCP located adjacent to the northeast border of GKP was constructed in 1954-55, commenced operations in 1956 and had a capacity of 15 MGD. The WPCP discharged its digested sludge to an area within OU1 (sludge impoundments) adjacent to the plant until 1969 (New York City, 1969). The remnants of these impoundments are visible on **Figure 2-2**. The practice of discharging digested sludge was then discontinued and the impoundments were taken out of service sometime after 1969. Shortly after 1969, an 8-foot diameter interceptor was constructed and the plant was upgraded to manage and treat the increase in sanitary effluent (40 MGD) due to Staten Island's growing population. The interceptor traverses beneath the GKP Site and a minor portion of the OU1from Fairlawn Avenue in the west to the Oakwood WPCP in the east.

2.1.3 Waste Characteristics

GKP was a major project in City's waterfront development and reclamation program and was patterned after Jones Beach on Long Island and Orchard Beach in the Bronx (New York City Department of Parks, 1952). Land reclamation activities at GKP included the use of sanitation fill to fill the former salt swamp marshland, infested by mosquitoes and harboring rats (New York City Department of Parks, 1949), hydraulic fill to replenish the beach between Crookes Point and the mainland, and City sewage sludge to amend the waste fill to create artificial soil to support vegetative growth. The following describes the use of sanitation fill, hydraulic fill, and City sewage sludge including the timing, volumes, sources, and character.

An incinerator, called the Bay Terrace Incinerator, was constructed on the central portion of GKP in 1926 (Sanborn, 1937), and was operational from the mid-1930s through the early 1940s until it was abandoned in 1941. The north-central portion of the GKP Site, surrounded the former Bay Terrace Incinerator, received incinerator residue/sanitation fill throughout its operational duration from the mid-1930s until 1941. The 1940 aerial photograph and 1943 (revised from 1936) GKP contract drawings involving dredging and filling confirm the suspected sanitation fill around the former Bay Terrace Incinerator. Another period of substantial disposal of sanitation fill by DSNY occurred from 1944 through 1948. Based on DSNY Annual Reports from 1946, 1947, and 1948 and a statistical summary in 1949, approximately 15 million cubic yards of sanitation fill were disposed at the GKP Site during the five-year period between 1944 and 1948. Approximately 2.0 million cubic yards of sanitation fill were disposed in 1944 and 1945; 5.4 million cubic yards were disposed in 1946; 5.1 million cubic yards were disposed in 1947; and 2.5 million cubic yards were disposed in 1948.

The DSNY reported that it used standard landfill engineering methods at all department reclamation projects. These methods included dumping waste material and pushing the waste by bulldozers and using a flusher truck to spray the waste with disinfectant. The waste was covered with successive layers of clean sand and cinders to seal in gases and odors. Compacting and grading of the waste filled area completed the operation. The City reported that it used a chemical disinfectant having a base of orthodichloro-benzene and that it mixed 7.5 gallons of chemical with 1,000 gallons of water (DSNY, 1949).

The source of the sanitation fill included trucked refuse, road sweepings, incinerator residue (from 11 city destructors a.k.a. incinerators) from Staten Island and the other boroughs of the City. A survey of landfill characteristics for five City landfills (e.g., Bay Chester, Canarsie, Fairfield, Floyd Bennett, and Rikers Island) was published in 1941. The survey found that the waste in these five landfills (and likely at GKP Site) consisted of a heterogeneous mixture of ashes, wood, paper, glass, metal, food refuse, sand, straw, street sweepings (e.g., leaves, branches, dust and soil), and excavation and construction materials (DSNY, 1941). Other items encountered in the waste included clothing, shoes, large cartons, boxes and pack cases. The survey also found that the amount of the waste materials varied seasonally and ash comprised the largest percentage (by both, volume and weight) during the fall, winter and spring months. The next largest categories of waste materials involved paper followed by food refuse and glass. Metal, wood, and miscellaneous waste materials had lower volume/weight percentages. Included with the metals category were items such as bedsprings, stoves, tabletops, plumbing fixtures and tin cans (DSNY, 1941). **Table 2-1** below summarizes the ranges in percentages (volume and weight) and averages for waste materials identified in the five landfills.

Table 2-1: Summary of Waste Fill Material (Percentage per Month) in Five City Landfills

Classification	Range (Average) of Monthly Percentage by Volume	Range (Average) of Monthly Percentage by Weight
Ashes	9.2 to 45.2 (24)	7.8 to 80 (43)
Glass	7.6 to 13.2 (11)	1.9 to 9.1 (6)
Metal	1.8 to 4.8 (3)	3.1 to 11.6 (7)
Wood	0.1 to 8.4 (4)	0.3 to 5.9 (3)
Paper	37.4 to 52.5 (46)	9.0 to 37.6 (22)
Misc	1.1 to 9.3 (4)	0.8 to 7.4 (3)
Food	6 to 14.3 (8)	3.5 to 43.8 (17)

The sanitation fill was disposed of at the GKP Site by the DSNY northwest of the hydraulic fill and the bulkhead and extends north-west approximately to the drainage ditch that parallels Hylan Boulevard principally in the northwest quadrant of the GKP Site (Sidney M. Johnson and Associates, 1985). The sanitation fill underlies the highest elevation at GKP Site at about 35 feet above mean sea level (USGS, 1981Arthur Kill, New York, 7.5 Minute Quadrangle Topographic Map). In addition, the sanitation fill was disposed northeast of Buffalo Street, extending approximately to the City property boundary along the edge of the residential community to the northeast.

With respect to the hydraulic fill, **Table 2-2** below summarizes the locations where USACE placed the hydraulic fill and associated dredging time period and dredged amount. Over 1.5 million cubic yards of hydraulic fill were placed by USACE along the beach, bulkhead, and utility corridor between the period of 1934 and 1948 (14 years). The hydraulic fill was used to provide firm foundations for improvements including beach, boardwalk, bathhouse, game areas, parking fields, picnic groves, roadways, walks and landscaped areas (New York City, 1947d). In 1951, the City placed additional hydraulic fill on the beach to improve swimming conditions at both high and low tides (New York City Department of Parks, 1949). This 1951 City dredge amount appears to be in addition to the 1.5 million cubic yards dredged by USACE. Based on the above, over 5.0 million cubic yards of hydraulic fill was used at GKP.

From 1955 to 1959, after the filling operations described above, approximately 213,000 cubic yards of clay were mixed with 285,000 cubic yards of sewage sludge and used to amend the surface areas underlain by hydraulic and sanitation fill to create artificial top soil (Wrenn, 1975). The New York City Department of Parks conducted a study regarding the costs of using artificial top soil made using sludge versus natural soil and found that the sludge amended soil could be produced in place at $1,600 per acre versus $4,500 per acre to buy natural soil (Scanlon, 1957).

After the discovery of the elevated radiation detections in 2005, NPS conducted a series of CERCLA response actions from 2005 through 2015. As a result, NPS identified several ROPCs in discrete locations in the waste filled area at GKP Site. The identified ROPCs included radium-226 (^{226}Ra), thorium-232 (^{232}Th), and U_{nat}, consisting of uranium-238 (^{238}U), uranium-235 (^{235}U), and uranium-234 (^{234}U), including their progeny (TCRA, 2015).

Table 2-2: Summary of Dredging Information for Great Kills Harbor Channel and Anchorage Area

Location	Date (Month and Year)	Volume (Cubic Yards)
Channel Entrance	12/1934 – 8/1935	271,408
Channel Entrance	12/1939	50,611
Channel and Anchorage Area	7/1941 – 2/1942	933,500
Channel and Anchorage Area	1943	27,876
Channel Entrance	1/1945 – 2/1945	62,516
Anchorage Area	6/1948	76,100
Anchorage Area	7/1948	93,712
Total		**1,515,723**

Source: NPS, 2013 and July 27, 2012 Email from Annette Baden, Assistant to the Freedom of Information Act Officer, USACE (Dallas, 2013)

To date, the U_{nat} appears to be from natural ore (based upon the isotopic ratios of previous samples) and thus is assumed to be in equilibrium with its progeny identified radiological sources included radio luminescent markers (e.g., personal and deck markers), radiotherapy medical devices (e.g., needles), a paint jar with radium paint residue, radium in incinerator ash, and uranium in soil/fill, with consideration of environmental transport factors (TCRA, 2015). The TCRA identified elevated radiological levels throughout the known waste filled area as shown on **Figure 2-3.**

Besides the ROPCs, there is very little data regarding other COPCs. Given this data, sampling of environmental media at the GKP Site and OU1 will include a wide array of analyses to determine presence of COPCs and to help determine any necessary response action. A previous investigation (Johnson 1985) indicated there were no chemicals detected above regulatory limits within the three soil samples collected. However, toluene (4.8 micrograms per liter [µg/L]; 7.4 µg/L; 20.3 µg/L) and tetrachloroethene (9.1 µg/L; 4.8 µg/L; 3.3 µg/L) were detected in 3 of the 4 groundwater water samples; and associated equipment blank tested positive for both of these chemicals and therefore the results were discarded/discounted due to suspected cross-contamination. The samples were collected near Great Kills Harbor and were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyl (PCBs), and metals.

2.1.4 Site Geology and Hydrogeology

The GKP Site and OU1 are located with the Atlantic Coastal Plain Physiographic Province. The surficial geology of the GKP Site primarily consists of artificial fill comprised of two types: 1) hydraulic fill; and 2) sanitation fill and overlain by artificial top soil made by clay mixed with sewage sludge. The artificial fill overlies Holocene deposits comprised of dark grey silty-clay to clayey-silt with sand lenses, overlying the glacial outwash deposits, followed by the Raritan Formation and the Staten Island Serpentine and Manhattan Schist. Information regarding the regional geology and GKP site-specific geology is

summarized below in **Table 2-3**. This information was obtained from Perlmutter, 1953, Soren, 1988, and Rosenbery 2013, as well as from on-site geotechnical investigations including: Sidney M. Johnson and Associates, 1985, Mueser Rutledge Consulting Engineers, 1991; French & Parrello Associates, PA.1993; and French & Parrello Associates, PA. 1998.

Table 2-3: Summary of Regional and Site Specific Geologic Rock Units[2]

Age (Harland, 1982)	Regional Geology (Unit and Description)	Site Geology (Unit and Description)
Recent	Artificial fill. Up to 30 feet thick or more.	Sanitation fill, consists of brown to black heterogeneous mixture of highly decomposed waste consisting of incinerator residue (cinder-like material), coal ash, and organic material with scattered glass, metal, rubber, and wood debris. Hydraulic fill consists of graded gray to brown sand. Thickness ranges 5 to 25 feet with an average thickness of 15 feet. Sewage sludge was mixed with clay to create artificial soil overlying the sanitation and hydraulic fill.
Holocene 10,000 years to present	Beach deposits consisting of brown sand and marsh/estuarine deposits consisting of plastic dark grey silty clay to clayey silt with organics. Approximately 10 feet thick.	Marsh/estuarine deposits (plastic dark grey silty clay to clayey silt with organics). Thickness ranges from 2 to 17.5 feet with an average thickness of 7 feet. Deposit ranges in depth from 5 to 25 feet below ground surface (bgs) but typically is 15 feet bgs.
Pleistocene 3 Ma to 10,000 years	Outwash consisting of melt water deposited stratified fine to coarse sand and gravel. Maximum thickness is 95 f85eet.	Outwash consisting melt water deposited stratified fine to coarse sand and gravel. Highly permeable. Thickness ranges from 16 to 22.5 feet with an average thickness of 17.6 feet. Deposit ranges in depth from 13 to 28.5 feet bgs but typically is 21.7 feet bgs.

[2] Sources used to compile geologic unit information include: Perlmutter, 1953; Soren, 1988; Rosenberg, 2013; Mueser Rutledge Consulting Engineers, 1991; French & Parrello Associates, PA.1993; and French & Parrello Associates, PA. 1998.

Age (Harland, 1982)	Regional Geology (Unit and Description)	Site Geology (Unit and Description)
	Terminal Moraine consisting of ice deposited and melt-water reworked poorly sorted sand, gravel, cobbles, and boulders in a clay-silt matrix. Ranges in thickness from 75 to approximately 200 feet thick.	Not Present.
	Ground Moraine consisting of ice deposited reddish-brown clayey till. Ranges in thickness to over 150 feet thick.	Not Present.
Upper Cretaceous 85 Ma to 65 Ma.	Raritan Formation consisting of stratified white, light to dark gray and red, beds and lenses of clay, silt, and sand with common zones of lignite and pyrite. Ranges from 100 feet thick to over 400 feet thick. When subdivided the Raritan Formation consist of upper Raritan Clay underlain by a Lower Sand.	Raritan Formation Undivided – The "mostly clayey formation" consists of a varicolored interbedded brown to tan to light grey to white medium to fine sand (with trace of silt) with a clayey silt (with mica). The top of the Raritan Formation occurs at 35 to 90 feet bgs and ranges in thickness from 230 to over 300 feet thick beneath GKP.
	Raritan Clay Lower Sand Unit consisting of varicolored gray, white and red fine to coarse sand.	The Raritan Formation at GKP appears undivided and the lower sand does not appear to be present (Soren, 1988).
Upper Triassic to Lower Jurassic 231 Ma to 188 Ma	Palisade Diabase Sill consisting of dark grey sill igneous intrusion.	Not Present.
	Newark Supergroup consisting of reddish brown medium to coarse sandstone and shale.	Not Present.
Upper Proterozoic (PreCambrian to Cambrian) >590 Ma	Staten Island Serpentine - greenish-brown metamorphic ultramafic crystalline rock.	Staten Island Serpentine – greenish brown metamorphic ultramafic crystalline rock. Present in northeast corner of GKP near intersection of Buffalo Street and Hylan Road. Present at a depth of approximately 270 feet below MSL.
	Manhattan Schist consisting of dark-gray micaceous metamorphic rock.	Manhattan Schist consisting of dark-gray micaceous metamorphic rock. Present at a depth of over 300 feet below MSL.

The hydraulic conductivities for the Staten Island aquifer units are presented in **Table 2-4.** The Ground and Terminal Moraine units are not encountered below the GKP Site. The upper glacial outwash aquifer unit thus is the primary permeable unit underlying the GKP Site through which potential groundwater contamination may migrate. The groundwater within this highly permeable glacial outwash is typically unconfined and the hydraulic conductivity is shown in **Table 2-4**. The glacial outwash deposit has a specific capacity ranging from 50 to 100 gallons per minute per foot of drawdown (Soren, 1988). The upper glacial outwash aquifer unit is underlain at the GKP Site by the Raritan Clay, which acts as an aquitard to potential groundwater migration vertically downwards into the deeper aquifers.

Table 2-4: Summary of Hydraulic Conductivities for Staten Island, New York Aquifers[3]

Aquifer Unit	Horizontal Conductivity	Vertical Conductivity
Upper Glacial Till (Ground Moraine and Terminal Moraine	0.01 to 0.16 feet per day	0.001 to 0.008 feet per day
Upper Glacial Outwash	270 feet per day	27 feet per day
Raritan Clay	Not Available	0.001 feet per day
Lower Sand (Raritan) (Lloyd Aquifer)	40 feet per day	5 feet per day
Bedrock (Staten Island Serpentine and Manhattan Schist)	Less than 0.1 to 10 feet per day.	Highly variable

Due to limited investigation, there is very little information concerning the groundwater quality and characteristics within GKP Site and OU1. Based on site investigations (soil borings) conducted in 1985, 1991, 1993 and 1998, the shallow unconfined groundwater table was encountered at 0.5 feet bgs to 10 feet bgs with an average depth of 4.5 feet bgs. The elevation of the shallow unconfined groundwater table ranged from -1.3 feet above MSL to 13.38 feet above MSL with an average elevation of 7.3 feet above MSL. Based on surface topography of the GKP, the groundwater flows from the north-west boundary of the GKP to the southeast towards the Raritan Bay coastline and GKP harbor (USGS, 2013). During the filling of the GKP, the City noted that certain portions of the waste filled area were always muddy due to shallow groundwater and underground springs. The presence of the springs and mud slowed fill hauling operations (City Department of Parks, 1949). Since the GKP Site and OU1 are located adjacent to and surrounded by the Great Kills Harbor and Raritan Bay, the saline/freshwater interface likely occurs along the shoreline and extends landward at various depths into the shallow Holocene deposits, Glacial Outwash deposit, and Raritan Formation. The groundwater within the GKP Site and OU1 flows through the glacial outwash deposits and discharges into the Great Kills Harbor and Raritan Bay along the saline/freshwater interface via the process of Submarine Groundwater Discharge.

[3] Hydraulic Conductivity data for Upper Till and Glacial Outwash Deposit is from Soren1988. Hydraulic Conductivity data for the Raritan Clay and Lower Sand/Lloyd Aquifer is from Stumm et al 2004.

Since 1971, all of the public water supply for Staten Island has been provided by the New York State surface reservoir system. While Staten Island groundwater is not used for potable water supply, it is used as a source for certain other uses including irrigation, swimming pools, and automobile uses. These uses are restricted from using municipal supplied potable water (Soren, 1988). Based on a recent search of New State Department of Environmental Conservation (NYSDEC) water withdrawal data, there are four water withdrawal wells located on Staten Island. These are: 1) Silver Lake Golf Course located 4.8 miles north of GKP; 2) Richmond County Country Club located 2.4 miles north of GKP; 3) Arthur Kill Generating Station located 4.2 miles northwest of GKP; and 4) South Shore Country Club located 4 miles west of GKP. These water withdrawals are located on the "other/opposite side" of the groundwater water divide from GKP in a separate groundwater basin. There are no water withdrawals mapped in the groundwater basin shared by GKP and OU1 as defined by the groundwater divide mapped by Soren (1988).

2.1.5 Site Hydrology

Two small surface water features are surrounded by land in GKP. First, a small unnamed stream and a tributary run through the northeastern extent of GKP within OU1. This stream empties into the Raritan Bay, and the areas around it are marshy with soft ground surfaces. Parts of this area are under 1 inch or more of standing water. This stream has a tributary stream joining it running roughly to the west of the wastewater treatment plant. The main stream is approximately 50 feet wide, and the tributary is 20 feet wide. Both flow through the swampy northeastern section of the GKP, which includes several areas of shallow ponded water. Second, a small constructed pond, approximately 145 square feet in surface area, is located near the NPS Education Field Station in the central part of the GKP. This pond is reportedly lined with concrete, and therefore manmade. These surface water features are illustrated in Figure 2-1.

The area closest to Great Kills Harbor and the Raritan Bay is composed of sandy beach vegetation. This includes low-level brush, small trees, and phragmites. In the northwestern and northern tip areas of the GKP, the land is more representative of local temperate forests found throughout wooded areas surrounding the City. The central area has vegetation similar to a transition zone between coastal and inland areas; it also has experienced a great deal of management of recreational fields.

The waters in and around GKP are often used for recreational activities. Great Kills Harbor features a boat launch and numerous anchored boats used primarily for recreational purposes. There are two year-round boating docks, with one attached to GKP and the Great Kills/Richmond County Yacht Club on the northern side of the harbor. Fishing areas run from Great Kills Harbor to the Raritan Bay area and attract numerous anglers year round. In addition, beaches are often co-located with fishing areas, and are used for sunbathing and swimming closer to the Great Kills Harbor. However, swimming areas are mainly restricted to beaches located south of the bay side of the harbor. The duck pond near the Education Field Station was used previously for educational purposes. No water in or around the park is used for drinking water.

GKP is used extensively for recreational purposes. A bike path runs along the road, which is frequently used for biking, jogging, walking, and other activities. Several grassy areas are used for recreational purposes, as areas for swing-sets or similar play areas designed for children. NPS historically allowed the facility to be used for environmental education, baseball/softball, athletics, and model airplanes; however, these activities no longer occur at the park because the NPS closed these sections of the park previously used for these public activities following the discovery of radiological contamination. In the northeastern area, the park is

in the floodplain of the unnamed stream and related tributary. Because of sea rise during storms, much of the beach and lower coastal area is in the floodplain of the Raritan Bay. During Hurricane Sandy in 2012, much of the park and the surrounding low-lying communities, particularly to the northeast, were flooded to some extent.

Based on Federal Emergency Management Agency flood maps, the GKP Site and OU1 are partially located within a Special Flood Hazard Area otherwise known as a 100-year floodplain. This area includes all low-lying areas in the proximity of GKP shores and east of Buffalo Street. Flood depth for areas northeast of Buffalo Street would be approximately 1 foot, and up to 3 feet in areas of ponding. The interior of GKP, northwest of Buffalo Street and south of Hylan Blvd, is located within a 500-year floodplain. This area has a flood depth of less than 1 foot along drainage pathways, and otherwise has no base flood depth listed. The entire area suffered flooding during Hurricane Sandy.

2.1.6 Local Climate

Under the Köppen climate classification, the area experiences a humid subtropical climate, while the area surrounding NYC sits in the humid continental zone. Winters are cold and damp, spring and autumn range from cold to warm, and summers typically are hot and humid. Summers can be impacted by the urban heat island, in which temperatures in an urban area tend to stay higher than the surrounding countryside due to entrapment of heat by the cityscape. Prevailing winds blow offshore (predominantly west to east), and tend to minimize warming effects from the Atlantic Ocean in summers. On average, the area receives 49.9 inches of rain per year, evenly spread throughout the year. In addition, the area may infrequently experience a tropical storm or hurricane seen during the stormy season from June 1 to November 30. Additionally, rain seeping through to groundwater may be impacted and could potentially impact larger surrounding water bodies as the groundwater flows towards them.

2.1.7 Sensitive Environments

The GKP Site, including the OU1 has several sensitive areas that could possibly be affected by environmental contaminants at GKP. These areas include tidal marshes, surface streams, coastal areas, adjacent oceanic inlet waters, and popular recreational areas. The northeastern area of the GKP includes large tidal marshes. Two streams run directly through and adjacent to the tidal marshes; one is a tributary to the other.

Coastal areas and adjoining waters, the Raritan Bay is located directly adjacent to OU1. Great Kills Harbor is located directly adjacent to the GKP Site to the southwest of OU1. The coastal areas are heavily used, as are the roads, biking areas, and playgrounds. These areas have a large cultural impact, especially the boating, fishing, exercise, and beach areas. Whether any of these areas are above the waste filled area is unknown; however, contaminants from the waste filled area may leach directly or indirectly into adjacent water bodies.

2.2 Summary of Previous Investigations

At the request of the Counter Terrorism Bureau of the New York City Police Department (NYPD), the U.S. Department of Energy (USDOE) conducted a 2005 aerial background radiation survey of the City metro

area for the purposes of developing a radiological baseline map (U.S. Government Accountability Office, 2006; Tidewater, 2015). During the survey, elevated radiation readings were identified at the GKP Site. In response to the aerial survey and its findings, from 2005 to 2015, NPS has acted as the lead agency under its delegated CERCLA authority and has implemented or overseen a series of response actions to investigate the nature of the radiological contamination and mitigate risk to human health and the environment. A chronological listing of previous investigations and activities is summarized below:[4]

- On August 2, 2005, the NYPD notified U.S. Environmental Protection Agency (USEPA) Region 2 that elevated gamma radiation levels were identified at the GKP Site. NYPD reported that the highest radiation reading was 1.5 milliroentgens per hour (mR/hr) located near a parking lot. (Baker, 2007).
- On August 3, 2005, USEPA conducted a ground radiological survey/assessment confirming that the "fire break" area had above-background, but relatively low-level, radiation readings. This survey also identified the source of the readings as radium-226. NPS further restricted access to the area by erecting a fence and allowing the area to re-vegetate (Baker, 2007; Tidewater, 2015).
- In November 2006, NPS and its contractor (Michael Baker, Jr., Inc.) initiated a CERCLA Preliminary Assessment (PA) for potential radiological contamination at the GKP Site (Tidewater, 2015).
- On March 6, 2007, while the PA was in progress, a brush fire occurred at the GKP Site (Baker, 2007). Following the fire, NPS surveyed the burned area on March 15, 2007 and detected elevated radiation readings (Baker, 2007: Tidewater, 2015). The NYPD was notified and responded with the USDOE Radiological Assistance Program (RAP) team. The highest gamma reading obtained by the RAP team was 0.2 mR/hr (Baker, 2007). On March 21, 2007, the City Department of Health and Mental Hygiene (DOHMH) conducted a survey and identified a hot spot just off the road leading to the model airplane field. Readings at contact at the grass were 10 mR/hr and 0.5 mR/hr at 1 meter over the spot. Natural background readings for the area are 0.01 mR/hr. (Baker, 2007).
- On March 30 and April 3, 2007, the DOHMH conducted a limited gamma radiological survey of the public access areas including the ball fields 1 through 5 and parking lot, model airplane field and parking lot, fishing area (Harbor Beach) and access road, hiking trail, Sewerline Road, Fire Road and the main Park access road (Buffalo Street). The survey confirmed the location of the three previously identified areas and identified two additional areas: south of ball field 1 and east of model airplane field parking lot. The DOHMH concluded that while the detected radiation levels were many times above background, the levels were reduced to background three feet from the source. The DOHMH recommended that a radiological contaminant assessment be conducted at the Site (Baker, 2007). As a result of DOHMH findings, NPS installed additional fencing to isolate the identified areas (Tidewater, 2015).
- On May 25, 2007, the U.S. Agency for Toxic Substance and Disease Registry (ATSDR) completed a Health Consultation and its evaluation of potential hazards to public health posed by

[4] The Site investigation information was previously presented in the June 2015, Final Great Kills Park Time Critical Removal Action, Completion Report, prepared by Tidewater.

the radiological contamination at GKP Site. The USEPA requested the ATSDR develop a public health statement based on existing data. The ATSDR concluded that the areas posed an "Indeterminate Public Health Hazard." ATSDR referred to its conclusions regarding past radiation exposures (for the areas of concern) as indeterminate because its conclusions were based on limited data and analyses. ATSDR also reported that past exposures were not expected to be a health hazard because the radioactivity readings "dropped" significantly three feet away from the peak readings, there was an unlikelihood that anyone would remain on any of the identified hot spots for an extended period of time (i.e., three hours or more), and the elevated readings were limited to five distinct areas (ATSDR, 2007; Tidewater, 2015).

- In August 2007, Michael Baker, Jr. Inc., on behalf of the NPS completed and issued its PA report. The PA concluded that the radiological contamination at the GKP Site appeared to be concentrated in five locations and comprised radium-226 and its decay products. It further concluded that the ROPCs identified were not likely to pose an immediate health risk to park users, because NPS closed public access to the five suspect areas with fencing. The PA recommended that the identified contaminated radiological material be removed and disposed of, with follow-up confirmatory screening, and that any future detections of radiological contamination be handled in a similar fashion (Baker, 2007; Tidewater, 2015).
- In January 2009, Cabrera Services on behalf of NPS conducted an Interim Response Action (IRA) consisting of additional radiological surveys and the removal of radiological materials. This action identified a total of fourteen hot spots. Seven of these hot spots were in the five areas previously identified and discussed above. The other seven areas were areas that had not been previously identified. Of the 14 areas, seven hot spots were prioritized for removal based on public accessibility and detected readings (e.g., highly accessible areas with the highest readings were prioritized over less accessible areas and/or those with lower readings). During excavation, two radium sources were recovered. Because of the discovery of these additional hot spots and the subsequent removal of two radium sources in public-use areas, NPS closed these areas to public access as well. As part of the IRA, a total of four drums of material were removed from the Site and disposed of at permitted and licensed facilities. One drum containing the two radium sources was disposed of at the U.S. Ecology facility (State of Washington Radioactive Materials License WN-I01902) in Richland, Washington. The three drums containing IDW were disposed at the Energy Solutions facility (State of Utah Radioactive Material License UT 2300249) in Clive, Utah. Cabrera Services completed the IRA and issued the subsequent report in November 2010 (Cabrera Services, 2010; Tidewater, 2015).
- On October 14, 2010, NPS issued an Approval Memorandum to conduct an Engineering Evaluation and Cost Analysis (EE/CA) at the GKP Site to evaluate non-time critical removal action alternatives (Tidewater, 2015).
- On February 2, 2012, NPS conducted fire protection activities, including cutting back vegetation in the area south of Wetland Road and east of Buffalo Street. The area was subsequently checked for radiation and three distinct hot spots were identified. Testing of the area by USACE confirmed the elevated readings and located a fourth elevated reading within the same area. The source of the radioactivity was identified as radium-226 (Tidewater, 2015).

- During June through August 2012, USACE at the request of NPS conducted a gamma walkover survey (GWS) of four additional areas including: 1) the multi-use path along Buffalo Road; 2) the trails around the Education Field Station; 3) the Bulkhead Road; and 4) the Bulkhead Road fishing area. No elevated readings were found and these public-use areas remain open (Tidewater, 2015).
- On July 31, 2012, NPS Northeast Regional Director signed an Action Memorandum approving the decision to conduct a TCRA at the GKP Site. The EE/CA, initiated per NPS October 14, 2010, Approval Memorandum, was put on hold to expedite the TCRA and the identification and removal of radioactive contamination, which posed an immediate risk to human health and the environment (Tidewater, 2015).
- In June 2015, Tidewater, Inc. produced a Final Great Kills Park TCRA Completion Report. Activities conducted as part of the TCRA involved clearing of brush, trees, and phragmites; installing security fencing along the perimeter of the waste filled area to prevent access; conducting drive-over and walk-over gamma surveys; installing 51 borings to delineate waste filled area; conducting a dose assessment for firefighters, park rangers/law enforcement officers, maintenance workers, nearby residents, and trespassers;, and the excavation and removal of "source areas" that exceeded a dose limit of 2 mR/hr. As a result of the TCRA, 25 drums of waste were generated, transported, and disposed of at permitted and licensed facilities. 24 of the 25 drums were disposed of at the U.S. Ecology facility in Grand View, Idaho and one drum was disposed of at the Energy Solutions facility in Clive, Utah (Tidewater, 2015).

2.2.1 Data Quality / Usability

This section presents the usability of previously collected data from GKP as evaluated against the five USEPA general assessment factors (USEPA 2003a; 2012) presented in **Table 2-5**. Of the previous investigations noted in Section 2.2, one study (Johnson 1985) collected environmental media (soil and groundwater) for non-radiological analysis from soil borings and test pits. The three soil samples collected were analyzed for VOCs, SVOCs, PCBs, and metals. According to the study, none of the analytes detected exceeded regulatory levels.

Table 2-5: USEPA General Assessment Factors

Assessment Factor	Description
Soundness	The extent to which the scientific and technical procedures, measures, methods, or models employed to generate the information is reasonable for, and consistent with, the intended application.
Applicability and Utility	The extent to which the information is relevant for the project's intended use.

Assessment Factor	Description
Clarity and Completeness	The degree of clarity and completeness with which the data, assumptions, methods, quality assurance, sponsoring organizations, and analyses employed to generate the information are documented.
Uncertainty and Variability	The extent to which the variability and uncertainty (quantitative and qualitative) in the information or the procedures, measures, methods, or models are evaluated and characterized.
Evaluation and Review	The extent of independent verification, validation, and peer review of the information or of the procedures, measures, methods, or models.

Toluene and PCE were detected in groundwater samples, with no exceedances above their respective MCLs except for PCE at a concentration of 9.1 µg/L. Toluene and PCE were also found in equipment blank samples; therefore, these detections in groundwater were dismissed as cross-contamination. Because of the equipment blank contamination associated with the groundwater samples, and no known data validation of the analytical data from this study, the analytical results are considered of poor quality and unusable for purposes of the OU1 RI. The Johnson's study, does provide limited, but reliable information regarding the depth, thickness and presence of waste filled area based on the soil borings and test pits.

Radiological contamination has been investigated during the August 3, 2005 radiological survey conducted by USEPA, the PA report, the January 2009 IRA, the February 2012 fire protection activities, and the June through August 2012 GWS. These studies all confirmed the presence of ^{226}Ra and its progeny at numerous locations throughout GKP. The information gathered during these five investigations at GKP was qualitatively reviewed as part of this planning process. For each study, the conclusions are consistent with the data collected; radiological contamination is present in surface and near surface soil and is distributed across the GKP site. The data generated appears to have been used in part to direct collection of radiological data at GKP during subsequent studies.

The recently completed TCRA (Tidewater 2015) represents the most thorough (to date) radiological survey of the GKP Site, and confirms the results of these prior studies where radiological contaminants remain at the GKP Site. The radiological gamma survey data generated by the TCRA were used for qualitative identification of radiological contamination. The data collected are applicable and usable for the purposes of identifying areas requiring further delineation during the OU1 RI since:

- Approved licensed procedures were employed to gather the data,
- Clarity and completeness of the gamma surveys performed as part of the TCRA were met, and
- The review performed by USACE and NPS was extensive.

Additionally, soil and vegetation samples were collected to assess the potential risks for the GKP Site, which meet the usability requirements. The results and level of uncertainty associated with samples collected as part of the TCRA are listed in **Table 2-6.** Data quality indicators for the OU1 RI are discussed and presented in Section 4.6.1. The radiological data generated during the TCRA at the GKP Site meet the data quality indicators for the OU1 RI.

2.2.2 Preliminary Identification of Data Gaps

Based on the limited quantity and the data quality issues of the samples collected in the 1985 Johnson study from both soil (three) and groundwater (four) as well as the results of the previous investigations from 2005 – 15 as summarized in earlier sections, data gaps at GKP Site include:

- Nature and extent of both ROPCs and COPCs(VOCs, SVOCs, metals, PCBs, dioxins/furans, polycyclic aromatic hydrocarbons [PAHs], pesticides, and herbicides) in surface and subsurface soil, surface water, sediment, and groundwater
- Background data set to determine naturally occurring and anthropogenic levels of constituents
- Contaminant transport pathways and mechanisms for potential exposure to both human and ecological receptors
- Lateral and vertical extent of waste filled area along the northeastern edge of GKP Site
- Groundwater potentiometric surface and seasonal/tidal fluctuations on groundwater flow, conductivity, and contaminant plume dispersion

Since the OU1 RI does not encompass other parts of the GKP Site, the above data gaps will not be completely addressed by the results of the OU1 RI. However, these results will be incorporated with data generated during the subsequent RI for OU2 to fill in remaining gaps in the data.

2.2.3 Contaminants of Potential Concern

The primary goal of this SAP is to collect sufficient data to delineate the nature and extent of ROPCs and COPCs in the various site media (e.g., soil, groundwater, surface water, and sediment) and to evaluate potential risks to human health and the environment associated with the ROPC/COPC data. Data will be collected during a single field season.

Non-Radiological Contaminants of Potential Concern

COPCs may be present at OU1 because of the use of the site as a waste filled area from 1944 to 1948, filling and grading from the dredging operations in the Great Kills Harbor, use of City sewage sludge, disposal of digested sludge and disposal of incinerator plant ash. COPCs may include, but are not limited to:

- Metals
- PCBs
- Dioxins/furans
- PAHs
- Pesticides/herbicides
- VOCs
- SVOCs

Radionuclides of Potential Concern

ROPCs have been identified in discrete locations in the waste filled area at the GKP Site. Current investigations have shown that, to date, the waste fill is contaminated with radium from radiotherapy

sources and radioluminescent devices and from U_{nat} and its decay progeny. Previous investigations have encountered soil with the following ROPCs: ^{226}Ra and U_{nat}, consisting of ^{234}U, ^{235}U, and ^{238}U, including their progeny and ^{232}Th. The progeny of ^{226}Ra and U_{nat} should be considered in equilibrium with the parent and thus can be used as a surrogate for identification with consideration of environmental transport factors. **Table 2-7** provides specific information pertinent to the ROPCs in soil at the GKP Site.

2.2.4 Media of Potential Concern

The media of potential concern for the OU1 RI include:

- Surface soils
- Subsurface soils
- Surface water
- Sediment
- Groundwater

2.3 Current and Future Property Use Scenarios

The current and future property use for GKP Site is discussed in Section 2.3.1. A preliminary conceptual site model for human and ecological exposures to COPCs in environmental media at the OU1 is provided in Sections 2.3.2 and 2.3.3.

2.3.1 Current and Future Land Use of Great Kills Park

Current Land Use for GKP. The portion of GKP that is currently open to the public is being used primarily for recreational purposes. A paved and wheelchair-accessible Multi-Use Path, which begins at the entrance to GKP and extends 1.5 miles to the Beach Center, is used for walking, jogging, biking, and roller skating. There are several grassy areas used for recreational purposes, as well as swing-sets and similar areas designed for children. There are hiking trails available in the southern portion (Crookes Point) of the park and bird watching is available along the shoreline.

The waters in and around GKP also are used for recreational activities including boating, fishing, and swimming areas. Great Kills Harbor features a boat launch and numerous anchored boats primarily for recreational purposes, and GKP offers the public a seasonal kayaking program. Fishing areas run from Great Kills Harbor to the Raritan Bay area, attracting numerous anglers year round. Swimming areas are restricted to beaches located south of the bay side of harbor.

The NPS has closed the portion of GKP where there is known radiological contamination. Prior to the discovery of radiological contamination, this section of the park historically was used for environmental education, baseball/softball, athletics, and model airplanes. Due to the closure of this portion of GKP, these activities currently are not occurring at the park.

Coastal areas and adjoining waters, the Raritan Bay and Great Kills Harbor, are directly adjacent or near the contaminated part of the park. These coastal areas are heavily used for human activity along with roads, biking areas, and playgrounds. It is not currently known if any of these locations are above waste filled

area, however it is possible that contaminants from the waste filled area may leach directly or indirectly into adjacent water bodies used for swimming/boating/fishing. Ecological receptors may also be exposed to contaminants in the waste filled area at GKP Site or that may leach directly or indirectly into adjacent water bodies.

No water in or around GKP is currently being used for drinking water.

Future Land Use for Great Kills Park. Future land use at GKP is anticipated to remain recreational. As discussed previously, GKP is part of the Staten Island Unit of Gateway National Recreation Area (NRA). Gateway NRA has three distinct geographic areas (the Jamaica Bay Unit, Sandy Hook Unit, and Staten Island Unit) linked together by similar types of resources and recreation uses, yet each retains distinctive characteristics. In June 2014, the NPS issued the Record of Decision for the Final Gateway National Recreation Area General Management Plan/Environmental Impact Statement. Subsequent to public comment, NPS weighed the proposed alternatives and selected Alterative B as the most appropriate for the future management of Gateway NRA (NPS, 2014).

Alternative B –Discovering Gateway: Staten Island Unit
Improved trailheads and more miles of trail within and between the Staten Island sites as well as picnic areas, camping facilities, and interpreted historic sites will create more recreation opportunities. Opportunities to access and experience Gateway waters will also be increased. Water trails, interpretive boat tours, launch sites, and expanded beach and fishing access will encourage exploration of the coastline and New York Bay. These water trails and guided tours will facilitate paddling from Fort Wadsworth and down the coast to Miller Field and GKP. The NPS will evaluate the possibility of developing overnight accommodations and expanding the locations and types of camping available throughout the Staten Island Unit.

Habitats and current natural resource practices will be maintained including controlling invasive species, planting trees and monitoring beach erosion. Cultural resources will be preserved, stabilized and maintained, where appropriate.

Improved public transportation and an expanded greenway, as well as, shuttles between the sites will make access more convenient. Also, bike infrastructure will be developed throughout the unit including a bike-sharing system, maps, and convenient bike parking to encourage more bikes.

OU1 future land use will also include the Civil Works coastal storm risk management plan which includes approximate 4.5 miles of buried seawall referred to as LOP, interior drainage features that include the acquisition and preservation of open space, pond excavation, construction of tide gates and gate chambers along the LOP, road raisings, and other interior drainage features.

2.3.2 Conceptual Site Model for Human Receptors at OU1

The following provides a preliminary conceptual site model (CSM) for human receptors at OU1. Based on the results of the RI sampling and additional information on the environmental/exposure setting obtained during the RI, the preliminary CSM will be revised accordingly prior to execution of the HHRA. Refer to the Work Plan (WP) in Appendix D for an overview of the methodology that will be used for the HHRA for OU1.

Exposure Setting at OU1. The GKP Site, including the OU1 area, is currently closed to the public; the only current receptors are NPS employees (to include park rangers, park police, fire fighters and maintenance

workers) and other government employees (including contractors). The potential future use of the OU1 area is still planned to be recreational; however the construction of the Civil Works coastal storm risk management plan may result in some minor changes in the future. There are no current or anticipated future residents at OU1. Groundwater at OU1 is not currently being used for potable purposes and it is not anticipated that groundwater underlying OU1 will be used for potable purposes in the future.

Identification of Human Health Receptors and Exposure Pathways. A CSM for exposure describes the relationships among contaminant concentrations and sources, transport pathways, and receptors at a contaminated site. The model reflects pertinent information including prior site operations, current and potential future land uses, potentially exposed populations, and potentially complete exposure pathways.

Risk assessments are intended to address only contaminants for which there is a complete or potentially complete exposure pathway under current and/or future land use scenarios. A potentially complete exposure pathway is defined as one that consists of the following four elements (USEPA, 1989):

- A contaminant source and mechanism of release;
- A retention or transport mechanism through an environmental medium;
- A point of potential human contact with the contaminated medium (exposure point); and
- A human receptor and an exposure route at the exposure point.

The CSM for OU1 was developed by addressing these elements and by considering available information on potential human receptors. When all elements were present, the pathway under consideration was determined to be complete. If any of these elements was missing, chemical uptake (i.e., exposure) by that pathway could not occur and the exposure pathway was considered incomplete.

Current/Future Human Receptors. Based on the preliminary characterization of the exposure setting and evaluation of existing land use and activity patterns, the potential receptors most likely to exist under current conditions were identified, along with the areas of the OU1 over which the receptors are likely to average their exposures (i.e., their exposure areas). Accordingly, the following human receptors are likely to be present at the OU1 and have the potential for exposure under current and/or future conditions:

- Current/Future NPS and City employees (to include park rangers, police, fire fighters and maintenance workers)
- Future Park Recreational User/Trespasser (for restricted areas)
- Future Construction Workers
- Future Off-site Resident

Potentially Complete Exposure Pathways for Human Receptors. A preliminary exposure pathway diagram (EPD), provided as **Figure 2-4,** has been developed to illustrate potential exposure pathways at OU1. A corresponding (preliminary) CSM for potential exposures has also been developed in tabular format (**Table 2-8**) which identifies exposure timeframe, exposure medium, exposure points, receptors, exposure routes, and rationale for considering exposure pathways as potentially complete, or excluding the pathway as incomplete or insignificant.

Off-site Residents. Groundwater wells will be installed as part of the RI for OU1 to determine the vertical and lateral extent of groundwater impacts. Off-site residents may be potentially exposed via potable use of groundwater and subsurface vapor intrusion to indoor air in a residence if it is determined that site groundwater contamination is impacting off-site locations. These exposure pathways will not be evaluated for the OU1 RI but will be evaluated during the RI for OU2.

2.3.3 Conceptual Site Model for Ecological Receptors at OU1

Populations of several animal and plant species have been identified in the GKP Site based on previous surveys. The selection of appropriate species to represent ecological exposure will be finalized prior to execution of the baseline ecological risk assessment (BERA) and will be based on factors including that several species must be selected to represent the entire flora and fauna of the area and different feeding guilds. Potential species that will be evaluated in the BERA are summarized in **Table 2-9**:

Table 2-9: List of Potential Ecological Receptor Species

Potential BERA Receptors	
Plants	
Benthic Organisms	
Fish	Fundulus sp.
Wildlife Species	
Insectivores	American Woodcock
	Short-tailed Shrew
Herbivore	Northern Cardinal
	Meadow Vole
Omnivore	American Robin
	Red Fox
	Eastern Box Turtle
Carnivore	Red-Tailed Hawk/American Kestrel
	Racer
Piscivore	Great Blue Heron
	Northern Water Snake
	River Otter

Potential complete exposure pathways for ecological receptors are identified in the EPD provided as **Figure 2-4.** Refer to the Work Plan in Appendix D for an overview of the methodology that will be used in completing the BERA for OU1.

2.4 Graphical Conceptual Site Model

A graphical Conceptual Site Model (CSM) of the GKP Site is presented on **Figure 2-5**. This initial CSM was generated from information obtained from the 2013 *NPS Integrated Resources Management*

Application (IRMA) Portal, Inventory of Coastal Engineering Projects in Gateway National Recreation Area report and from the 2015 TCRA Report.

2.4.1 Key CSM Assumptions

- Assumptions regarding the approximate pre-fill (1924) shoreline and extent of historic waste filled areas depicted on the CSM are based on available information.
- The thickness and depth of the waste fill material presented in **Figure 2-5** is based on the Johnson study (Johnson 1985) and the TCRA (Tidewater 2015).
- This CSM will be updated based on additional data and information (e.g., extent of waste fill material, depth to groundwater, COPC nature and extent) generated from the OU1 RI.

3 Data Quality Objective Planning Team and Stakeholders

Identifying an appropriate DQO Planning Team is key to successfully developing DQOs. The DQO Planning Team should include the primary decision makers and project team members, such as risk assessors or remediation engineers, who will use the data generated as a result of the DQOs. The size of the DQO Planning Team often depends on the size and complexity of the site under investigation (USEPA 2006a).

The NPS Project Manager (PM) facilitates the DQO Planning Team meetings. Preparation for the initial DQO Planning Team meeting must be comprehensive for the meeting to be successful. Prior to the DQO Planning Team meeting, team members will need a summary of existing site information and data, an evaluation of the usability of previous data, detailed Site maps, a draft CSM illustrating potential contaminant transport and exposure pathways (Section 2), and a draft problem statement (see Section 4.1 for problem statement formulation).

The DQO Planning Team members, primary decision makers, and stakeholders for the OU 1 RI are identified in Sections 3.1, 3.2, and 3.3, respectively. **Figure 3-1** provides an organizational chart that identifies the relationships between these entities.

3.1 Data Quality Objective Planning Team

The DQO Planning Team develops the project DQOs according to the DQO process. The DQO process is iterative, and team members may be added or changed to address technical issues that were not initially identified. The DQO Planning Team for the OU1 RI includes:

- Kathleen Cuzzolino, NPS PM (kathleen_cuzzolino@nps.gov)
- Brenda Barber, USACE, Baltimore District (NAB), Program Manager (Brenda.M.Barber@usace.army.mil)
- Julia Battocchi, NAB, OU1 Technical Lead (Julia.L.Battocchi@usace.army.mil)
- Cliff Opdyke, NAB, Risk Assessor (Clifford.a.opdyke@usace.army.mil)
- Dave Watters, NAB, Health Physicist (Dave.Watters@usace.army.mil)
- Tom Colozza, NAB, Geologist (Thomas.S.Colozza@usace.army.mil)
- Alan Warminski, NAB, Chemist (Alan.S.Warminski@usace.army.mil)
- Allen Roos, USACE, New York District (NAN), Branch Chief (allen.d.roos@usace.army.mil)
- Helen Edge, NAN, PM (helen.k.edge@usace.army.mil)
- Mark MacEwan, AECOM-TIDEWATER JV, OU1 RI Task Lead (Mark.MacEwan@aecom.com)
- Kurt VanGelder, AECOM-TIDEWATER JV, OU1 RI Deputy Task Lead (Kurt.Vangelder@aecom.com)
- Clif Gray, AECOM- TIDEWATER JV, OU1 RI Radiological Lead (clif.gray@tideh2o.net)
- James Reese, AECOM-TIDEWATER JV, Health Physicist (james.reese@tideh2o.net)

- Mark Moese, AECOM-TIDEWATER JV, Ecological Risk Lead (Mark.Moese@aecom.com)
- Leonard Fried, AECOM-TIDEWATER JV, Human Health Risk Lead (Leonard.Fried@aecom.com)
- Ankit Gupta, AECOM-TIDEWATER JV, OU1 RI Technical Quality Control (Ankit.Gupta@aecom.com)

3.2 Decision Makers

The decision makers have the ultimate authority for making final decisions based on the recommendations of the DQO Planning Team. The decision maker for this project is:

- Kathleen Cuzzolino, NPS PM

3.3 Stakeholders

Stakeholders are parties who may be affected by the results of the investigation and/or persons who may later use the data resulting from the DQO process. Stakeholders for NPS-managed lands (including OU1) may include tribal governments, States, non-governmental organizations, and other Federal agencies. The stakeholder(s) for this project are:

- City of New York Agencies
- U.S. Environmental Protection Agency (USEPA), Region II
- New York State Department of Environmental Conservation
- New York State Department of Health
- U.S. Nuclear Regulatory Commission (NRC)
- Public (e.g., residents of Staten Island)

Because the GKP Site is a CERCLA site, a Community Involvement Plan has been prepared by NPS, and will be updated as necessary.

Early involvement of stakeholders in the DQO process can help build a healthy communication platform, establish trust in the decision-making process, and ultimately achieve more effective results from the investigation.

4 Data Quality Objectives

The DQO process specifies anticipated project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified.

The DQO process consists of the following seven steps, described in detail below:

1. State the Problem
2. Identify the Goal of the Investigation
3. Identify the Information Inputs
4. Define the Boundaries of the Investigation
5. Develop the Analytic Approach
6. Specify Performance or Acceptance Criteria
7. Develop the Plan for Obtaining the Data

The following sections detail each step in the DQO process for this investigation.

4.1 State the Problem

ROPCs have been identified at discrete locations in the waste filled area at the GKP Site, including the OU1 area. The waste filled area is contaminated with radium from various sources and from U_{nat} and its decay progeny. Previous investigations have encountered soil with the following ROPCs: ^{226}Ra and U_{nat}, consisting of ^{238}U, ^{235}U, and ^{234}U, including their progeny and ^{232}Th. The short-lived progeny of ^{226}Ra are considered in equilibrium with the radium.

ROPCs/COPCs and contaminants of potential ecological concern (ROPECs/COPECs) may be present as a result of the filling of OU1 with sanitation and hydraulic fill and City sewage sludge, and its use as a disposal area for incinerator ash from the former incinerator located on the GKP Site, and from digested sludge impoundments.

The following problems will be addressed by the RI for the OU1 area:

1. Delineate the limits of the waste filled area within OU1 and to the north-northeast, if necessary;
2. Determine whether ROPCs/ROPECs and COPCs/COPECs (i.e., contaminants exceeding human health/ecological screening criteria) are present in: (1) surface and subsurface soil (2) sediment and surface water at the drainage canal immediately adjacent the OU1 boundary, and (3) groundwater within OU1.
3. Determine whether ROPCs/ROPECs and COPCs/COPECs in environmental media (soil, sediment, surface water, and groundwater) are present at concentration levels that pose an unacceptable risk to human and/or ecological receptors.

4. Delineate the extent of ROPCs/ROPECs and COPCs/COPECs in environmental media (soil, sediment, surface water, and groundwater); and
5. Determine whether the construction of the currently planned Civil Works buried seawall LOP will encounter waste filled area and/or elevated levels of ROPCs/COPCs.

4.2 Identify the Goal of the Investigation

The RI, which includes GWS, geophysical surveys, and environmental sampling, will be conducted to obtain the information necessary to delineate the limits of the waste filled area within OU1 and to the north-northeast, determine whether ROPCs/ROPECs and COPCs/COPECs are present at levels that pose an unacceptable risk to human and/or ecological receptors, and support the Civil Works evaluation of the feasibility of LOP construction within OU1.

4.2.1 Principal Investigation Question(s)

The principal investigation questions for the GKP OU1 area are as follows:

- Principal Investigation Question 1: What chemicals and radionuclides are present in environmental media (soil, groundwater, surface water, and sediments) in the investigation area and if present, what is the horizontal and vertical extent?
- Principal Investigation Question 2: Are chemicals or radionuclides present in environmental media at concentrations that pose an unacceptable risk to human health?
- Principal Investigation Question 3: Are chemicals or radionuclides present in environmental media at concentrations that pose an unacceptable risk to ecological receptors?
- Principal Investigation Question 4: Is chemical or radiological contamination migrating into or beyond the area of investigation?

4.2.2 Decision Criteria for the Identification of COPCs/COPECs

A chemical will be identified as a COPC for a particular media if it is detected at a maximum concentration that exceeds the following human health criteria (all references to USEPA Regional Screening Levels [RSLs] assume RSLs calculated using a target risk of 1E-06 for carcinogens and a hazard quotient of 1.0 for non-carcinogens):

- Soil and Sediment – USEPA Regional Screening Levels (November 2015) for soil based on residential land use (residential criteria will be used to inform decisions regarding risk)
- Groundwater – Federal MCLs for drinking water and USEPA RSLs for tap water (November 2015) for chemicals where an MCL has not been established
- Surface Water – Federal MCLs for drinking water and USEPA RSLs for tap water (November 2015) for chemicals where an MCL has not been established

A chemical will be identified as a COPEC for soil, sediment, and surface water if it is detected at a maximum concentration that exceeds the following ecological criteria :

- NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes (NPS, 2016)

Specific chemicals to be analyzed for the RI and their respective screening limits are discussed in Section 4.5.2 (Action Levels).

Analyte concentrations, particularly metals, will be compared to background data obtained from a nearby area shown in **Figure 2-1** to determine the naturally occurring and anthropogenic concentrations within the immediate vicinity of OU1..

4.2.3 Decision Criteria for the Identification of ROPCs/ROPECs

A radionuclide will be identified as a ROPC for a particular media if it is detected at a maximum concentration that exceeds the following human health criteria:

- Soil and Sediment Surface Screening Levels–NUREG 1757, Volume 1 Revision 2, Table B.2, Screening Values of Common Radionuclides for Soil Surface Contamination per 25 millirem [mrem] above background;
  - ^{226}Ra 0.6 picocuries per gram[pCi/g],
  - U_{nat} = ^{238}U 0.5 pCi/g
  - ^{232}Th 1.1 pCi/g
- Drinking Water – EPA 2000 Radionuclide Rule, 66 FR 76708, December 7, 2000, Effective Date December 8, 2003, total radium (226/228) at 5 picocuries per liter [pCi/L], gross alpha of 15 pCi/L, gross beta of 4 mrem per year (50 pCi/L) and uranium of 30 micrograms per liter (ug/L).

A radionuclide will be identified as a ROPEC for a particular media if it is detected at a maximum concentration that exceeds the following ecological criteria:

- NPS Protocol for the Selection and Use of Ecological Screening Values for Radiological Analytes (NPS, 2016a)

Since the GKP site is comprised of various types of soils, sludge, and debris, identification of a reference area to provide a true measure of a background radiation value that will be applicable needs to be determined. Background for radionuclides will be established as described in Section 5.

4.3 Identify the Information Inputs

The purpose of this section is to identify the data required to answer the principal investigation questions presented in Section 4.2.1 and to determine which inputs require environmental measurements.

4.3.1 Previous Data Usability

To date, the only environmental activities conducted within the OU1 area were related to the radiological survey conducted during the TCRA at approximately 29 acres of the 43-acre OU1 area. At areas of the GKP Site located outside of the OU1 area, radiological sampling has shown surficial radiological contamination

throughout the GKP Site during the TCRA while chemical analyses of a limited number of soil samples (three) and groundwater samples (four) during the 1985 Johnson Study were deemed unreliable (Johnson 1985).

4.3.2 Data to be Collected in the Current Investigation

Data will be collected to answer the principal investigation questions asked in Section 4.2.1 as follows:

- Principal Question 1 – soil, groundwater, sediment, and surface water samples will be collected and analyzed to determine what chemicals and radionuclides are potentially present in environmental media in the investigation area.
- Principal Question 2 – analytical data from the sampling listed above will be compared to background concentrations and applicable human health screening values and used in a baseline human health risk assessment to answer the question of whether chemicals or radionuclides are potentially present in environmental media at concentrations that pose an unacceptable risk to human health.
- Principal Question 3 - analytical data from the sampling listed above will be compared to background concentrations and applicable ecological screening values and used in a baseline ecological risk assessment to answer the question of whether chemicals or radionuclides are potentially present in environmental media at concentrations that pose an unacceptable risk to ecological receptors.
- Principal Question 4 – the data collected from the gamma walkover and geophysical surveys, completion of test pits, soil, groundwater, sediment, and surface water sampling, water level measurements, and aquifer testing will answer the question of whether chemical or radiological contamination is potentially migrating into or beyond the area of investigation.

Data will be used as described below:

Data Description	How the Data Will Be Used
Gamma walkover survey instrumentation readings	Identify hot spots (if any), determine the horizontal extent of surface soil radiological contamination, and aide in determining the biased soil sample locations during the investigation
Geophysical instrumentation readings	Determine the boundaries of the waste fill material within OU1 and identify anomalies that may require visual observation during the completion of test pits
Visual and field screening instrumentation readings during completion of test pits	Ground truth information obtained during the geophysical investigation (boundaries of waste fill material in OU1) and aide in determining the horizontal and vertical extent of contamination
Samples from soil and sediment analyzed for the following constituents: VOCs, SVOCs, metals (including mercury), pesticides, PCBs, herbicides, dioxins and furans, and ^{226}Ra, ^{232}Th, and U_{nat} via HASL 300 and isotopic uranium and thorium analyses via alpha spectroscopy on 10% of the samples to more accurately quantify the activity . Samples from groundwater and surface water analyzed for the following constituents: VOCs, SVOCs, metals (including mercury), pesticides, PCBs, herbicides, dioxins and furans, and ^{228}Ra and ^{226}Ra via EPA 904/903, total uranium via EPA 200.8 and gross alpha and beta via EPA 900.	Aide in determining the horizontal and vertical extent of contamination
Samples from soil, groundwater, sediment, and surface water will be collected from background areas and analyzed for the full suite of constituents listed above.	Determine the naturally occurring and anthropogenic levels of constituents that exist in background areas within the immediate vicinity of OU1.
Other water quality parameters (e.g., temperature, conductivity, pH, oxidation reduction potential, turbidity, and dissolved oxygen measurements) that will be measured in the field during groundwater sampling	Determining the point at which groundwater parameters have stabilized so the well can be sampled, and provide groundwater geochemical information to aide in interpreting analytical data
Water level measurements from groundwater monitoring wells	Provide groundwater flow direction within OU1 and assist in evaluating tidal influences
Instrumentation readings during aquifer testing	Evaluate tidal influences and groundwater flow velocity
Survey information	Geo-reference the activities listed above

4.4 Define the Boundaries of the Investigation

The objective of this step is to identify the sampling units (SUs) and to define the spatial and temporal elements of the investigation area. The boundaries of the investigation are delineated by combining the target population (population of interest) with the spatial and temporal boundaries. Practical constraints that could interfere with sampling are also identified. This step helps ensure the data are representative of the population. Spatial and temporal boundaries permit the identification of decision units (DUs), the smallest user-defined area(s) for which a decision will be made.

4.4.1 Spatial Boundaries

The OU1 area is located along the northeastern corner of the GKP Site. The spatial boundary of the RI for the OU1 area was decided based upon the extent of the area that could be potentially impacted by the Civil Works buried seawall LOP construction project as shown on **Figure 2-2**. A geophysical survey coupled with test pits and borings will be implemented during the RI to identify the limits of the waste filled area within OU1 and to the north-northeast, as necessary.

The spatial boundary for obtaining soil background data is within the Willowbrook Parkway Right-of-Way identified in **Figure 2-1.** The Willowbrook Parkway Right-of-Way Area, which is approximately 15 acres and is located northwest and opposite of intersection of Buffalo Road and Hylan Boulevard (refer to Figure 2-1), is recommended as the best location for the following reasons:

- Based on the United States Department of Agricultural soil survey, the area is underlain by a naturally occurring dry soil type referred to as "BHBu", whose parent material is a red coarse-loamy till derived from sedimentary rock and is associated with the ground moraine deposits found within Staten Island. Thus, these soils represent the naturally occurring concentration levels for inorganics and radionuclides native to Staten Island.
- The area is similar to GKP since it is an urban park area with woods and vegetation and a walking trail through it. The area has likely been subject to anthropogenic impacts (such as PAHs and pesticides) related to its urban setting similar to GKP and surrounding environments.
- Site access for collection of dry surface and vadose zone sub-surface soil samples is generally favorable. The site is forested, but can be navigated with a small track-mounted direct push technology (DPT) rig for collecting subsurface soil samples.
- There are no known environmental impacts to the area.

The spatial boundary for obtaining groundwater background data is an area of GKP along Hylan Boulevard which is hydraulically upgradient of the waste fill areas at OU1 and OU2 (Refer to **Figure 2-1**). Monitoring wells will be installed within this area to establish background levels of naturally occurring constituents and to monitor potential contamination that may follow from areas upgradient of the GKP waste fill areas.

There are two distinct spatial boundaries for obtaining surface water and sediments background data which are both up-stream of the drainage canals located at GKP (Figure 2-1). The first location is along the creek within the Willowbrook Parkway Right-of-Way Area, which is upstream of the drainage canal that crosses under the Hylan Boulevard and enters GKP and splits into two drainage canals – with one running parallel to the Hylan Boulevard and eventually draining into the GKP Harbor and the second running parallel to the

Buffalo Street through OU1 and eventually draining into the Raritan Bay. The second location is along the drainage canal within the tidal marshes north-east of OU1, which is upstream of the drainage canal that runs along the north-east extent of OU, merges with the drainage canal running along Buffalo Street and eventually drains into the Raritan Bay.

4.4.2 Temporal Boundaries

OU1 RI field activities are scheduled to be completed during the 2016 calendar year. Fieldwork is projected to begin in late spring 2016 for an expected calendar duration of 14 weeks and will consist of nine weeks of actual fieldwork and includes breaks of four-weeks and one-week. A four-step approach will be undertaken for the RI that will include:

- Step 1 (Waste Filled Area Delineation) and Step 2 (Initial Surface/Subsurface Investigation) are expected to be completed within a four week timeframe.
- A four week data review period is anticipated to compile and review the initial investigate results.
- Step 3 (Delineating Extent of Contamination) and Step 4 (Groundwater Well Installation and Sampling) are expected to be completed within a six week timeframe.
- Background data will be collected in Step 4.
- Demobilization for the OU1 field effort is expected to be completed by the end of August 2016.

4.4.3 Sampling Units

Sampling Units (SUs) for the GKP OU1 will correspond to environmental media to be sampled for the RI: surface soil, subsurface soil, sediment, surface water, and groundwater. Additional information on the sampling plan for the RI is presented in detail in the FSP (Section 5).

4.4.4 Decision Units

Decision units (DUs) are the smallest user-defined area(s) for which a decision will be made (e.g., to cleanup or not cleanup) based on sampling. The RI DUs will be as follows:

- Decision Units for Soil

Surface Soil. Surface soil samples are planned to be collected at 50 DPT locations during Step 2. DPT sample locations have been predetermined using a systematic grid pattern that evenly spaces the 50 sample points within the area using Visual Sampling Plan (VSP) software resulting in a 95% confidence level such that the size of the "hot spot" that can be detected is approximately 1 acre. Based on the DPT surface soil analytical results, approximately 30 1-acre DUs are planned for Step 3. Surface soil within each DU will be sampled by incremental sampling methodology (ISM). It is anticipated that the locations of the 30 ISM DUs will correspond to the DPT locations exhibiting the highest chemical/radiological concentrations (Refer to Section 4.5 and 5.0 for details of the soil sampling approach). Based on the ISM results, the 1-acre DUs for surface soil may be aggregated during the RI to establish the final DUs for surface soil upon which decisions will be made with respect to potential remedial actions.

Subsurface Soil. Subsurface soil samples are planned to be collected during Step 2 at the 50 initial DPT locations, determined using VSP software, where surface soil samples will be collected (discussed above). In addition, subsurface soil samples are planned to be collected at approximately 20 "step-out" DPT locations for additional horizontal and vertical delineation during Step 3. Based on the sampling results, subsurface soil underlying OU1 may be established as one decision unit or multiple decision units.

- Decision Unit for Groundwater underlying OU1.
- Decision Unit (Surface Water and Sediment) for the drainage canal within OU1.

4.5 Develop the Analytical Approach

The following samples (discussed further in the FSP, Section 5) will be collected to address the primary investigation questions and achieve the goals of the RI:

Soil

- Fifty locations within OU1 will be sampled for surface and subsurface soil samples using direct push technology (DPT). Borings will be advanced to a depth of 10 feet bgs or to the bottom of the waste fill, whichever is greater at 44 DPT locations while six DPT borings will be advanced to the underlying confining Raritan Clay layer which is anticipated to be approximately 70 feet bgs.
- The following will be collected at each DPT location: a surface soil (0 to 6 inches) sample and a subsurface soil sample from the interval just above the saturated zone or from native soil encountered below the waste fill if within the vadose zone. Thirty additional biased subsurface soil samples will be collected at the discretion of the field team based on visible staining, elevated field instrument readings, or other indicators of potential contamination.
- Based upon the DPT results, ISM will be used to collect a surface soil sample at 1-acre decision units. It is anticipated that ISM sampling for surface soil will be conducted at 30 decision units that exhibited the highest chemical/radiological concentrations.
- Based upon the DPT results, four "step-out" DPT borings will also be advanced at five selected DPT locations.
- For the background data set, one surface soil sample (with two replicates) will be obtained using the ISM approach in addition to 15 discrete surface and subsurface soil samples collected from DPT locations within the background study area consistent with the soil sampling approach for OU1.

Surface Water and Sediment

- Four co-located surface water and sediment samples within the drainage canal within OU1.
- For the background data set, four co-located surface water and sediment samples within the drainage canals located up-stream from OU1.

Groundwater

- Twenty-five (25) groundwater grab samples will be collected from selected DPT boring locations.
- Fifteen monitoring wells are planned to be installed within OU1 area. A single groundwater sample will be collected from each of these wells following development.
- Four background monitoring wells are planned to be installed within the GKP hydraulically upgradient of the waste fill areas within OU1 and OU2. A single groundwater sample will be collected from each of these wells following development.

4.5.1 Decision or Estimation Parameters

Decision criteria for identifying ROPCs/ROPECs and COPCs/COPECs are discussed in Section 4.2.2. For the purposes of identifying COPCs/COPECs in environmental media for the RI, if a chemical is detected at a maximum concentration that exceeds a screening criterion, it will be identified as a ROPC/ROPEC or COPC/COPEC.

The OU1 RI sampling results will also be used to develop additional summary statistics for detected analytes: minimum and maximum detected concentrations, frequency of detection, range of reporting limits, and location of the maximum detected concentration.

4.5.2 Action Levels

Specific analytes and their respective reference limits (MCL/RSL/ecological screening value [ESV]) are presented in **Tables 4-1 through 4-4**.

4.6 Specify Performance or Acceptance Criteria

The purpose of this step is to establish the criteria needed to maximize the ability of the investigation to obtain the data needed to answer the principal investigation question(s) accurately and with confidence.

4.6.1 Quality Assurance / Quality Control

Quality assurance/quality control (QA/QC) measures will be implemented for the RI to minimize variability, mitigate the potential for false positive and/or false negative error, and increase accuracy and defensibility in the collected data. The analytical laboratory for the OU1 RI is ARS International, LLC, which has Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) certification (provided in Appendix B). QA/QC measures that will be implemented for the RI with respect to the analytical laboratory operations and field activities include:

- Field QC will be implemented and measured through collection of field QC samples, including field-designated matrix spikes/matrix spike duplicates (MSs/MSDs), field duplicates, and trip blanks; and implementation of sample collection, handling, and shipping standard operating procedures (SOPs) (presented in Appendix A). The frequency of collection of field QC samples is presented in **Table 4-5**, discussed below and provided in greater detail in the FSP (Section 5).

- Environmental samples will be analyzed following laboratory SOPs (Appendix B) that employ appropriate QC checks to ensure precision and accuracy of data.
- Processing of ISM samples by the laboratory will not include grinding due to the fine-grained nature of the soils at GPK (Johnson 1985; Mueser et al 1991; FPA 1993). The laboratory that will conduct the analyses has confirmed that their SOP includes option for processing ISM samples without grinding. Not grinding also eliminates concerns with producing biased-high metals concentrations by exposing mineral grain surfaces that are otherwise not exposed under the natural site conditions, and by grinding and increasing the chemical influence of small particles of entrained trash (i.e., small metal and bottle fragments) that do not represent the same exposure potential of natural fine-grained soil. The Project Chemist will coordinate with the lab to ensure a 10g subsample of the sieved ISM soil is used for analysis of metals.
- Project-specific Data Quality Indicators (DQIs) —precision, accuracy, representativeness, completeness, comparability, and sensitivity— have been established for the RI to aid in assessing overall data quality. The DQIs specify the performance criteria, QC sample and/or activity that will be used to assess the performance criteria and the type of error (sampling, analytical, or both) that will be used to assess data quality. The project-specific DQIs have been established for environmental media (soil, sediment, groundwater, and surface water) to be sampled for the RI and laboratory analyses to be conducted. The project-specific DQIs are provided in **Table 4-8 through 4-17**.

The remainder of this section provides a more detailed discussion of each of the QA/QC measures with respect to laboratory and field operations, and the project-specific DQIs.

Laboratory Quality Assurance / Quality Control and Samples

Laboratory QA/QC as well as laboratory QA/QC samples are outlined by the laboratory SOPs. The Laboratory Quality Assurance Manual and SOPs are presented in Appendix B.

Field Quality Assurance / Quality Control

Field QC will be implemented and measured through the collection of field QC samples, including field-designated MS/MSDs, field duplicates, and trip blanks; and implementation of sample collection, equipment decontamination, handling, and shipping SOPs (presented in Appendix A). Field sampling personnel will properly identify all samples collected in the field with an adhesive sample label attached to each sample container. The sample label will contain the site name, field identification number, date, time, location of the sample collected, and identification of preservatives used. Sample information will be legibly printed with waterproof ink. The sample identification numbers will be used on field sheets, Chain-of-Custody (CoC) forms, and other documentation records.

Field Quality Control Samples

Field QC samples will consist of field-designated MS/MSDs, field duplicates, and trip blanks. Field-designated MS/MSDs will be collected at the standard collection frequency of 5% (i.e., one MS/MSD per 20 samples). Field duplicates will be collected at a frequency of 10%. One trip blank will accompany each cooler shipped to the analytical laboratory that contains samples for VOC analysis. All non-radiological

samples will be collected in appropriate sample containers with appropriate preservatives and stored on ice at 4 degrees centigrade (˚C) ± 2 ˚C. Refer to **Table 4-5** for a summary of field QC samples to be collected **and Table 4-6** for a summary of sample handling, including container requirements, number of containers, volume requirements, preservatives, and holding times. Details of sample locations, sample identifications (IDs), and sample location figures are presented in the FSP (Section 5).

Decontamination Procedures

Decontamination will be performed on equipment (e.g., drilling equipment, scoops, pumps) that is to be reused at each sampling location. Decontamination will be performed before sampling at each sampling location in order to minimize the possibility for sample cross-contamination. Decontamination procedures are presented in SOP 3-06 (Appendix A).

Instrument/Equipment Testing, Inspection, and Maintenance

Equipment that is to be used on site will be inspected daily before use. Equipment inspection will follow the Equipment Inspection Worksheet (Appendix C). If the equipment is found to be deficient, the use of that equipment will be discontinued until proper maintenance can be performed and it passes a re-inspection. If the maintenance cannot be performed promptly or the equipment does not pass a re-inspection, the equipment will be replaced and the replacement will be inspected before use. Equipment testing, inspection, and maintenance guidelines are outlined in **Table 4-7**.

Instrument/Equipment Calibration and Frequency

Instruments to be used on site will be, at a minimum, quality control checked daily, which may include daily calibration for specific instruments. Quality control checks may occur more frequently as the conditions require. Instrument calibration and frequency guidelines are outlined in **Table 4-7.**

Radiological measurement instrumentation will be inspected by the Site Radiation Safety Lead or designee to ensure its proper working condition prior to use. Field equipment and instruments will be properly protected against inclement weather conditions during the field investigation. At the end of each working day, field equipment and instruments will be removed from the field and placed in a dry location for overnight storage and charging, as appropriate to the instrument. A quick overview of the QC requirements for radiological field instrumentation is presented in **Table 4-7**.

Sodium iodide (NaI) detectors will be used to measure gamma radiation levels. SOPs will be used as the procedure for operation of these instruments. All radiation instrumentation used in the investigation will be maintained and calibrated to operate within manufacturer's specifications to ensure the required sensitivity and precision for the emissions of the ROCs. Specific calibrations and maintenance are conducted by personnel trained on the equipment or by the manufacturer.

Operational procedures are utilized for all field instruments to verify the equipment is operating properly and used correctly in the field to produce accurate and reliable data. At a minimum, calibrations of radiation detection instruments will be performed annually and after repair. Field instrument checks will verify instrument response and will be performed at the beginning and end of each day, at a minimum. All calibrations will be conducted with National Institute of Standards and Technology traceable sources. If the instrument checks reveal that the instrument is outside established accuracy limits, the instrument will be

marked out of service. If necessary, the instrument will be returned to the manufacturer for immediate repair and servicing. At a minimum, calibration records will contain the following information:

- Instrument name and identification number (e.g., model and serial number)
- Manufacturer
- Date of calibration
- Calibration due date
- Name of company and person performing the calibration
- Calibration points
- Results of the calibration
- Calibration source documentation (e.g., serial number, certification, radionuclides)

Inspection/Acceptance of Supplies and Consumables

At the beginning and end of each day, the field personnel will inspect all consumables to ascertain their condition and supply. If the field personnel determine that the condition or supply of the consumables will impact work performance, the Field Team Leader will procure additional consumables prior to the start of field activities the following day.

Special Training and Certification

Onsite field personnel will receive 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training (and associated 8-hour refresher training as necessary), Radiation Worker training in accordance with the RPP, and additional training, if necessary, as outlined in the Site-Wide APP.

Field Audits

A field audit of activities conducted on site, including calibration of equipment, inspection of equipment, performance of the sampling program, and other field tasks will be performed within the first week of active environmental sampling. A field audit early in the field program will allow for issues to be identified and rectified before significantly impacting the quality of the field data produced. Corrective actions will be developed for any issues identified, and a subsequent field audit conducted as warranted to ensure field data are of the highest quality and all SOPs are followed.

Data Quality Indicators Table

- DQI Tables for Soil/Sediment: VOCs and SVOCs (**Table 4-8**); metals, including mercury (Table 4-9); herbicides/pesticides/PCBs (**Table 4-10**); dioxins and furans (**Table 4-11**); and uranium, thorium, and radium (**Table 4-12**)
- DQI Tables for Groundwater/Surface Water: VOCs and SVOCs (Table 4-13); metals, including mercury (Table 4-14); herbicides/pesticides/PCBs (**Table 4-15**); dioxins and furans (**Table 4-16**); and uranium, and radium (**Table 4-17**)

4.6.2 Decision Error Limits and Uncertainty Evaluation

Uncertainty limits are proposed by establishing performance goals of the analytical data for precision, accuracy, repetitiveness, completeness, and comparability parameters. Uncertainty limits will be examined through statistical evaluation, which is an important tool used in the data assessment to determine:

- Whether the data meet the assumptions under which the DQO and the data collection design were developed.
- Whether the total error in the data is small enough to indicate that the data is of sufficient quality to allow the decision maker to use the data to support decisions within the tolerable decision error rates expressed in the DQO.

Sample collection and measurement decision errors will be minimized by following the SOPs provided in Appendix A and documenting field activities that deviated from the SOPs. Similarly, laboratory analyses will follow the standard laboratory procedures and QA/QC samples will be collected to identify errors associated with sample collection and analyses. Ideally, laboratory-reporting limits would be less than the various risk-based screening levels that will be used to screen the analytical results. Analytical methods selected for this project optimize achievement of the required low reporting limits. In instances where reporting limits may exceed the screening levels, this will be discussed in the RI report uncertainties section.

Analytical data used in risk assessments will typically be 100% validated by a data validator that is independent of the laboratory to ensure data usability and facilitate data reduction.

4.6.3 Data Validation and Usability

Data Verification

Data verification will be performed on 100% of the data obtained during the OU1 field activities. Data verification may be done electronically or manually, or by a combination of both, and shall include, but is not limited to, the following:

- Sampling documentation (e.g., CoC forms)
- Preservation summary and technical holding times
- Presence of all analyses and analytes requested
- Use of the required sample preparation and analysis procedures
- Method detection limit (MDL) and level of quantitation (LOQ) evaluated against the project requirements
- The correctness of the concentration units
- Case narrative

Data Validation (Level II)

The data validation process builds on data verification. The laboratory case narrative, QC sample results, and calibrations will be reviewed and data qualifiers removed or added in light of project knowledge for

100% of the data. Method-specific instrument calibration and QC parameters will be reviewed for compliance with calibration and for QC requirements.

Data Validation (Level IIa) will be conducted in compliance with methods, procedures, and contracts identified in Table 10, page 117, UFP-QAPP manual, V.1, March 2005). Data Validation (Level IIb) will be conducted via comparison with measurement performance criteria in the QAPP (see Table 11, page 118, UFP-QAPP manual, V.1, March 2005). Validation qualifiers applied in accordance with National Functional Guidelines for organic and inorganic data review. Methods for which no data validation guidelines exist will be validated following the NFG deemed most appropriate by the data validator.

An in-depth review of the raw data to verify accuracy will be performed on 10% of the data and include, but not limited to, the following:

- Instrument calibration and QC parameters (method-specific) (these will be reviewed for compliance with the criteria specified in the applicable Summary of Calibration and QC Procedures tables and flagged, as necessary)
- Review of raw data such as instrument print outs, preparation logs, and run logs
- Review of system performance
- Random check of calculations, including, but not limited to, sample and QC results, initial calibration response factors and relative standard deviations, calibration verification standard response factors, and percent differences or percent drifts from expected values
- Random verification of sample results to the raw data
- Check for interference problems or system performance problems
- Estimated results (F-qualifiers)
- Resolution by the laboratory of any identified problems, as necessary

Assessment, which includes data validation, will be accomplished by AECOM-TIDEWATER JV's analytical data manager. The data assessment will identify out-of-control data points and omissions. Coordinate with the laboratory to correct data deficiencies will be completed. Decisions to repeat sample collection and analyses may be made by the OU1 PM in consultation with the NPS and USACE, on the basis of the extent of the deficiencies and their importance to the overall context of the investigation.

4.7 Develop the Plan for Obtaining the Data

The goal of the RI, as previously stated, is to collect sufficient analytical data to:

- Delineate the limits of the waste area within OU1 and to the north-northeast, if necessary;
- Determine whether ROPCs/ROPECs and COPCs/COPECs are present that may pose an unacceptable risk to human health or the environment.

To accomplish these goals, samples collected will be assessed for a wide range of analytes. Analytical methods include:

- VOCs – SW 846 Method 8260C

- SVOCs – SW 846 Method 8270D
- Inorganics – SW 846 Method 6020A
- Mercury – SW 846 Method 7471B/7470A
- Organochlorine pesticides – SW 846 Method 8081B
- PCBs – SW 846 Method 8082A
- Chlorinated herbicides – SW 846 Method 8151A
- Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) – SW 846 Method 8280B
- Total uranium for drinking water – EPA 200.8
- ^{232}Th, U_{nat}, and ^{226}Ra – HASL 300
- ^{228}Ra and ^{226}Ra for drinking water – EPA 904/903
- Gross alpha and gross beta for drinking water – EPA 900
- Isotopic uranium and thorium (alpha spectroscopy) for soils

Analytical data generated from these analyses will be provided from the analytical laboratory as Level IV data packages with an electronic data deliverable (Refer to Section 6.0 for a discussion of the electronic data deliverable and data management that will be conducted for the OU1 RI). One hundred percent (100%) of the analytical data will be validated.

Each of these methods for obtaining the required data is discussed in greater detail in the FSP (Section 5).

5 Field Sampling Plan

This FSP was developed to ensure that samples collected during the OU1 RI are representative of the investigation areas and media being sampled and characterized. The following subsections discuss the FSP for the proposed 4-step investigative approach and provide the rationale (based on the DQOs established in Section 4) for the associated activities. Each subsection discusses the proposed activities, sample media, sampling locations, number of samples to be collected, sampling procedures, analyses to be performed and other measurements that will be conducted during each step. The following AECOM-TIDEWATER JV's SOPs (provided in Appendix A of this SAP), which were prepared in March 2016 (Revision 0) and have not been modified for this project, will be followed by all field personnel during the OU1 RI to reduce data variability associated with sample collection:

- AECOM-TIDEWATER JV SOP 3-01 Utility Clearance
- AECOM-TIDEWATER JV SOP 3-02 Logbooks
- AECOM-TIDEWATER JV SOP 3-03 Recordkeeping
- AECOM-TIDEWATER JV SOP 3-04 Sample Handling, Storage and Shipping
- AECOM-TIDEWATER JV SOP 3-05 IDW Management
- AECOM-TIDEWATER JV SOP 3-06 Equipment Decontamination
- AECOM-TIDEWATER JV SOP 3-10 Surface Water Sampling
- AECOM-TIDEWATER JV SOP 3-12 Monitoring Well Installation
- AECOM-TIDEWATER JV SOP 3-13 Monitoring Well Development
- AECOM-TIDEWATER JV SOP 3-14 Monitoring Well Sampling
- AECOM-TIDEWATER JV SOP 3-15 Monitoring Well Abandonment
- AECOM-TIDEWATER JV SOP 3-16 Soil and Rock Classification
- AECOM-TIDEWATER JV SOP 3-17 Direct Push Sampling Techniques
- AECOM-TIDEWATER JV SOP 3-19 Headspace Screening for Total VOCs
- AECOM-TIDEWATER JV SOP 3-20 Operation and Calibration of a PID
- AECOM-TIDEWATER JV SOP 3-21 Surface and Subsurface Soil Sampling
- AECOM-TIDEWATER JV SOP 3-22 Sediment Sampling
- AECOM-TIDEWATER JV SOP 3-35 Hydraulic Testing, Slug Testing
- AECOM-TIDEWATER JV SOP RS-010.2 Gamma Walkover Survey

Additional non AECOM-TIDEWATER JV SOPs used during the OU1 RI include:

- Geoprobe® DT325 Dual Tube Sampling System SOP (Technical Bulletin No. MK3138, November 2006)

- Geoprobe® 2.0-in.x3.4-in OD Prepacked Screen Monitoring Wells SOP (Technical Bulletin MK3172, January 2011)

5.1 Soil Sampling

This section describes the soil sampling and analysis activities that will be conducted to meet the objectives of the Step 1, Step 2 and Step 3 RI approach described in the WP (Appendix D). **Figure 5-1** presents the OU1 investigation area including the three access control points/contamination reduction zones.

5.1.1 Gamma Walkover Survey

The GWS will be performed for the part of the waste filled area not previously surveyed during the TCRA investigation and at areas newly identified as containing waste fill from the geophysical survey. **Figure 5-2** shows the OU1areas surveyed during the TCRA. The areas to be covered during the OU1 GWS are depicted on **Figure 5-3**.The GWS will be performed to locate surface and near-surface radiation anomalies, indicating either dispersed residual radioactive soil contamination or discrete radioactive sources. In general, the GWS will be completed in accordance with the SOP provided in Appendix A. The GWS will employ a 3-inch by 3-inch NaI detector connected to a Ludlum Model 2221 or equivalent scaler/rate meter and a Trimble Pro 6T Global Positioning System with a Trimble Nomad handheld device. The minimum detectable concentration (MDA) for the GWS based on ^{226}RA is 1.48 pCi/g. The calculations are included as an Appendix E.

The typical walkover survey will occur along unidirectional transects across a defined area. Each transect will contain data points that are 0.5 meter (m) apart set by the operators pace of 0.5 meter/second (m/s). The meter will be held as close as possible to minimize the drop-off in the intensity of the gamma particles and increase the chances that gamma rays will interact with the sensor giving as representative a reading as possible. Each transect will be no more than 1.0 m apart from any other transect. In total, this will ensure 100% coverage within the survey area.

Personnel will designate a fixed GPS calibration point and will conduct daily QC checks at the start of each workday. This will ensure proper operation of the equipment and optimum GPS environment for data collection. Internal checks will also be conducted to ensure proper communication between the Ludlum 2221 and the GPS to ensure that data is collected on a per second basis. Data will be extracted from the Trimble using GPS Pathfinder Office at the end of each day. The nearest governmental base station or base station with equivalent error will be utilized for differential correction before integration into the site GIS.

GWS Data Processing

Once the GWS has been completed, all the data collected will be plotted to create the data set. The 1- acre grid will be used to subdivide the data (using ArcMap 10.1) into one data set per acre grid. Given that more than one survey method (walkover, cart, etc.) was used to survey the investigation area during the TCRA, most acre grids yield more than one data subset.

Data subsets will be evaluated using Microsoft Excel® data analysis tool and ProUCL Version 5.0 (US EPA, 2013). The data analysis tool will be used to generate basic descriptive statistics. The summary tables will include mean, median, mode, standard deviation, standard variance, kurtosis, minimum, maximum, and

sample population count. The mean and the standard deviation variables will be used in the calculation of the z-score (described below).

ProUCL software will be used to provide similar general statistics, and generated percentile information for the data subsets. ProUCL will also be used to generate histograms, quantile-quantile (Q-Q) plots, and scatter plots for each data subset.

Each data subset will be normalized by the calculation of z-scores per the formula below:

$$Zscore = \frac{\chi - \mu}{\sigma}$$

Where;

χ = result;

μ = mean of the population; and

σ = standard deviation

For the data analysis, a z-score >3 sigma will be considered indicative of likely contamination. The review will combine observation of individual data points that exceed 3-sigma with any identifiable spatial patterns or trends that might indicate areas of relatively elevated activity. Based upon discussion with the project team, approximately 30 locations will be selected for bias sampling of the elevated areas determined from the GWS data analysis. These biased samples will be collected during Step 3 (see Radiological Bias Sampling). Locations will be selected based upon a variety of factors:

- Z-score result
- Step 2 results near elevated location
- Distribution pattern (several elevated spots in proximity)

The results of the GWS will be summarized in a field report describing the survey methods, field investigation program and results, which will be included as an appendix to the OU1 RI Report. The GWS data will be presented as a series of georeferenced color-enhanced contour maps depicting the respective radiological measurements across the surveyed area.

5.1.2 Geophysical Survey

Archives record search efforts identified the suspected area where waste fill was placed within the GKP Site and OU1 during the 1944 to 1948 timeframe. However, there is uncertainty concerning: (1) possibility that waste fill extends beyond the 1944-1948 fill area illustrated in **Figure 5-4**, and (2) what types of waste may be contained in the waste fill. To address these uncertainties, a geophysical survey will be conducted during an approximately two-week period. The survey will utilize these two technologies: electrical conductivity and magnetic.

The geophysical survey will be conducted around the edge/perimeter of 1944-1948 fill area highlighted in orange on **Figure 5-4**, after conducting the necessary clearing and grubbing. This area represents the edge/perimeter of the 1944-1948 fill area located within the OU1 minus the area along the southwestern OU1 boundary where the 1944-1948 fill area extends beyond the OU1 boundary.

The geophysical survey will be conducted along 50-foot long transects that cross the edge/perimeter of the 1944-1948 fill area in a perpendicular fashion. Approximately half of each transect will be located on the mapped waste filled area and half will extend outside of the mapped waste filled area. The spacing between transects will be 15-feet, thus representing 440 transects (approximately 22,000 liner feet) around the edge/perimeter of 1944-1948 fill area. Interpolation of the geophysical data along and between these transects will produce survey results for an area of approximately 7.5 acres.

The 1944-1948 fill location border will be laid on the field out via spray paint or stakes at a minimum of every 10 ft using GIS data from the 2013 Gateway report. Grubbing will be conducted along the laid out border to clear a 50+ foot swath. The geophysics crew will then use onboard GIS to locate/verify the border and manually mark out transects located approximately every 15 feet depending on site access or obstructions.

Electrical Conductivity

The electrical conductivity survey will be completed using the Geonics Ltd. EM-31 or an equivalent geophysical instrument. The EM-31 provides a rapid means of measuring the electrical conductivity of subsurface materials including soil, rock and buried wastes. If they are present in the subsurface, EM-31 data will aid the characterization of the following:

- buried metallic objects;
- lateral extent of buried wastes, landfills and/or trench materials;
- buried non-metallic wastes including solvents and bulk materials
- Preferred pathways for groundwater flow.

The EM-31 transmitter coil generates a low alternating current that creates a primary, time varying magnetic field in the subsurface. The primary magnetic field produces subsequent secondary magnetic fields. The EM-31 receiver coil measures both the primary and secondary fields. Changes in magnitude and phase of the individual fields are output as voltages and are able to be related to subsurface electrical conductivity.

The depth of investigation with the EM-31 is dependent on the mode of operation. The EM-31 can be operated in either the horizontal or vertical dipole mode, which provides maximum depths of investigation of approximately 8 and 16 feet, respectively. The horizontal dipole mode will be used to investigate the OU1 since the top of the waste fill is not expected to be deeper than about 4 feet below ground surface. The EM-31 measures both the quadrature phase and in-phase components of the induced magnetic field. The quadrature phase is linearly related to terrain conductivity and is, therefore, particularly responsive to geologic variations. The inphase component represents the ratio of the induced magnetic field to the primary field and is more responsive to the presence of metallic objects than the quadrature phase.

Values for each component of the EM response will be plotted and contoured to evaluate conductivity variations across the OU1. Interpretation of an EM contour map requires that the basic characteristics and causes of conductivity anomalies be understood. Electrical conductivity is a function of the soil or rock type, the porosity and the permeability of the rock units, and the nature and extent of fluid filling the pore spaces. Most types of soil and rock are electrical insulators of low conductivity. The electrical conduction that takes place in the subsurface primarily occurs through the interconnected, moisture-filled pores contained in the matrix.

If a conductive body such as a metal drum exists within the matrix, ion flow and conduction occurs preferentially through the metal, thus increasing the bulk conductivity. Conversely, if non-conductive materials such as a plastic drum or un-reinforced concrete are placed in the matrix, ion flow and conduction occur around the resistor, thus reducing the bulk conductivity. Therefore, buried metallic objects, process wastes, sludge, and leachate are generally manifested as conductivity highs, while buried concrete, asphalt, wood, or dry backfilled soil materials are generally manifested as conductivity lows. These facets are superimposed on the geologic framework of the site, which can also produce varying conductivity conditions due to the characteristics and thicknesses of the lithologic units.

Variations in the subsurface conductivity resulting from buried metallic objects are generally manifested by relatively large (greater than 25 milliSiemen per meter [mS/m]) anomalies. However, these anomalies, as well as smaller ones, can be masked by the interfering effects of surface debris, buried utilities, overhead utilities, communications equipment, or any large metal structures in close proximity to the survey area.

Magnetic Survey

The magnetic survey will be completed using a Geometrics G-858 magnetic gradiometer or an equivalent instrument to provide confirmatory information on any potential metallic objects detected. Magnetic (MAG) methods aid subsurface characterization through measurement of the earth's magnetic field and local variations in this field. Magnetic surveys are often used in the detection of buried metallic objects as well as delineation of areas of disturbed soil. A magnetic survey involves the measurement of the earth's magnetic field at various discrete points on the ground surface. Variations in the magnetic susceptibility of subsurface materials produce discernable anomalies within the earth's magnetic field, which can subsequently be resolved with a high-resolution magnetometer. A Geometrics G-858 cesium-vapor dual sensor magnetometer will be used for the proposed survey. All data will be stored in the internal memory of the G-858 for future transfer to a personal computer, which will be used to analyze the data.

Magnetic measurements generally fall into one of two categories: magnetic total field and magnetic gradient measurements. The total field intensity is simply a measurement of the magnitude of the earth's magnetic field vector at each discrete point on the ground surface, and is often recorded with a single sensor. Gradient data are typically recorded with two sensors, where both horizontal and vertical gradient surveys can be conducted. The vertical magnetic gradient is a measurement of the difference in the total magnetic field between the field recorded by two sensors set at different fixed heights above the ground and at a fixed separation from each other. Since the angle at which the earth's magnetic field contacts the ground surface is different across the globe, sensor orientation is adjusted to best measure the ambient field at a particular geographic location. The collection and analysis of total field and vertical gradient magnetics data aids in the interpretation of an indicated anomaly's depth of burial; the vertical gradient response accentuates shallow targets relative to the total field response.

Several sources of interference can affect magnetic surveys, resulting in the distortion of desired magnetic field measurements. However, industry standard surveying techniques allow for these effects to be minimized in the field, or corrected from the recorded magnetics data during post-processing. Natural diurnal variations in the earth's magnetic field are a common source of interference, and are primarily caused by increased particle and electromagnetic radiation from the sun. These variations are often monitored through periodic readings of a common base station within the local survey area, or by utilizing an independent, continuously recording magnetic base station. Other sources of interference are generally

due to cultural features, such as buildings, parked cars, and anything metallic situated at or near the ground surface.

Magnetic values (or magnetic gradient values) will be plotted on a map and contoured so that variations over the OU1 can be spatially analyzed. Buried subsurface metal can be indicated by high magnetic values or high vertical gradients. Generally, areas with magnetic anomaly highs indicate buried ferromagnetic materials. Alternatively, magnetic anomaly lows can indicate disturbed soils with no ferromagnetic constituents. In many cases, a magnetic anomaly will appear as a dipole characterized by both high and low values in close proximity to each other, with the target itself situated at the inflection point between the high and low values. The amplitudes of these high and low values (i.e., relative strength of the values) are dependent primarily upon the direction the survey traverse approaches the buried target, upon the orientation of the anomaly-producing object buried in the subsurface, and upon the target's depth of burial. The magnetic response from a ferromagnetic object of interest is proportional to the mass of the object and inversely proportional to the object's depth of burial. For example, a single 55-gallon drum can typically be detected to a depth of approximately15 feet; groups of drums can be detected at depths of 25 feet or greater.

Daily Calibration and Data Collection Procedures

The EM-31 will be calibrated on a daily basis in an area free of metal. When possible, the instrument will be calibrated in the same location to limit the response variability from day to day. However, due to the size of the site, several calibration locations might need to be established throughout the survey area. The EM-31 will be set to collect approximately 10 readings per second in the vertical dipole mode while simultaneously collecting both quadrature and inphase readings. The operator will created a new file for each geophysical transect with the line number and starting position inputted into the data logger. Each line will be collected individually and at a consistent pace in order to insure the accuracy of each measurements positioning.

The G-858 magnetic gradiometer will be zeroed in an area free from metal at the start of each day or during an operator change. This process compensates a measured magnetic value and sets that level to zero. During testing the magnetic gradiometer will record the relative fluctuations in the magnetic field as a positive or negative response relative to the bench marked zero. The magnetic gradiometer will be set to record data every 0.1 meters.

Positional data will be collected using either a Trimble ProXH differential global positioning system (DGPS), or similar model. The DGPS data will be used to survey each geophysical transect prior to geophysical surveying. If possible, DGPS will be streamed into the magnetic and electromagnetic data loggers so positional data can be collected simultaneous of the geophysical readings. The accuracy of the DGPS data are generally one (1) meter or less and the field team will reference a known point at the start of each day to account for any day-to-day variation in the DGPS.

Data Processing

Electromagnetic Data

The EM data will be downloaded and then converted to a format compatible with contouring software using the program Dat31W by Geonics, Inc. In Dat31W the limits of each line will be defined and the data will be outputted into an XYZ format. The data will then be imported into the program Oasis Montaj by Geosoft. Quadrature data generally requires very little post processing and are generally displayed with only minor

variations to the color scale. Inphase data will be leveled using a subroutine called UCEDRIFT GX. This tool removes instrument drift from observable data sets but can also be used to level data. This process brings the "no response" or background values to zero by calculating the long wavelength embedded in the data using a non-linear convolution filter. Once data processing is completed, both the inphase and quadrature readings will be gridded using the minimum curvature method and then exported into Golden Software's Surfer 12.0 for final presentation.

Magnetic Gradient Data

The MAG data will be downloaded and then converted to a TXT format file compatible with contouring software using the Geotrics data transfer software. The data will then be imported into the program Oasis Montaj by Geosoft. These gradient data will first be leveled using a subroutine called UCEDRIFT GX. This tool removes instrument drift from observable data sets but can also be used to level data. This process brings the "no response" or background values to zero by calculating the long wavelength embedded in the data using a non-linear convolution filter. This is particularly useful for removing slight alternating variations (i.e., striping) caused by orientation of the sensors as the operator alternates direction of data collection. The process of removing this effect is known as de-striping. Once the data are de-striped the magnetic gradient readings will be gridded using the minimum curvature method and then exported into Golden Software's Surfer 12.0 for final presentation.

The results will be summarized in a field report describing the survey methods, field investigation program and results, which will be included as an appendix in the OU1 RI Report. The EM and MAG data will be presented as a series of georeferenced color-enhanced contour maps depicting the respective geophysical response variations across the surveyed area. The maps will be annotated to clearly identify interpreted waste filled area boundaries.

Test Pit Excavation

Test pits will be excavated to: 1) ground-truth the geophysical survey results, and 2) provide for inspection and field screening of potentially encountered waste fill. After review of the geophysical survey results, test pits will be excavated at approximately 10 selected locations along the waste fill boundary to evaluate geophysical anomalies suggested by the survey results, and waste material type and variability, including vertical extent if possible. Test pits will be excavated with a tracked hydraulic excavator (John Deere 200LC or equivalent) with a 2-foot wide bucket capable of reaching to a depth of 15 feet. Excavation will continue to the bottom of the waste layer until clean, natural material is encountered or the limit of the excavation equipment is reached. It should be noted that depending on site conditions at each location, the bottom of the waste layer may not be accessible due to excavation heaving resulting from the presence of shallow groundwater. The test pit results (presence or absence of waste, type extent) will be used to refine the interpretation of the geophysical survey results. The test pits will also provide for visual inspection, photo-documentation and screening of encountered waste. Visual inspections will focus on identifying evidence of potentially hazardous materials (drums, paint cans, etc.), construction debris or insulation suggestive of asbestos, medical waste (indicated by red plastic disposal bags, hypodermic needles, etc.), as well as evidence of more innocuous waste such as construction rubble and domestic waste. Special attention will be afforded to paper wastes (e.g., newspapers and magazines) with the intent to date the waste.

During waste excavation, real-time screening of the waste will be conducted to assess whether hazardous waste have been encountered, which should not be placed back into the excavation. Screening for organic chemicals will be conducted by the bucket load using a photoionization detector (PID). Any PID response greater than 100 ppm will be considered indicative of hazardous waste and the waste causing the exceedance will not be placed back into the excavation and will be collected for offsite disposal. Field screening will also include a gross gamma survey of the excavated waste. Any gross gamma response greater than twice the background gross gamma level will be considered indicative of rad-contaminated waste and the waste causing the exceedance will not be placed back into the excavation and will be collected for offsite disposal.

In the event source materials are identified during the investigations, items will be segregated for additional analysis. Isotopic analysis will be performed of the item to determine the radioisotope and activity of the item. Additional information, including date, time, technicians, GPS coordinates, photographs, dose levels, etc. will be documented for the item of interest. The location will be flagged and the item will be given a unique identifying number based upon the grid where the item was identified. All pertinent information will be noted in field notebook.

If discrete radioactive materials are identified during sampling activities, they will be segregated and stored separately. Additional screening of residual materials upon removal of source materials will be accomplished to determine whether materials are contaminated. This will be accomplished with instrumentation with sufficient sensitivity to detect low-level alpha/beta contamination e.g. GM Pancake probe (Ludlum 3/44-9). An action level will be established for each detector (e.g. 100 counts above background for the GM Pancake probe). The residual materials will be containerized and staged for disposal as IDW.

Specific additional test pit procedures include:

- Record the GPS position of the center of the planned test pit. A gamma scan of the surface will be performed prior to beginning the excavation.
- Collect all excavated material onto plastic sheeting.
- Overburden material (non-waste) will be segregated on the plastic sheet away from waste that may be excavated.
- Excavated waste material exceeding field-screening criteria (PID or rad) will be segregated into a separate pile on the plastic sheeting away from waste not causing an exceedance for offsite disposal.
- Visually describe and photo-document the excavated material and pit sidewalls and bottom (no personnel will enter the pit).
- Perform a scan for gamma radiation of the sides of the pit and of the material removed from the pit.
- Record all field screening measurements and photo-document any material that causes exceedance of the screening levels previously described.
- During backfilling, first place excavated fill material into the pit, following by the overburden material.
- Tamp the filled test pit using the excavator bucket.

If the edge of the waste cannot de delineated by test pitting along the drainage canal bordering the marsh area, borings will be advanced using a hand auger at approximately five locations to confirm the presence/absence of waste material and the edge of the waste fill. In addition, if test pitting confirms the presence of waste material up to the edge of the accessible area adjacent to the WPCP, approximately three DPT boring will be advanced in the roadway adjacent to the WPCP to confirm the presence/absence of waste material.

5.1.3 DPT Soil Boring Locations

DPT will be used to advance 50 borings within OU1 for the collection of continuous soil cores, surface and subsurface soil samples, and groundwater grab samples. DPT sample locations have been predetermined using a systematic grid pattern that evenly spaces the 50 sample points within the area using Visual Sampling Plan (VSP) software resulting in a 95% confidence level such that the size of the "hot spot" that can be detected is approximately 1 acre. Proposed DPT boring locations are presented on **Figure 5-5**. The co-ordinates for the 50 DPT boring locations are presented in **Table 5-1**.

DPT borings will be advanced to a depth of 10 feet or to the bottom of the waste fill (whichever is greater) at 44 of the 50 locations. In addition, six borings equidistantly spaced along the length of the impacted area will be advanced to the underlying Raritan confining layer (anticipated to be up to 70 feet deep) to characterize the underlying lithology. A Geoprobe® DT37 Dual-Tube sampling system will be used to collect continuous soil cores at each location in accordance with the Geoprobe® Dual-Tube Sampling System SOP. The DT37 soil sampling system uses a 3.75-inch O.D. probe rod to create 3-inch inner diameter (I.D.) boreholes, provides collection of 2-inch diameter continuous soil cores and allows for installation of 2-inch I.D. pre-pack wells or conventional monitoring wells within the inner cased borehole.

Each DPT soil core will be logged, screened for radiological contamination, and soil samples will be collected as described in the following sections. Upon completion of these activities, boreholes will be backfilled with bentonite (chips or pellets) and hydrated. Soil boring locations will be surveyed by a licensed surveyor. Drilling and lithologic logging procedures are presented in SOP No. 3-16 and SOP No. 3-17 and borehole abandonment procedures are presented in SOP No. 3-15. Excess soil generated during the DPT boring activities will be containerized and transported to the IDW storage area as low-level radioactive waste.

5.1.4 DPT Soil Sampling

At each DPT location, soil samples will be collected from the 5-foot soil core sections recovered in the Dual-Tube sampler plastic sleeves for ROPC and COPC analyses as follows:

- A surface soil sample will be collected from 0 to 6 inches bgs.
- A subsurface soil sample will be collected from the depth interval just above the saturated zone or from native soil encountered below waste fill if still within the vadose zone.
- This SAP assumes that an additional 30 biased subsurface soil samples will be collected from selected soil cores based at the discretion of the field team in locations along the soil core that exhibit visible staining, elevated readings on field instruments (e.g., PID readings above background), or other indicators of potential contamination.

- Two samples will also be collected from each location for ROPCs. One sample will be from the surface soil and a second sample will be a biased subsurface soil sample based on radiological screening of the core.

Following collection, samples will be immediately labeled and transferred to a cooler with ice and a trip blank. All equipment that is to be used at each location (spoon or scoop) will be stainless steel and will be decontaminated with Alconox/Liquinox cleaner and de-ionized water between each location. Soil sampling procedures are presented in SOP No. 3-21 and decontamination procedures are presented in SOP No. 3-06.

Soil Field Measurements

The cores will be screened by both a PID and a gamma detector to support the identification of gamma emitting radionuclides present on the GKP Site. Samples will be selected from the section of the core exhibiting the highest level of radiation. Material will not be removed from the core, before screening, to preserve volatiles for sampling.

Each DPT soil core will be logged by a geologist for lithology using the Unified Soil Classification System. All data collected (soil classification, PID readings, radiological survey results) will be recorded on the boring log. An example of the boring log is presented in Appendix C. Soil logging procedures are presented in SOP No. 3-16. Materials will be field screened using gamma spectroscopy prior to shipment of samples.

Down-Hole Gamma Radiation Survey

Each DPT borehole will be surveyed for gamma radiation by performing a down-hole gamma logging (DGL) radiation survey with the gamma count rates logged every foot of depth. A polyvinyl chloride (PVC) casing with an end cap will be inserted into the borehole prior to insertion of the probe to prevent water/running sand intrusion into the tube and possible trapping of the detector at depth. A gamma detector will be inserted inside the outer Dual-Tube sampler to provide data regarding the variation in gamma fluence with depth. A 1-minute integrated measurement will be performed using an environmentally encapsulated 1-inch by 1-inch NaI detector. Measurements will be collected starting at the bottom of the borehole and working toward ground surface. Integrated count rates in units of counts per minute (cpm) at each borehole location will be logged on the Field Boring Log sheet. An additional biased soil sample may be collected from the highest subsurface DGL interval recorded on the Boring Log, unless the interval coincides with the interval recorded during Soil Core Scanning.

Step-out DPT Soil Borings

During Step 3, it is assumed that four "step-out" DPT borings (i.e., located 10 feet north, south, east and west from the original boring) will be advanced at five selected Step 2 DPT locations based on evaluation of the Step 2 data. Sampling and analysis of surface and subsurface soil from the "step-out" borings will be the same as Step 2. However, based on the evaluation of the Step 2 data, selected analytes may be eliminated based on the absence of their detection. All "step-out" DPT locations will be surveyed after Step 3 (20 locations assumed).

5.1.5 Incremental Surface Soil Sampling

Surface soil sampling using ISM will be conducted during Step 3 to provide additional data to fulfill the RI requirements to delineate nature and extent of surface contamination for use in the human health and ecological risk assessment. The baseline risk assessment (See Section 8.0) requires a reliable estimate of the mean chemical concentrations in surface soil to which current and future receptors may be exposed. Such a mean estimate would require a very large number of discrete soil samples/analyses, especially for large areas such as the OU1, depending on a-priori estimates/assumptions about variability in chemical concentrations in surface soil at the OU1. Accordingly, the ISM approach is proposed to fulfill the goal of estimating mean chemical concentrations with greater confidence in OU1 surface soil for lower cost.

Potential Surface Soil Chemical Sources

No specific source areas for conventional chemicals contamination in surface soil have yet been identified within the OU1. Such areas may exist, however, considering these factors.

- A broad area of waste fill was deposited within the OU1 during the 1944-1948 timeframe.
- Waste fill may have become exposed at the surface at unknown locations within the OU1 during storm events that may have caused erosion of soil cover.
- The following existing borings from the TCRA confirm the presence of waste material (which could potentially contain chemical contamination) within the OU1 (see **Figure 5-2**):

GKP-B23-16

GKP-D23-14

GKP-F23-13

GKP-G24-11

GKP-J24-05

GKP-L24-06

GKP-N23-07

GKP-O23-08

GKP-Q23-09

GKP-R22-10

- Within the following map grids (**Figure 2-3**) elevated radiological reading have been confirmed, which could potentially be associated with conventional chemical contamination:

F22

H23

J22

J23

M22

M23

O22

O23

R22

S22

- Additional locations impacted by radiological and or conventional chemicals, to be identified based on the discrete soil sample results associated with the DPT boring program.
- Unknown potential sources not identified in the preceding bullets above.

Planned Decision Units

The 30 1-acre DUs planned are roughly consistent with the Step 2 DPT program based on the VSP generated 1-acre hot spot sampling design. Based on the above source considerations, **Table 5-2** lists the incremental surface soil DUs to be sampled by ISM. Of these, the locations for 14 DUs (DU1 through DU14) are proposed based on review of existing radiological survey data that confirm elevated radiological measurement, and boring data, which confirm the presence of waste material. The locations for DU15 through DU30 will be determined based on the results of the planned DPT boring program and associated discrete soil samples.

Incremental Sampling

From each DU, 30 soil increments will be collected and mixed together for shipment to the laboratory for processing and analysis. Section 5.3.5 of the ITRC guidance (ITRC, 2012) recommends the collection of a minimum of three replicate samples per each DU to evaluate variability and quantify uncertainty in the estimate of the mean concentration within the DU. However, the guidance further states that for sites with multiple similar DUs, "batch" type replicates may be a consideration; for example, three replicates in one DU could be used to provide an estimate of variability that is extrapolated to a number of similar DUs (similar to how labs use batch replicates for determining lab analysis precision). Replicate samples per DU consist of the initial ISM sample plus two additional ISM samples that are collected from locations that are different than the original, and each other. Since the 30 1-acre DUs are similar of type in terms of land use, release mechanism, COPC, and geology, replicate samples are not needed for each DU but will be collected in a batch manner at a rate of 10% for the 30 1-acre DUs for a total of 6 (six) replicate samples from three 1-acre DUs. By this approach, 30 analytical results corresponding to the 30 DUs (plus three sets of replicate results) will be produced by the laboratory for analyses (Section 5.1.6).

The reproducibility of the proposed three ISM replicates will be evaluated in terms of the relative standard deviation (RSD). The RSD will be calculated by taking the standard deviation of the three replicates divided by the mean of these replicates and multiplying by 100 to get RSD in percent. The RSD will serve as an estimate of dispersion or variability. An RSD of 35% or less will be indicative of low dispersion/variability. For risk assessment purposes, a 95% UCL will be calculated using the Student's t calculation. If the RSD exceeds 35%, it is indicative of a sampling design that did not adequately capture the heterogeneity within the decision unit. In these cases, the Chebyshev UCL calculation will be used for risk assessment purposes.

Using a professional licenses surveyor, the boundaries of each DU to be sampled will be marked in the field using stakes and flagging. By a random-walk approach, the surface soil increments will be collected using a

2-inch diameter 6-inch long foot driven corer. The sampling team will also utilize a hand-held GPS (Trimble Pro 6T units with hand-held Trimble Nomads) while collecting the increments to assure that coverage across the entire DU is achieved.

Radiological Bias Sampling

Up to 30 biased samples will be collected based upon the 3z evaluation of the GWS. Once identified, those locations exceeding the investigation level of 3z, will be placed on a site map and compared to the locations selected for ISM to determine if the radiological samples match to the ISM sample locations. During the collection of the ISM samples, a health physicist technician will conduct gamma radiation surveys at each incremental sample location. Depending on the relative radiation readings within each DU, the health physics technician will collect one biased surface soil sample for gamma spectroscopy analysis from the location of the highest count rate from each DU. If after collecting the surface sample, post sampling survey indicates the elevated activity remains, a subsurface sample (up to 1 foot in depth) will be collected.

Incremental Sample Processing

Prior to extraction in preparation for analysis, the following sample processing will be conducted by the laboratory in accordance with their SOP No. ST-QA-0038 (provided in Appendix B):

- Sample drying - The entire soil sample will be dried in air at room temperature (or less) to a constant weight, being careful not to expose the samples to direct sunlight.
- The dried samples will be placed into a 10-mesh (2 mm) sieve and the oversize fraction will be removed by passing it through a 10-mesh (2 mm) sieve.
- To obtain a subsample, the entire sample will be spread out on a clean surface so that it is only 1 or 2 cm thick.
- Then at least 30 different increments, i.e., portions (~0.3 g) will be obtained from randomly chosen locations by sampling the whole profile.

No sample will be subjected to grinding since the vast majority of the sample particle sizes are naturally smaller than 2 mm in size.

5.1.6 Soil Analytical Measurements/Methods

Surface and subsurface DPT soil samples will be analyzed for VOCs, SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs, PCDFs (as a cost saving measure, only 50% of the Step 2 soil samples will be analyzed for PCDDs and PCDFs), ^{226}Ra, ^{232}Th, and U_{nat} (isotopic uranium and isotopic thorium analyses may be conducted on 10% of the samples to more accurately quantify the activity). See Section 4.7 for analytical methodology. At each sampling depth, soils will first be collected for VOC analysis via Terra Core® samplers to minimize loss due to volatilization.

ISM surface soil samples will be analyzed for SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs and PCDFs. Sampling and analysis for VOCs is not planned since their presence in the highly exposed surface soil is unlikely.

Container type, quantities, required volumes, preservation requirements, and technical holding times for the soil samples are presented in **Table 4-6**. **Table 4-1** presents the RSLs, MCLs, ESVs, and laboratory MDL and LOQ for each analyte under the analytical methods to be used for soil analyses. **Table 5-3** presents the sample ID, field parameters to be measured, chemical analyses, and associated QC sample frequency for each individual soil sample to be collected during the OU1 RI.

5.2 Groundwater Sampling

This section describes the groundwater sampling and analysis activities that will be conducted to meet the objectives of the Step 2 and Step 4 RI approach described in the WP (Appendix D).

5.2.1 Groundwater Grab Sampling Locations

Following the DGL activities conducted during Step 2, shallow groundwater grab samples will be collected from 25 of the 50 DPT boring locations (**Figure 5-5**) where groundwater is present (including the six deep DPT borings advanced to the confining layer). For the purposes of the SAP, groundwater samples will be collected from every other DPT boring as shown on Figure 5-5. Some limited samples may be biased based on field observations of apparent soil chemical or radioactive contamination.

Temporary Well Point Installation and Development

Grab samples will collected from temporary well points installed through the outer tube of the Dual Tube sampler, which will consist of a suitable length of 1.5-inch I.D. schedule 40 PVC slotted screen fitted with an end cap. The well points will be surged and pumped using a 1.5-inch electrical submergible pump and dedicated plastic tubing to remove sediment until purge water is flowing clear. Well-point development and purge waters will be containerized and transported to the IDW storage area.

Temporary Well Point Sampling

Grab samples will be collected from selected well points by low-flow methodology using a peristaltic pump and disposable plastic tubing. The purge water will be directed through a flow-through cell, which will house a multi-parameter water quality meter (YSI 6920 or equivalent). The water quality parameters will be recorded every 5 minutes until the water quality parameters have stabilized (i.e., when three consecutive field parameter measurements of temperature, pH, specific conductivity, dissolved oxygen, oxidation-reduction potential and turbidity are within approximately 10%) or the well point has been pumped for 15 minutes. The flow-through cell will be disconnected and a sample will then be collected directly from the tubing unless the well point runs dry, in which case purging will be stopped. When the water level in the well has recovered, a sample will be collected. Samples for metals analysis will be field filtered using a 0.45 micron filter and analyzed for dissolved metals.

Following sample collection, the sample will be immediately labeled and transferred to a cooler with ice and a trip blank. Plastic tubing and filters will be discarded between wells. Groundwater sampling procedures are presented in SOP No. 3-14; decontamination procedures are presented in SOP No. 3-06.

Temporary Well Field Measurements

Groundwater quality parameters will be collected with a multi-parameter water quality meter (YSI 6920 or equivalent) with flow-through cell before sampling at each temporary well point, as discussed above. An example groundwater/surface water sampling log is provided in Appendix C. Groundwater field measurements will include:

- Visual inspection
- Time
- Amount purged at the time of recording
- pH
- Temperature (°C)
- Conductivity (milliSiemens per centimeter [mS/cm]
- Dissolved oxygen (milligrams per liter [mg/L])
- Oxidation-reduction potential/redox(millivolts [mV])
- Turbidity in nephelometric turbidity units (NTUs)

Groundwater field measurement procedures and methods are presented in SOP No. 3-14.

5.2.2 Monitoring Well Installation and Sampling

Step 4 includes permanent groundwater monitoring well installation and sampling, aquifer testing and a tidal study as described in the following subsections.

Monitoring Well Sampling Locations

While the exact locations of the permanent groundwater monitoring wells will be determined based on the results of the Step 2 groundwater investigation, this SAP provides the following preliminary monitoring well design to fulfill the OU1 RI requirements and determine the vertical and lateral extent of groundwater impacts:

- 5 water table wells within the waste filled area (screened 5-15 feet bgs)
- 5 shallow wells within waste filled area screened below fill (screened 20-30 feet bgs)
- 1 intermediate well within waste filled area (screened 40-50 feet bgs)
- 1 deep well within waste filled area (screened 60-70 feet bgs)
- A nested set of 1 shallow (20-30 feet bgs), 1 intermediate (40-50 feet bgs) and 1 deep well (60 – 70 feet bgs) downgradient of the waste filled area approximately 400 feet from the Raritan Bay Shoreline

These monitoring wells will also provide valuable groundwater data to determine groundwater flow direction, tidal influences, and transmissivity.

Monitoring Well Installation

The Step 4 monitoring wells will be constructed of 2-inch I.D. schedule 40 PVC riser pipe, and 10-foot pre-packed screen sections installed to bracket the sample depth intervals based on Step 2 groundwater grab sample analytical results. The driller will be licensed in the State of New York.

The 2-inch I.D. pre-packed monitoring wells will be installed via the Geoprobe® Dual Tube DT37 Sampling System in accordance with the Geoprobe® Dual-Tube Sampling System SOP, SOP 3-12 and Geoprobe® 2.0-in. I.D. x 3.4-in. outer diameter Pre-packed Screen Monitoring Wells SOP with the exception of ECT PrePak screens replacing the Geoprobe® pre-packed screens. (http://www.ectmfg.com/Product/WellConstructionSupplies/PrePackScreen.html)

ECT PrePak screens consist of an outer layer made of 0.065-inch mesh 304 Stainless Steel mesh and an inner layer of flush-threaded 0.010-inch (ten slot) machine-slotted Schedule 40 PVC screen with an O-ring seal and are packed with #0 silica sand acting as filter between the two layers. The screens will be 2-inch I.D. and composed of 5.0-foot long sections threaded together. The blank casing will also be constructed of 2-inch I.D. Schedule 40 PVC.

For wells screened below the water table, an expanding foam bridge of 2-inch I.D. and 0.5-feet length and a bentonite/quick seal sleeve of 2-inch I.D. and 2.5-foot length will be installed above the pre-pack well screen. The expanding foam bridge forms a compressible foam seal, wrapped in a degradable paper sleeve and expands instantly when it exits the bottom of the drive casing to provide a positive placement of a barrier that prevents solids and bentonite from passing into the screen interval. The bentonite sleeve further provides a positive placement of an impermeable annular seal below the water table.

Wells screened above the water table will be constructed using just the 0.5-foot expanding foam bridge (without bentonite/quick seal) and a 2-foot sand pack and 0.5-foot bentonite seal. All wells will be grouted above the bentonite seal to the surface.

Per direction from the NPS, wells will be lock-secured with keyed alike locks, and constructed as flush mount wells or "stick up" in areas where vegetation is dense. Per direction from the NPS, wells will be permanently labelled or marked for identification. The wells will be properly developed, and surveyed to ± 0.1-foot horizontal accuracy, and the base and top of riser casing surveyed to ± 0.01-foot vertical accuracy. All soil cuttings from well installation, and well development and purge waters, will be containerized and transported to the IDW storage area. Cuttings from the well drilling will be surveyed by gamma scanning to identify radiological anomalies. Monitoring well construction and development procedures are presented in SOP No. 3-12 and SOP No. 3-13.

Monitoring Well Sampling

Groundwater samples will be collected from monitoring wells using low-flow procedures via bladder pump from the installed monitoring wells. Water level measurements will be collected prior to sampling a monitoring well. An initial round of water level and depth to bottom measurements will be collected on the day before sampling is to begin. On the day of sampling, a water level measurement will be collected only as to not disturb sediment, which may have settled at the bottom of the well. A submersible low-flow bladder pump will be lowered to the mid-point of the submerged screen to ensure that the pump does not disturb sediment at the bottom of the well. An air compressor will be used to activate the pump and begin

the purging of the well. The pumping rate will then be adjusted as necessary to achieve the optimal flow rate of 0.1 to 0.5 liters per minute with minimal drawdown (target of less than 0.1-meter).

The purge water will be directed through a "Flow through Cell," which will house a multi-parameter water quality meter (YSI 6920 or equivalent). The water quality parameters will be recorded every 5 minutes along with the depth to water to monitor drawdown and pumping rate. The well will then be purged until the water quality parameters have stabilized, three casing volumes have been removed, or the well has been pumped for 1 hour with minimal or no drawdown. When any of these conditions have been met, the sample will be collected. If the monitoring well runs dry, purging will be stopped and the well will be allowed to recover (water level rebounds to initial water level). When the water level in the well has recovered, a sample will be collected using bailers.

Following sample collection, the sample will be immediately labeled and transferred to a cooler with ice and a trip blank. The bladder pump housing (stainless steel) will be decontaminated with Alconox/Liquinox cleaner and de-ionized water between each location. All non-stainless steel equipment will either be dedicated to a well (e.g., Teflon lined tubing) or will be discarded between wells (e.g., poly bladder kits). Groundwater sampling procedures are presented in SOP No. 3-14; decontamination procedures are presented in SOP No. 3-06.

Monitoring Well Field Measurements

Groundwater quality parameters will be collected with a multi-parameter water quality meter (YSI 6920 or equivalent) with flow-through cell before and during sampling at each monitoring well, as discussed in Section 5.4.4. An example groundwater/surface water sampling log is provided in Appendix C. Groundwater field measurements will include:

- Visual inspection
- Time
- Amount purged at the time of recording
- pH
- Temperature (°C)
- Conductivity (mS/cm)
- Dissolved oxygen (mg/L)
- Oxidation-reduction potential/redox (mV)
- Turbidity (NTU)
- Depth to water (feet below top of casing)
- Purge rate (milliliter per minute)

Groundwater field measurement procedures and methods are presented in SOP No. 3-14.

5.2.3 Groundwater Analytical Measurements/Methods

Groundwater samples will be analyzed for VOCs, SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs, PCDFs (as with soil only 50% of the Step 2 groundwater samples will be analyzed for PCDDs and PCDFs), ^{226}Ra and ^{228}Ra (via EPA 904/903), total uranium (via EPA 208) and gross alpha/beta via EPA 900. Container type, quantities, required volumes preservation requirements, and technical holding time for the groundwater samples are presented in **Table 4-6. Table 5-4** presents the sample ID, field parameters to be measured, chemical analyses, and associated QC sample frequency for each individual groundwater sample to be collected for the OU1 RI.

5.2.4 Aquifer Slug Testing

Aquifer hydraulic conductivity will be assessed by conducting slug tests on 3 shallow, 2 intermediate, and 2 deep monitoring wells. Slug tests will be conducted in accordance with SOP No. 3-35. The test data will be evaluated using AQTESOLV©, or a similar industry accepted software.

Slug tests will be performed a minimum of one week after well development to allow for stabilization of the water level in each well. Down-well equipment used during the slug testing will be decontaminated prior to insertion (SOP No. 3-06). The edges of the protective casing will be covered with duct tape to protect the pressure transducer cables. Prior to beginning the slug test, the static water level in the well will be measured and recorded.

The pressure transducer and cable will be installed in the well at least two feet from the bottom, and held in place using duct tape to keep the transducer at a constant depth. Typically, a minimum of a 7-foot water column is required in the well; however, adjustments can be made in the field utilizing different slug sizes (volumes) to accommodate actual conditions encountered. Due to this uncertainty with water level elevations, the seven wells for which slug testing will be performed will be identified after monitoring well construction and development.

Once the pressure transducer is in place, it will then be connected to the data-logging device and the initial water level recorded. The slug length and diameter will be recorded in the field logbook or field form for use in the data analysis. Either a pressure transducer connected to a data logger or a programmable down-hole data logger will be used to record the changes in water level during the test. The transducer will be set at least one slug length below the water surface so the slug does not disturb the transducer. After the water level has equilibrated to the static level, the data logger will be programmed to record water levels at logarithmically increasing intervals. A measured length of nylon string will be tied to the slug. The line will be of a length that will allow the top of the slug to be submerged beneath the static water level without touching the transducer.

A falling head test will initially be performed. The slug will be lowered part way into the well so that the bottom of the slug is just above the water surface. The data logger will be started and the slug will be simultaneously lowered into the water, so that the top of the slug is below the static water level. Care will be taken to lower the slug fast enough to produce as close to an instantaneous rise in the water level as possible, but not so fast as to produce a wave when the slug enters the water. When the water level returns to the static level, the falling head test is complete and the rising head test can be started.

After the data logger is reset following the falling head test and the static water level has stabilized, the rising head test will be started by activating the data logger and simultaneously removing the slug from the water column. The slug will be quickly removed from the water so that an instantaneous drop in the water level will occur, but it will be done smoothly enough to not disturb the transducer when removing the slug. When the water has returned to a static condition or the maximum duration of time has elapsed (typically 30 minutes), the test will be terminated.

All equipment that comes into contact with groundwater (e.g., slugs, transducer, and water level meter) will be decontaminated in accordance with SOP No. 3-06 before moving to the next location.

5.2.5 Tidal Study

Recording pressure transducers (Solinst Edge 3000 or equivalent) will be installed in six selected wells of different depths for a one-month duration to evaluate potential tidal influences on groundwater levels and movement within the OU1. Groundwater levels will be recorded every 15 minutes. Recorded tidal data will be compiled and compared with tidal data from the National Oceanographic and Atmospheric Administration tidal station at Great Kills Harbor (ID:8519436).

5.3 Surface Water Sampling

This section describes the surface water sampling and analysis activities that will be conducted to meet the objectives of the Step 2 RI approach described in the WP (Appendix D).

5.3.1 Surface Water Sampling Locations

Co-located surface water and sediment samples will be collected from four (4) discrete locations along the drainage canal within the OU1 (**Figure 5-5**). All surface water sampling locations will be surveyed in the field to ± 0.1 foot horizontal accuracy.

5.3.2 Surface Water Sampling

Surface water samples will be collected by submerging the sample containers directly below the surface of the water. The sample container will be allowed to fill slowly to prevent the collection of sediments and the loss of preservative, if present. If this sampling method cannot be used safely, a discrete sampler (e.g., Kemmerer, Van Dorn) or a dip sampler will be used to collect the surface water sample, which will be directly transferred from the sampler into the sample container.

Following sample collection, the samples will be immediately labeled and transferred to a cooler with ice and a trip blank. For all samples that are not collected directly, the sampler will be decontaminated with Alconox/Liquinox cleaner and de-ionized water between each location. Surface water sampling procedures are presented in SOP No. 3-10, and decontamination procedures are presented in SOP No. 3-06.

5.3.3 Surface Water Field Measurements

Surface water field measurements will be taken from samples collected using a multi-parameter water quality meter (YSI 6920 or equivalent). A reading will be collected at each sampling location and/or depth before sampling. An example groundwater/surface water sampling log is provided in Appendix C. Surface water field measurements will include:

- Visual inspection
- pH
- Temperature (°C)
- Conductivity (mS/cm)
- Dissolved oxygen (mg/L)
- Oxidation-reduction potential/redox (mV)
- Turbidity (NTUs)

Surface water field measurement procedures and methods are detailed in SOP No. 3-10.

5.3.4 Surface Water Analytical Measurements/Methods

Surface water samples will be analyzed for VOCs, SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs, and PCDFs. Values for Hardness will be calculated by the laboratory from the calcium and magnesium analyses results. Surface water samples will be analyzed for ^{226}Ra and ^{228}Ra (via EPA 904/903), total uranium (via EPA 908) and gross alpha/beta via EPA 900. Container type, quantities, required volumes, preservation requirements, and technical holding times for these surface water samples are presented in **Table 4-6**. **Table 4-3** presents the RSLs, MCLs, ESVs, and laboratory MDL and LOQ for each individual analyte under the analytical methods to be used for surface water analyses. **Table 5-5** presents the sample ID, field parameters to be measured, chemical analyses, and associated QC sample frequency for each individual surface water sample to be collected for the OU1 RI.

5.4 Sediment Sampling

This section describes the sediment sampling and analysis activities that will be conducted to meet the objectives of the Step 2 RI approach described in the WP (Appendix D).

5.4.1 Sediment Sampling Locations

Co-located surface water and sediment samples will be collected from four (4) discrete locations along the drainage canal within the OU1 (**Figure 5-5**). All sediment sampling locations will be surveyed in the field to ± 0.1 foot horizontal accuracy.

5.4.2 Sediment Sampling

Sediment samples will be collected using a hand operated dredge (e.g., Ponor, Young) or scope where possible from the 0 to 6-inch depth interval

Material to be sampled will first be excavated and placed in a stainless steel bowl for subsampling for the various analytes. If more than one collection is needed to provide enough material to complete sampling, VOC samples will be collected immediately after the collection of the first batch of material via Terra Core® samplers to minimize loss due to volatilization. After VOC sample collection and storage, additional material will be collected from the sample location to provide required volume. At that time, the material will be homogenized via stainless steel spoon and the remaining sample containers will be filled.

Following sample collection, the samples will be immediately labeled and transferred to a cooler with ice and a trip blank. All equipment that is to be used at each location (e.g., bowl, spoon, dredge, scoop) will be stainless steel and will be decontaminated with Alconox/Liquinox cleaner and de-ionized water between each location. Sediment sampling procedures are presented in SOP No. 3-22; decontamination procedures are presented in SOP No. 3-06.

5.4.3 Sediment Field Measurements

All material that is collected for sediment sampling, either by scoop or dredge, will be screened with a PID and a detector capable of gamma radiation detection. To screen the material with a PID, a portion of the material to be sampled will be collected into a plastic bag and sealed. After a period of 5 minutes, the bag will be opened slightly and the tip of the probe for the PID will be inserted into the bag (SOP No. 3-19). The material in the bowl will also be screened after homogenization, but before sample collection by a detector capable of gamma radiation detection. The highest value detected on each device will be recorded in the daily field log book.

5.4.4 Sediment Analytical Measurements/Methods

Sediment samples will be analyzed for VOCs, SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs, PCDFs, ^{226}Ra , ^{232}Th, and U_{nat} via gamma spectroscopy (isotopic uranium and isotopic thorium analyses may be conducted on 10% of the samples). Total organic carbon (TOC) analysis will also be conducted on sediment samples. The sediment samples will be collected after collecting the co-located surface water sample to minimize particulates in the surface water samples collected from the same locations. Container type, quantities, required volumes, preservation requirements, and technical holding times for the sediment samples are presented in **Table 4-6. Table 4-4** presents the RSLs, MCLs, ESVs, and laboratory MDL and LOQ for each individual analyte under the analytical methods to be used for sediment analyses. **Table 5-6** presents the sample ID, field parameters to be measured, chemical analyses, and associated QC sample frequency for each individual sediment sample to be collected for the OU1 RI.

5.5 Background Sampling

Surface and subsurface soil, groundwater, sediment, and surface water background samples will be collected consistent with the sampling processes described above in Sections 5.1 through 5.4. The

preliminary locations of background samples subject to field verification of accessibility are provided on **Figure 5-6.** The actual locations may vary slightly based on field determination. The background sampling and analysis activities include:

- Advancement of 15 DPT borings evenly spaced within the background soils study area using VSP software resulting in a 95% confidence level such that the size of the "hot spot" that can be detected is approximately 1 acre and collection of continuous soil cores to a depth of 10 feet or the water table, whichever is shallowest.
- From each soil core, collection of one surface soil (0-6 inches bgs) sample, and one subsurface soil sample from the depth interval just above the saturated zone.
- Collection of one ISM sample for surface soil consisting of 30 increments by a random walk approach throughout the background soils study area (considered as one decision unit), plus two replicate ISM samples of the same area.
- A gamma walkover survey for the locations to be sampled (i.e., 10-foot x 10-foot area centered over the sample point).
- Gamma radiation survey of each DPT borehole via down-hole gamma logging with the gamma count rates logged every foot of depth.
- DPT surface and sub-surface soil samples will be analyzed for VOCs, SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs, PCDFs [consistent with OU1, only 50% of the samples will be analyzed for PCDDs and PCDFs], and ^{226}Ra, ^{232}Th, and U_{nat} (isotopic uranium and isotopic thorium analyses may be conducted on 10% of the samples to more accurately quantify the activity). ISM samples will be analyzed for all of the same analytes except VOCs and radionuclides.
- Installation, development, and sampling of four shallow background groundwater monitoring wells located along Hylan Boulevard. Monitoring wells will be sampled using low-flow methodology and groundwater samples will be analyzed for VOCs, SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs, PCDFs, and ^{226}Ra and ^{228}Ra via EPA 904/903, total uranium via EPA 208, gross alpha/beta via EPA 900 and isotopic uranium via alpha spectroscopy.
- Four background surface water samples will be collected from locations upstream of the OU1 area and analyzed for VOCs, SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs, PCDFs, and ^{226}Ra and ^{228}Ra via EPA 904/903, total uranium via EPA 208, gross alpha/beta via EPA 900 and isotopic uranium via alpha spectroscopy.
- Four background sediment samples will be collected from locations co-located with the background surface water sample locations upstream of the OU1 area and analyzed for VOCs, SVOCs, metals including mercury, pesticides, PCBs, herbicides, PCDDs, PCDFs, and ^{226}Ra, ^{232}Th, and U_{nat} (isotopic uranium and isotopic thorium analyses may be conducted on 10% of the samples to more accurately quantify the activity).

5.6 Sample Handling

This section describes the sample handling protocol for environmental samples collected during the OU1 RI.

5.6.1 Sample Designation

Each sample will receive a unique designator. (i.e., the field sample ID). Unique designators will be an alpha-numeric combination that signifies the sample location or decision area, matrix, depth, or river reach. Sample handling and designation will conform to the procedure presented in SOP No. 3-04 and as described below.

5.6.2 Sample Labeling

Field sampling personnel will properly identify all samples collected in the field with an adhesive sample label attached to each sample container. The sample label will contain the site/project name, sample designation (field sample ID), date, time, sample location, sampler's initials, analyses required, and identification of preservatives used. Sample information will be legibly printed with waterproof ink. The sample designation will be used on field sheets, CoC forms, and other documentation.

A sample numbering system is used to uniquely identify each sample collected and submitted for analysis. The purpose of the numbering system is to assist in the tracking of samples and facilitate retrieval of analytical results. Sample identification numbers will be used on sample labels, CoC forms, field logbooks, and all other applicable documentation. A listing of all sample identification numbers will be recorded in the field logbook along with the depth of samples if collected in the subsurface.

General Scheme for Normal and Duplicate Field Samples

- **Field Sample ID for Soil Samples: XXX-#-TTZZZ**
- **Field Sample ID for Groundwater Samples: XXX-#-TTZZZ**
- **Field Sample ID for Sediment Samples: XXX-#-TTZZZ**
- **Field Sample ID for Surface Water Samples: XXX-#-TTZZZ-DD**

where:

1. XXX-# = **"OU1-# "** (Operable Unit 1) to be used for all samples within OU1. Each corresponding sample will additionally be identified by which step (#) the sample was taken. For background samples, "XXX-#" will be just "BG" since there are no steps associated with the background study
2. TTZZZ = Location ID (5 characters) – unique identifier for the sampling locations

    2a. TT = Sample Location Type: ; **SW** – surface water (e.g., pond, river, stream) location; **SE** – sediment location (co-located with surface water locations); **SS**– surface soil sample; **SU**– sub-surface soil sample; **ISM**–Incremental sampling methodology location; **MW** –

permanent monitoring well; **TW** – temporary monitoring well location collected at a soil boring;

2b. ZZZ = A sequential three-digit integer starting with 001 and running through 999. Unique ID assigned by AECOM-Tidewater JV to identify the sampling location.

Surface and subsurface soil samples collected at the same location (i.e., soil boring) will be assigned the same location ID.

Co-located surface water and sediment samples will be assigned the same location ID.

Field Sample IDs for Field Duplicates. The following will be added to the end of the sample ID: "DUP" In addition to the field duplicates, Matrix Spike (MS) and Matrix Spike Duplicates (MSD) will be collected at a rate of 5%. The MS/MSD samples will be identified on the COCs.

Examples of Field Sample IDs for Surface and Subsurface Soil Samples collected during Step 2:

- For Soil Boring Location 001: **OU1-2-SS-001** (surface soil sample); **OU1-2-SSZZZ-DUP** (surface soil sample duplicate; location TBD); **OU1-2-SU-001** (subsurface soil sample collected); **OU1-2-SUZZZ-DUP** (sub-surface soil sample duplicate; location TBD).

Examples of Field Sample IDs for ISM Samples collected during Step 3:

- For ISM Locations, 30 aliquots of soil will be collected within the OU1 sample unit (SU) to create a homogenous sample: **OU1-3-ISM001-XX**, where the "XX" will be the location and number (out of 30) within the SU.

Examples of Field Sample IDs for Sediment and Surface Water Samples collected during Step 2:

- For Surface Water Location 001: **OU1-2-SW001,** (surface water sample); **OU1-2-SE001-and OU1-2-SWZZZ-DUP** (surface water and duplicate sample collected from stream for first sampling event).

Examples of Field Sample IDs for Groundwater Samples:

- For a groundwater sample collected at monitoring well MW004 during Step 2 sampling: **OU1-2-GW-TW-ZZZ.**
- For groundwater sample collected at monitoring well MW004 during Step 4 sampling: **OU1-4-GWZZZ**.

Water Quality Control Samples – Trip Blanks, Ambient Blanks, and Equipment Blanks

Field Sample ID = **XXXTTMMDDYY-CCC**

where:

1. XXX = OU1 to be used for all samples.
2. TT = QC Sample Type. **TB** – trip blank; **AB** – ambient blank; **EB** – equipment blank.
3. MMDDYY = Sample Date.
4. CCC = Sample Counter. A sequential two-digit integer starting with 001. Unique ID assigned by AECOM-Tidewater JV to be used if multiple samples of a particular type (trip blank) are collected on the same day.

Examples of Field Sample IDs for Water Quality Control Samples:

- For trip blank #1 collected on May 7, 2016: **OU1TB050716-001**.
- For trip blank #2 collected on May 7, 2016: **OU1TB050716-002**.
- For ambient blank #1 collected on August 2, 2016: **OU1AB080216-001**.
- For ambient blank #2 collected on August 2, 2016: **OU1AB080216-002**.
- For equipment blank #1 collected on November 20, 2016: **OU1EB112016-001**.
- For equipment blank #2 collected on November 20, 2016: **OU1EB112016-002.**

6 Data Management

This section summarizes the data management procedures that will be implemented for the OU1 RI, specifically:

- Field documentation procedures
- The analytical laboratory's electronic data deliverables
- Project file management and retention
- Field sampling and laboratory test and result data, including QC, will be compiled in an EQuIS (http://www.earthsoft.com) database. EQuIS is an industry-standard environmental data management platform, which will allow the project team to rapidly integrate, verify, and report on sampling and lab test results. The AECOM Tidewater JV is currently using EQuIS version 6.4.2, and keeps current with EQuIS version releases. Security of the EQuIS database will be controlled so that only the AECOM Tidewater JV data manager and other trained personnel they designate will be allowed to add or edit data. The EQuIS database will be available to select project team staff for reporting purposes, and the data manager will verify that these staff are trained to perform these tasks accurately.

6.1 Field Documentation Procedures

Fieldwork will include fully documented sample collection, preservation, and handling procedures as defined in the FSP. A number of different documents will be completed for the fieldwork. The documents will provide a summary of the sample collection procedures and conditions, shipment method, analyses requested, sample custody history, and field technique improvements as required. The field documentation for the OU1 will include:

- Field logbooks
- Sample collection forms
- CoC forms
- Field QC audit reports

Direct read data and/or measurements collected during fieldwork will be written into the field logbook or on customized and numbered field forms, immediately upon collection of measurements. All notations will be written in indelible ink and all entries will be signed and dated. If entries must be changed, the reason for the change should be noted and the change should not obscure the original entry (e.g., a single line drawn through text or an X through figures, tables, or maps). The change will be initialed and dated by the responsible person. If space is available, revisions will be added to the same page. Otherwise, the page where the revision is entered will be noted. Any lost, damaged, or voided field logbooks will be reported to the PM immediately.

Field records will be collected and verified daily by the site manager (or designee), who will review the data for completeness, accuracy, legibility, and comparability with other data collected, and verify the field data records have been signed and dated. Based on this review, the site manager will direct field staff to make

necessary corrections to the record and to initial and date the corrections. Any omissions or inconsistencies discovered will be resolved by the site manager, who will seek clarification from the field personnel responsible for data collection.

After data reduction and entry into the project database, field data will be verified by qualified personnel for completeness, consistency with hardcopy records, and anomalous values. Field data, including both electronic and hardcopy documentation, will be reviewed by the site and/or PM prior to inclusion in technical reports, and may be reviewed by the Program QC Manager (or technical designee) as part of ongoing QC review of project activities.

6.2 Analytical Laboratory Electronic Data Deliverables

Analytical data from the laboratory for the OU1 will be managed using the EQuIS database, therefore, analytical data from the laboratory for the OU1 will be delivered using AECOM's version of the EQuIS 4-file format. The format and EDP software to check the EDDs before delivery are available from http://www.earthsoft.com/products/edp/edp-format-for-aecom/ The OU1 data manager will provide ARS International with the Reference Values File, containing valid values for coded data elements, before the first sampling event begins.

EDD files received from the laboratory will be stored in the project file archive (see Section 6.3). The AECOM Tidewater JV data manager will verify the EDD is error free using the EDP software and AECOM format, and if so, will load the EDD into the project EQuIS database. If errors are found in the EDD, the laboratory will be contacted for corrective action.

The analytical laboratory also will be required to provide a .pdf document file of the laboratory's final data report. The laboratory will be required to make available any supplemental information (e.g., chromatograms, instrument calibrations) upon request. All electronic data submitted by the laboratory will be required to be error-free and in complete agreement with the hardcopy data. Data files will be delivered via e-mail, high density compact disk (CD), or ftp site. The data files will be submitted with a transmittal letter from the laboratory that certifies that the files are in agreement with hardcopy data reports and have been found to be free of errors using the EDP software and AECOM format referenced above. The laboratory, at their cost, will be required to correct any errors identified by the AECOM-Tidewater JV or USACE.

6.3 Project File Management and Repository

Electronic Data. Electronic files provided by the analytical laboratory and any geographic information system (GIS) data layers, historic records/documents including previous study reports, historic drawings and maps, and related items provided by USACE or other stakeholders will be securely stored on a secure private network located at the AECOM office at 3101 Wilson Boulevard, Suite 900, Arlington, Virginia, and the Tidewater office in Elkridge, Maryland. Access to these files is restricted to only those personnel with key responsibilities to the project and who have been granted authority by the AECOM-Tidewater JV PMs. These electronic files will be backed-up daily, weekly, monthly, and yearly.

Hardcopy Data. Various hardcopy files, including the Task Order and any modifications, correspondence, including meeting minutes and monthly reports, all relevant records, reports, logs, field logbooks, pictures,

subcontractor reports, and data reviews, draft submittals, responses to comments and final submittals, and correspondence will also be stored within the secure AECOM-Tidewater JV project files located at the AECOM Arlington office and the Tidewater office in Elkridge, Maryland. Access to these offices is limited to AECOM-Tidewater JV personnel though a door security system and all employees and visitors are badged.

The project information files will include, at a minimum:

- Field logbooks;
- Field data and data deliverables;
- Photographs
- Drawings
- Laboratory data deliverables
- Data validation reports
- Data quality assessment reports
- Progress reports, QA reports, interim project reports
- All custody documentation (e.g., tags, forms, air bills)

In addition to the above information, the project files will also maintain contractual information. This includes, but is not limited to, contract information, cost proposal information, and invoice records.

7 Assessment and Oversight

This section describes the measures that will be employed to ensure that this SAP is implemented properly. These include conducting planned and documented performance audits for field operations to assess the accuracy of the measurement systems and to determine the effectiveness of QA/QC procedures outlined in Section 4.6 and compliance with project SOPs.

7.1 Assessment and Corrective Actions

The assessment and corrective actions will be implemented as follows:

- The PM will have the ultimate responsibility for implementing project QA/QC procedures. He will have primary responsibility for coordinating audits and the authority to delegate certain audit functions to technical specialists, as necessary. Auditors will be independent of any direct responsibility for performance of the activities that will be audited.
- Field audits will be scheduled to provide coverage and coordination with ongoing project activities. Audits will be performed in accordance with written procedures or checklists as early in the life of the task or work activity as practical.
- Activities that have been selected for auditing will be objectively evaluated against the specific requirements for the activity, including methodologies, procedures, instructions, and recordkeeping. Documents and records will be examined to the extent necessary to determine if the QA program is effective and properly implemented. Audit reports will include the following information (as appropriate):

Description of the audit scope

Name of the auditor(s)

Audit notification

Identification of persons contacted during audit activities

Summary of audit results, including the effectiveness of the QA program elements that were audited

Descriptions of each reported audit finding in sufficient detail to enable corrective action to be taken by the audited organization

Audit completion notification

- Audit reports will be prepared by the specified auditor within 2 weeks of audit completion. A copy of each audit report will be given to the PM and the QA Manager for appropriate review and distribution. The management of the audited organization or activity will investigate audit findings, determine the cause of the condition identified in the finding, schedule corrective action (including measures to prevent recurrence), evaluate the impact of the finding on completed work, and notify the PM or designee and the QA Manager in a written report of action taken or planned. The PM or designee and the QA Manager will be responsible for verifying and documenting completion of the corrective action.

7.1.1 Field Audit and Response Actions

The PM or his designee will conduct the field investigation audit(s) and review of records of field operations to verify that field-related activities are performed in accordance with appropriate project procedures. Items to be examined will, as appropriate, include:

- Availability and implementation of approved SOPs
- Calibration and operation of equipment
- Labeling, packaging, storage, and shipping of samples
- Performance documentation and checking
- Subcontractor performance and nonconformance documentation
- Field documentation and the collection of field quality control samples, including duplicates/replicates and field quality control samples (trip blanks, ambient blanks, equipment blanks, and MS/MSDs)
- The field auditor(s) will document specific deviations from the SAP in an audit report that will be provided to the PM and QA Manager. The PM will be responsible for identifying necessary corrective actions, communicating the corrective actions to the field team, and verifying the corrective actions have been implemented. Depending on the deviations and potential impact to project quality, the PM may stop work on the project if necessary.

7.2 Quality Assessment Reporting

In addition to the performance audit reporting discussed in Section 7.1, QA reports will also be generated for activities discussed in the following sections.

7.2.1 Data Verification

Data verification procedures described in Section 4.6.3 will be conducted on each SDG by the Project Chemist as sample data packages are generated by the laboratory. Verification activity findings will be included along with data summaries in the OU1 RI Report. Issues potentially affecting the usability of data will be reported by the Project Chemist to the PM and QA Manager as soon as they are identified so that appropriate corrective actions can be identified and implemented.

7.2.2 Data Validation

Data validation procedures described in Section 4.6.3 will be conducted on each SDG by the Project Chemist as sample data packages are generated by the laboratory. Validation activity findings will be included along with data summaries in the OU1 RI Report. Issues potentially affecting the usability of data will be reported by the Project Chemist to the PM and QA Manager as soon as they are identified so that appropriate corrective actions can be identified and implemented.

7.3 Reconciliation with DQOs and Data Usability

An assessment of data quality will be conducted to determine whether the project DQOs have been achieved. The Project Chemist will document the results of the assessment, including whether any changes are necessary to the DQOs because data do not met usability criteria, in data quality assessment reports that will be included in the OU 1 RI Report.

The data usability assessment will include a review of the sampling and analysis activities in comparison to the project DQOs. The results of the data validation will be reviewed to identify specific limitations to the data (i.e., results qualified as estimated [J/UJ] or rejected [R]) for particular uses, such as data interpretation/analysis/risk assessment. The assessment will also consist of a comprehensive evaluation of how the data meet the DQIs (precision, accuracy, representativeness, and completeness) to identify potential or actual problems with the data collection process and impacts to data so that corrective measure can be identified and implemented. Data that do not satisfy DQIs will be evaluated to determine the potential impacts based on the extent of the deficiencies and the importance of the data in the overall context of the investigation. Corrective measures will be implemented including conducting additional field measurements and resampling as warranted to ensure that all data are valid, legally defensible, of known quality, and can be used without limitations as qualified to meet the investigation DQOs.

8 Investigation Outputs

After completion of the field program of the OU1 RI, an RI Report will be submitted to the Project Management Teamthat presents pertinent information gathered during the RI, summarizes pertinent analytical data in environmental media, screens analytical data against human and ecological risk screening values (RSLs and ESVs) to identify ROPCs/ROPECs and COPCs/COPECs in environmental media, provides baseline human health and ecological risk assessments, and summarizes the findings and recommendations of the RI.

The RI Report will include:

- Introduction
- Summary of historical investigations conducted to date
- Description of the areas investigated
- Physical characteristics of the areas investigated
- Nature of contamination identified, including environmental media
- Background area investigation findings
- Screening assessments (as part of the baseline risk assessments) to identify ROPCs/ROPECs and COPCs/COPECs
- A baseline human health risk assessment (HHRA) to provide an analysis of baseline risks posed to human health as a result of potential exposures to radiological and non-radiological contaminants in environmental media
- A baseline ecological risk assessment (BERA) to provide an analysis of baseline risks posed to ecological receptors as a result of potential exposures to radiological and non-radiological contaminants in environmental media
- Appendices, including boring logs, well construction diagrams, field sampling forms, SDGs containing the laboratory analytical results, and data validation reports

9 References

Agency for Toxic Substance and Disease Registry (ATSDR). 2007. *Health Consultation, Great Kills Park, Richmond County, Gateway National Recreation Area, National Park Service, Staten Island, New York*. 25 May.

ANSI/HPS N13.12-1999, Draft 2010, ANSI/HPS N13.12 Surface and Volume Radioactivity Standards for Clearance.

Baker. 2007. *Final Preliminary Assessment Report for Potential Radiological Contamination at Great Kills Park*. August.

Cabrera Services. 2010. *Interim Response Action Report, Radiological Material Removal and Disposal, Great Kills Park, Staten Island, New York.* November.

Dallas, K., P. Ruggiero, and M. Berry. 2013. *Inventory of coastal engineering projects in Gateway National Recreation Area. Natural Resource Technical Report NPS/NRSS/GRD/NRTR—2013/738.* National Park Service, Fort Collins, Colorado.

Environmental Data Resource. 1929. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: July 1, 1924.* Source: EDR.

Environmental Data Resources. 1940. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: April 6, 1940.* Source: EDR Proprietary Aerial Viewpoint.

Environmental Data Resources. 1951. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: April 7, 1951.* Source: EDR Proprietary Aerial Viewpoint.

Environmental Data Resources. 1961. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: April 23, 1961.* Source: EDR Proprietary Aerial Viewpoint.

French & Parrello Associates, PA. December 2, 1993. *Report of Subsurface Exploration and Geotechnical Engineering Evaluation, Phase II Design, Great Kills Visitor Center, Staten Island, New York.* (GATE_646_0243_0001.pg.pdf).

French & Parrello Associates, PA. June 22, 1998. *Report of Subsurface Exploration and Geotechnical Engineering Evaluation, Great Kills Field Station, National Park Services, Staten Island, New York*. (646__D358.pdf).

Harland, W.B., A.V. Cox, P.G. Llewellyan, C.A.G. Pickton, A.G. Smith, and R. Walters, 1982. *A Geologic Time Scale.* Cambridge University Press, Cambridge.

Intergovernmental Data Quality Task Force (IDQTF). 2005. *Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs*. EPA/505/B-04/900A; DoD DTIC ADA 427785.

Interstate Technology Regulatory Council (ITRC). 2012. *Technical and Regulatory Guidance: Incremental Sampling Methodology (ISM-1)*. February.

Johnson. 1985. *Structural Engineering Services for the Beach and Bathhouse Facility at the Gateway National Recreation Area, Staten Island, New York.*

Merguerian, C., and Sanders, J.E. 2010. *Guide 04: Staten Island and Vicinity, New York and New Jersey, Trip 04: April 15, 1989; Trip 19: September 29, 1991; Trip 33: October 16, 1994.* New York Academy of Sciences Section of the Geological Sciences, Trips on the Rocks Guidebook, 110p.

Moses R. NYC Department of Parks. 1949. *Letter to W. O'Dwyer, Mayor NYC re Summary of Dept. of Parks Activities on Staten Island*. July 1, 1949.

Mueser Rutledge Consulting Engineers. 1991. *Letter Report to Lane Frenchman & Associates, re Great Kills Park, Subsurface Investigation Report*, May 21, 1991.

National Aerial Resources. 1975. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: April 1, 1975.* Source: EDR NAR.

National Park Service (NPS). ND. *Natural Resource Management Reference Manual #77.* http://www.nature.nps.gov/rm77/. Accessed February 2, 2014.

NPS. 2014. *Gateway National Recreation Area, Final General Management Plan, Environmental Impact Statement. Record of Decision*. June.

NPS. 2014a. *NPS Sampling and Analysis Plan Template*, Final, 13 November.

NPS. 2014b. *NPS-Specific CERCLA ARARs and TBCs*.

NPS. 2014c. *Conceptual Site Model Guidance*.

NPS. 2016a. *NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes*. Revision 2. February.

NPS. 2016b. *NPS Protocol for the Selection and Use of Ecological Screening Values for Radiological Analytes*. Revision 2. January.

NPS. 2014e. *NPS Data Quality Primer*.

NRC Title 10 Code of Federal Regulations, Part 20, Appendix B

NUREG-1757, Vol. 1, Rev 2; Consolidated Decommissioning Guidance, Decommissioning Process for Materials Licensees, Sept 2006

New York City Department of Parks. *1936. Press Release,* November 19, 1936.

New York City Department of Parks. *1941. Press Release,* April 28, 1941.

New York City Department of Parks. 1943a. *Contract Drawings for Dredging of Basin for Unloading Plant in Great Kills Park, Borough of Richmond*, Contract No. R-16-243.

New York City Department of Parks. 1943b. *Great Kills Park, Borough of Richmond, Dredging and Fill Areas, Plan & Sections. R-16-243 Sheet No. 2* (August 6, 1943).

New York City Department of Parks. 1943c. *Great Kills Park, Borough of Richmond, Dredging and Fill Areas, Coordinates and of Dredging Area*. R-16-243 Supplemental Sheet No. 1 (October 8, 1943).

New York City Department of Parks. 1947a. *Great Kills Park, Borough of Richmond, Hydraulic Fill in Great Kills Park, Borough of Richmond*. Contract No. R-16-147 (Sheet 1 of 3).

New York City Department of Parks. 1947b. *Great Kills Park, Borough of Richmond, Hydraulic Fill Plan and Sections. R-16-147 Sheet No. 2*. (January 31, 1947).

New York City Department of Parks. 1947c. *Great Kills Park, Borough of Richmond, Hydraulic Fill Plan and Descriptive Sign. R-16-147 Sheet No. 3*. (January 31, 1947).

New York City Department of Parks. *1947d. Press Release*, April 17, 1947.

New York City Department of Parks. *1947d. Press Release*.

New York City Department of Parks. *1949. Press Release.* (Included attached statistical data furnished by the NYC Department of Sanitation.

New York City Department of Sanitation. 1941. *Survey of Landfill Characteristics, New York City, as a report on Official project no. 65-1-97-1, W. P. SU-1, Federal Works Agency, Work Projects* Administration for the city of New York.

New York City Department of Sanitation. *1946. Annual Report*.

New York City Department of Sanitation. *1947. Annual Report*.

New York City Department of Sanitation. *1948. Annual Report*.

New York City Department of Sanitation. *1949. Annual Report*.

New York City Department of Water Resources. 1969. *Report on Preliminary Design, PW-136 Oakwood Beach WPCP. April 1969. New York City*, Environmental Protection Administration, Department of Water Resources, Bureau of Water Pollution Control.

Perlmutter M. N., T. Arnow. 1953. *Ground Water in Bronx, New York and Richmond Counties with Summary Data on Kings and Queens Counties, New York City, New York.* State of New York, Department of Conservation, Water Power and Control Commission, Ground Water Bulletin GW-32.

Rosenberg, S. 2013. *Hydrogeology of Staten Island, New York, A Final Report. M.S. Thesis*. Stony Brook University.

Scanlon, Arthur J., 1957. Utilization of Sewage Sludge for the Production of Topsoil. Presented at the 1957 Annual Meeting, New York Sewage and Industrial Wastes Association; New York, NY. January 17-18, 1957.

Sidney M. Johnson and Associates. 1985. *Report Structural Engineering Services for the Beach and Bathhouse Facility at the Gateway National Recreation Area, Staten Island, New York*. Depart of the Interior, National Park Service, Denver Colorado, 80225-0287, Contract No. CX-2000-5-0004.

Soren, J. 1988. *Geologic and Geohydrologic Reconnaissance of Staten Island, New York:* United States Geological Survey Water Resources Investigations Report 87-4048, 22 p.

Stumm, F., Lange, A.D., Candela, J.L. 2004. *Hydrogeology and Extent of Saltwater Intrusion in the Northern Part of the Town of Oyster Bay, Nassau County, New York*: 1995-98: U.S. Geological Survey Water-Resources Investigations Report.

Tidewater. 2015. *Final, Great Kills Park Time Critical Removal Action Completion Report, Great Kills Park, Staten Island, New York*. June.

U.S. Coastal and Geodetic Survey. 1949. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: April 28, 1949*. Source EDR USC&GS.

U.S. Department of Agriculture National Agriculture Imagery Program. 2006. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Year: 2006*. Source: EDR USGS/NAIP.

U.S. Department of Agriculture National Agriculture Imagery Program. 2009. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Year: 2009*. Source: EDR USGS/NAIP.

U.S. Department of Agriculture National Agriculture Imagery Program. 2011. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Year: 2011*. Source: EDR USGS/NAIP.

United States Environmental Protection Agency (USEPA), 1989. Risk Assessment Guidance for Superfund (RAGS): Vol. 1, Human Health Evaluation Manual, Part A. Interim Final. Office of Emergency and Remedial Response, Washington, DC. EPA/5401-89/002. December.

USEPA, 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual. Supplemental Guidance, Standard Default Exposure Factors - Interim Final. OSWER Directive 9285.6-03. Office of Emergency & Remedial Response Toxics Integration Branch, Washington, DC. March.

USEPA. 1992. Guide to Management of Investigative-Derived Wastes. Publication: 9345.3-03FS. January.

USEPA, 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. Office of Emergency and Remedial Response, EPA/92857-08. May.

USEPA, 2000, Radionuclide Rule, 66 FR 76708, December 7, 2000

USEPA. 2001. *EPA Requirements for Quality Assurance Project Plans*. EPA/240/B-01/003. March.

USEPA, 2001. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments). December.

USEPA. 2002a. *Guidance for Quality Assurance Project Plans*. EPA/240/R-02/009. December.

USEPA. 2002b. *Guidance on Choosing a Sampling Design for Environmental Data Collection: for Use in Developing a Quality Assurance Project Plan*. EPA/240/R-02/005. December.

USEPA. 2002c. *Guidance on Environmental Data Verification and Data Validation*. EPA/240/R-02/004. November.

USEPA, 2003. Human Health Toxicity Values in Superfund Risk Assessment. Office of Superfund Remediation and Technology Innovation. December 5, 2003. OSWER Directive 9285.7-53.

USEPA. 2003a. *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information*. EPA/100/B-03/001. June.

USEPA. 2003b. *Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples*. EPA/600/R-03/027. November.

USEPA, 2004. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final. Office of Superfund Remediation and Technology Innovation, Washington, DC. July.

USEPA. 2006a. *Guidance on Systematic Planning Using the Data Quality Objectives Process*. EPA/240/B-06/001. February.

USEPA. 2006b. *Data Quality Assessment: Statistical Methods for Practitioners*. EPA/240/B-06/003. February.

USEPA. 2006c. *Data Quality Assessment: A Reviewer's Guide*. EPA/240/B-02/002. February.

USEPA. 2008. *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*. EPA/540/R-08/002. April.

USEPA, 2009a. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). Final. Office of Superfund Remediation and Technology Innovation, Washington, DC. EPA-540-R-070-002. January.

USEPA, 2009b. 2009 Edition of the Drinking Water Standards and Health Advisories. Office of Water. October.

USEPA, 2009c. National Recommended Water Quality Criteria. Office of Water, Washington, D.C.

USEPA, 2010. Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds. Risk Assessment Forum, Washington, DC. EPA/600/R-10/005.

USEPA. 2011. *Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model*. EPA/542/F-11/011. July.

USEPA. 2012. "Guidance for Evaluating and Documenting the Quality of Existing Scientific and Technical Information." Addendum to: *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information*. December.

USEPA, 2015. Regional Screening Level Table, Mid-Atlantic Risk Assessment. USEPA Region 3. November. Available online at http://www.epa.gov/reg3hwmd/risk/human/index.htm

USEPA, 2014a. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120. February.

USEPA. 2014b. USEPA Region 9, *Regional Screening Levels (RSLs)*. http://www.epa.gov/region9/superfund/prg/. Accessed September 22, 2014.

USEPA, 2015. Regional Screening Level Table, Mid-Atlantic Risk Assessment. USEPA Region 3. November. Available online at http://www.epa.gov/reg3hwmd/risk/human/index.htm

U.S. Geological Survey (USGS). 2002. *Techniques of Water-Resources Investigations of the United States Geological Survey: Statistical Methods in Water Resources*. Book 4, Hydrologic Analysis and Interpretation. September.

USGS. 2008. *Techniques of Water-Resources Investigations: National Field Manual for the Collection of Water-Quality Data*.

U.S. Geological Survey. 1954. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: March 7, 1954.* Source: EDR USGS.

U.S. Geological Survey. 1966. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: February 23, 1966.* Source: EDR USGS.

U.S. Geological Survey. 1984. *Aerial Photograph Scale 1-inch equals 500 feet. Flight Date: April 7, 1984*. Source: EDR USGS.

U.S. Geological Survey Digital Orthophoto Quarter Quadrangles. 1995. *Aerial Photograph Scale 1-inch equals 500 feet. DOQQ Acquisition Date: March 29, 1995.* Source: EDR USGS/DOQQ.

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Respiratory Protection

Approval:		Concurrence:	
5-10-2019		5-10-2019	
Radiation Safety Officer	**Date**	**ARSO**	**Date**

1.0 SCOPE

1.1 Purpose

In order to ensure worker health and safety, and maintain compliance with applicable regulatory requirements, Tidewater is committed to maintaining a respiratory protection program. This document establishes a respiratory protection program, that meets both the State of Maryland Department of Environment, Radiation Protection Standards for airborne radiological hazards and the federal Occupational Safety and Health Act (OSHA) requirements for other airborne physical and chemical hazards, 29 CFR 1910.139.

1.2 Applicability

This document applies to workers operating under the Tidewater radioactive material license. It includes medical evaluation and fit testing requirements for respirator users, as well as respirator selection, control, maintenance, inspection, and storage requirements.

2.0 REFERENCES

2.1 Title 29 CFR Part 1910, Occupational Safety and Health Standards.

2.3 NUREG-0041 "Manual of Respiratory Protection Against Airborne Radioactive Materials", U.S. Nuclear Regulatory Commission, October 1976.

2.4 NUREG-1400 "Air Sampling in the Workplace", U. S. Nuclear Regulatory Commission, September 1993.

2.5 NUREG/CR-4884 "Interpretation of Bioassay Measurements", U.S. Nuclear Regulatory Commission, July 1987.

2.6 Regulatory Guide 8.25 "Air Sampling in the Workplace, Revision 1", U.S. Nuclear Regulatory Commission, June 1992.

2.7 "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices" American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio (issued annually).

2.9 ANSI Z88.2-1992 "American National Standard for Respiratory Protection", American National Standards Institute, New York, New York, 1992.

3.0 DEFINITIONS

Airborne Radioactivity Area - an area in which airborne radioactivity, composed wholly or partly of licensed material, exists in concentrations: in excess of the amounts specified in 10 CFR 20, Appendix B, Table 1 Column 3; or to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the

hours an individual is present in any week, an intake exceeding 0.6% of the amounts specified in 10 CFR 20, Appendix B, Table 1, Column 2; or 12 DAC hours; or in excess of more restrictive criteria as established in the radiological safety program.

ALARA (As Low As is Reasonably Achievable) - Making every effort to maintain exposure to radiation and radioactive materials as far below the limits as is reasonable consistent with the purpose for which the licensed activity is undertaken, and taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other socioeconomic considerations.

Annual Limit on Intake (ALI) - The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in 10 CFR 20, Appendix B, Table 1, Columns 1 & 2, respectively).

Bioassay - The identification and determination of concentration of radioactive material in the human body, whether by direct measurement (in vivo) or by analysis and evaluation of materials excreted or removed from the body (in vitro).

Ceiling Level - A worker's exposure which shall not be exceeded during any part of the work day.

Derived Air Concentration (DAC) - The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), would result in an intake of one ALI. DAC values are given in 10 CFR 20, Appendix B, Table 1, Column 3.

Excursion Limit (EL) - A short term exposure limit used when no STEL (see Definition 3.13) is listed in the regulations. Excursions in worker exposures may instantaneously exceed three times the TLV-TWA for no more than 30 minutes in a working day and should never exceed five times the TLV-TWA.

Immediately Dangerous to Life or Health (IDLH) – This is an atmospheric concentration of any toxic, corrosive, or asphyxiate substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere.

Oxygen Deficiency – This is a concentration of oxygen by volume below which atmosphere-supplying respiratory protection must be provided. It exists in atmospheres where the percentage oxygen by volume is less than 19.5 percent oxygen.

Permissible Exposure Limit (PEL) – This is an upper legal limit found in 29 CFR 1910 on exposure for a non-radioactive hazardous material in air.

Protection Factor (PF) - A ratio of the concentration of a contaminant outside the

respirator over the concentration inside the respirator. PF indicates the effectiveness of a respirator's protection.

SCBA - Self Contained Breathing Apparatus

Short Term Exposure Limit (STEL) - is the worker's 15-minute (unless another time is specified) time weighted average exposure as found in 29 CFR 1910 which shall not be exceeded at any time during the working day.

Time Weighted Average (TWA) - is the average airborne exposure in any 8-hour work shift of a 40-hour work week.

Threshold Limit Values (TLV's) - are recommendations of the American Conference of Governmental Industrial Hygienists for airborne concentrations of substances under which it is believed that nearly all workers could be repeatedly exposed without adverse health effects.

Radiation Work Permit (RWP) - a document which authorizes personnel to perform identified tasks based on radiological considerations in areas containing or suspected to contain radiation and/or radioactive material. The document describes work to be done, known or suspected area radiological conditions, and prescribes limits and precautions to be taken while work is in progress.

Radiation Worker - An individual receiving or expected to receive an occupational exposure in the course of accomplishing his/her work assignment.

Radiologically Controlled Area -An area established with controlled access to provide for occupational radiation exposure and contamination control.

Respiratory Protective Device - An apparatus, such as a respirator, used to reduce an individuals intake of airborne radioactive materials.

4.0 MEDICAL EVALUATION OF PERSONNEL

Prior to using respiratory protection equipment, each worker must be examined by competent medical personnel to ensure no limitations exist that would prevent the worker from using a respirator. The examination is a standard one to determine the cardio-vascular health of the worker and, using spirometry, to determine the volumetric capacity of the lungs and check for impaired lung function. Medical personnel performing the evaluation should refer to ANSI Z88.6, American National Standard for Respiratory Protection - Respirator Use - Physical Qualifications for Personnel.

4.1 Information regarding the worker's on-the-job respirator use shall be supplied to the medical personnel performing the evaluation by the Radiation Safety Officer (RSO) or designee.

4.2 If personnel performing the medical examination for respirator use note any psychological factors which could be aggravated by the wearing of respiratory

equipment, they should notify the RSO, or designee for further investigation. In addition, close observation of workers during training and fitting procedures will also be used to indicate any psychological factors affecting their ability to function adequately under routine and emergency use situations.

4.3 Personnel performing the medical examination shall provide a written statement indicating whether or not the worker can wear a respirator, and if they can, any limitations that may exist.

4.4 Medical evaluations shall be repeated annually.

5.0 BIOASSAYS

Individual radiological bioassays will be performed in accordance with RS-015, Internal Dosimetry. Bioassays for other hazards not specified in this program will be performed as appropriate when regulatory requirements and/or prudent health and safety practices dictate them. If there are permanent changes in the work environment additional requirements may be added to this procedure by a revision.

6.0 FIT TESTING OF PERSONNEL USING RESPIRATORS

6.1 Prior to initial respirator qualification and annually thereafter each user will be fit tested for the specific size, manufacturer, and model of respirator that the user will wear. Fit testing of respirators may be accomplished using quantitative or qualitative tests.

6.2 Prior to each use of a respirator, the wearer shall perform the following qualitative tests after donning their respirator.

6.2.1 Positive Pressure Test: close off the exhalation valve with the palm of the hand, and exhale gently so that a slight positive pressure is built up in the face piece. If no outward leakage of air is detected at the periphery of the face piece, or at inhalation valves, the test is satisfactory.

6.2.2 Negative Pressure Test: Close off the inlet opening of the canister or the breathing tube by covering it with the palm of the hand or by replacing the tape seal, gently inhale so that the face piece collapses slightly, and hold breath for 10 seconds. If the face piece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is satisfactory.

6.2.3 A visual inspection of the equipment to be used.

7.0 RESPIRATORY EQUIPMENT SELECTION AND TRAINING

Respirator selection shall be made by the RSO, or designee after considering the type and quantity of airborne hazards expected to be encountered, duration of periods of respirator use, specific regulatory requirements and availability of equipment.

7.1 Respirators approved must include respirator manufacturer, model, filter (if any) type, NIOSH/MHSA approval number, and specific type(s) and quantities of airborne hazards for which they are approved. The "Respirator Approval" form (or equivalent documentation) found in Appendix B shall be used to document this required information.

7.2 Protection factors for each respirator shall be assigned in accordance with Reference 2.1 when radioactive hazards are present or per ANSI Z88.2 (reference 2.9) Table 1 for non-radioactive hazards (or the more limiting of the two when both hazards are present). See Appendix A of this procedure for a summary.

7.3 Each respirator user shall complete a training program on the hazards likely to be encountered (both routine and emergency), the type(s) of respirator(s) to be worn, and how to properly wear the respirator(s). Completion of initial training will be recorded on the "Respiratory Protection Training Record" form in Appendix B. Where personnel use respiratory protection, provide annual refresher training. Log refresher training on the "Requalification-Respiratory Protection Training" form in Appendix B.

8.0 PROTECTION FACTOR

Credit for a Protection Factor (PF) in conditions of exposure to airborne radioactive and non-radioactive contamination may be taken provided that:

8.1 The respiratory equipment is certified or had certification extended by the National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA).

8.2 Selected respiratory equipment has a PF greater than the multiple for peak concentrations which are expected to exceed values specified DAC values when radionuclides are the hazard or 29 CFR 1910.1000 (reference 2.2) PEL values when non-radioactive hazards are present or the most limiting when both are present.

8.3 Respiratory equipment used by personnel is the same as that indicated on the RWP by the RSO.

8.4 Air sampling is conducted to satisfy requirements of References 2.1, 2.2, 2.4, and 2.6 as applicable.

9.0 SUPERVISION OF PERSONNEL USING RESPIRATORS

Individuals who directly supervise respirator users shall be trained per Section 7 above. Supervisors are responsible for the periodic observation of individuals who wear respiratory equipment while working. Any observed misuse, malfunctions, etc., shall be immediately reported to the RSO for follow-up corrective action.

10.0 ISSUING AND CONTROL OF RESPIRATORS

10.1 Upon receipt, all new respirators shall be inspected by the RSO. Non-disposable respirators shall be assigned a tracking number.

10.2 All work involving respiratory protection shall be indicated on the RWP specifying the type of respiratory protection required and the reason.

10.3 The RSO, or designee will manage the issue and maintenance of respiratory equipment and identify individuals qualified (medically screened, properly trained, and fit-tested) to use a respirator along with the specific model and size authorized.

10.3.1 Individuals will sign out respiratory protection equipment, based on the requirements stipulated in the RWP and/or during their pre-job briefing. This will ensure that workers use the respiratory protection equipment that meets the special needs of that particular job.

10.3.2 Respirator maintenance will be performed by qualified individuals or contract maintenance personnel.

10.4 When a non-disposable respirator is issued for use, the respirator number shall be assigned to the requesting individual for that period of use.

10.5 Any person having hair in the facial area (stubble, moustache, side-burns, beard, low hairline, bangs) which interferes with the sealing surface of the face piece of the respirator shall not be permitted to wear the respirator. Any person who has hair (moustache, beard) which interferes with the function of a respirator valve(s) shall not be permitted to wear the respirator. At no time during use may other items (i.e., temple bars or straps to glasses, head covering, etc.) which interfere with the seal of a respirator to the face of the wearer be allowed.

10.6 Respirators that may have become contaminated in use must be decontaminated (and surveyed per paragraph 11.1 below if radioactively contaminated) before reuse or release for maintenance. Respirators issued to a specific individual must be cleaned and sanitized before reuse by another individual.

10.7 Non-disposable high efficiency filters on respirators may be reused for no more than one work shift if used by a single individual throughout the shift.

11.0 RESPIRATOR MAINTENANCE

Respirator maintenance shall include inspections and the acquisition and replacement of parts/filters. A leak test of respirator face pieces may be necessary when parts replacement may affect face piece integrity (e.g. replacement of valves, diaphragms, lens, etc.).

11.1 Surveys

Before respirators are released for reuse or maintenance, they must be surveyed for potential contamination. The following standards must be met:

11.1.1 No loose surface contamination in excess of 200 dpm/100 cm^2 beta-gamma, 20 dpm/100 cm^2 alpha.

11.1.2 No fixed contamination in excess of 3000 dpm/100 cm^2 beta-gamma. No fixed alpha contamination in excess of 300 dpm/100 cm^2.

Before breathing air hoses and breathing tubes are released for maintenance or reuse, the fittings must be smeared to insure that there is no loose surface contamination in excess of 200 dpm/100 cm^2 beta-gamma, 20 dpm/100 cm^2 alpha.

11.2 Decontamination and Cleaning

If radioactive decontamination of respirators and associated equipment becomes necessary, it shall be accomplished with a mild solution of water and appropriate decontamination agent. Remove contamination with a soft brush or cloth. Respirators shall be cleaned and sanitized by a qualified worker after each day's use.

The following general procedure should be followed for cleaning non-disposable respirators:

1. Remove the filters, cartridges, or canister and breathing tube.
2. Wash the respirator in cleaner-sanitizer solution (for respirators surveyed and found to be contaminated, the exterior of the face piece should be carefully cleaned first, making every attempt to prevent cross-contamination of face piece interiors and sealing surface).
3. Rinse completely in clean, warm or hot water (140^o F. maximum). Ensure that all cleaner-sanitizer has been thoroughly rinsed off since some sanitizer compounds can cause minor skin irritations.
4. Air dry in a clean area.
5. Inspect valves (look for hair, lint or cleaner affecting valve seal), headbands, and other parts; replace or clean as required.
6. Decontaminate or remove sleeving on the breathing tube and resleeve as necessary.
7. Insert new filters.
8. Store in a plastic bag or approved storage shelf.

NOTE: In the absence of washing facilities, hand cleaning with sanitizing by disposable disinfectant wipes in a manner that will not deform the facepiece may be used.

12.0 INSPECTIONS

Respirator users should inspect their respirator prior to each use by the following

checklist:

- Straps and suspension are intact and not cracked or torn
- Face piece material is not cracked,
- Integrity of face piece (absence of tears, mold, defects, etc.)
- Filter cartridge mounts,
- Breathing air hose or cartridge gaskets (where applicable),
- Integrity of inhalation and exhalation valves and seals,
- Speaking diaphragms assembly (mylar diaphragms, diaphragm gasket, assembly tightness),
- Lens (absence of scratches, cracks, blemishes)
- All clamps and connections (check for tightness)
- Inspection date on maintenance inspection sticker is within one month of the use date.

13.0 STORAGE

After cleaning, inspection, testing and repair, the respiratory equipment shall be placed in plastic or paper bags or original shipping carton. An inspection tag shall be affixed to the storage container. The tag must include the inspector's name and the date of inspection. Stored respirators shall not be exposed to direct sunlight, heat, extreme cold, excessive moisture or other environment likely to cause damage. Respirators shall be packed and stored so that they are not damaged by adjacent equipment or twisted out of their normal configuration by improper storage. Respirators in storage more than one month must be re-inspected.

14.0 ASSOCIATED EQUIPMENT

Breathing tubes for airline respirators and SCBAs shall be checked for:

- holes or defects in the rubber
- tightness of connections at each end

Regulators for airline respirators and SCBAs shall be visually inspected for:

- damage
- proper setting

Compressors used to provide air for atmosphere-supplying respirators should be inspected and tested to ascertain the following:

- Proper and adequate intake filters
- Presence of moisture trap
- Quality verification for Level D Air quality monthly
- Adequate air output and presence of proper connectors for equipment to be used
- Heat alarm function (for oil-type compressors)

NOTE: Oil-type compressors may only be used if fitted with either a continuous carbon monoxide monitor and high temperature alarm.

Air-line hose shall be inspected for the following:

- Contaminants (mold powder, ground rubber, etc.) inside the hose
- Proper fittings and connections (i.e., not compatible with other gas systems)
- Cuts, breaks, or weak spots in hose

Tanks and harnesses for SCBAs shall be inspected according to the manufacturer's recommendations.

15.0 EVALUATION OF PROGRAM EFFECTIVENESS

15.1 Wearer Acceptance

Workers are encouraged to relate to the RSO, or designee, any observed problems with respiratory protective equipment such as:

- Inability to breathe without objectionable effort
- Inadequate visibility
- Inability to communicate
- Inability to perform all tasks without undue interference
- Lack of confidence in the face piece fit.

Supervisors are to monitor work in progress for any problems which might affect the reliability of the respiratory protection program.

15.2 Evaluation of Protection

Bioassay results correlated to air sampling data shall be reviewed. Evidence of an intake linked to inhalation shall be investigated, if in excess of established action levels. See RS-008, Air Monitoring for further details.

16.0 RECORDS

All records generated as a result of or in support of the requirements of this procedure shall be maintained in accordance with RSP-001, Radiation Protection Plan, and applicable regulatory requirements.

17.0 REVISION HISTORY

REVISION HISTORY		
Revision Number	**Issue Date**	**Revision Description and Reason for Change**

Appendix A - Protection Factors for Respirators

PROTECTION FACTORS FOR RESPIRATORS[a]
(Rule 1200-2-5.161, or ANSI Z88.2 Table 1)

Description[b]	Mode	Particulate Gases and Vapors[c]	Particulate Only
1. Air-Purifying Respirators Full Face	Negative pressure Positive pressure (PAPR)		100 1000
2. Atmosphere-Supplying Full Face Hood	Demand Pressure Demand and Continuous Flow Continuous Flow	2000 100 1000 1000	
3. Self-Contained Breathing Apparatus Full Face	Demand Pressure Demand	100 10,000[d]	
3. Combination Respirators Any combination		Protection factor for type and mode of operation as listed above.	

NOTES:

a. Only for shaven faces and where nothing interferes with the seal of tight-fitting face-pieces against the skin. (Hoods are excepted).

b. For air-purifying respirators only when High Efficiency Particulate Air filters are used.

c. Equipment shall be operated in a manner that ensures that proper air flow-rates are maintained. A protection factor of no more than 1000 may be used for tested-and-certified supplied-air hoods when a minimum air flow of 6 cubic feet per minute is maintained and calibrated airline pressure gauges or flow measuring devices are used. A protection factor of up to 2000 may be used for tested and certified hoods only when the air flow is maintained at the manufacturer's recommended maximum rate for the equipment, this rate is greater than 6 cubic feet per minute and calibrated airline pressure gauges or flow measuring devices are used.

The design of the supplied-air hood or helmet (with a minimum flow of 6 cfm or air) may determine its overall efficiency and the protection it provides. For example, some hoods aspirate contaminated air into the breathing zone when the wearer works with hands-over-head. This aspiration may be overcome if a short cape-like extension to the hood is worn under a coat or overalls. Other limitations specified by the approval agency shall be considered before using a hood in certain types of atmospheres, such as the design and its permeability to the contaminant under conditions of use.

d. SCBA's may provide greater protection and be used as an emergency device in unknown concentrations against inhalation hazards. External radiation hazards and other limitations to permitted exposure, such as skin absorption, must be taken into account is such circumstances.

Appendix B - Forms

RESPIRATORY PROTECTION
TRAINING RECORD, Form 012.0-1

NAME_____ SS#_____

ADDRESS_____ City_____ State____ Zip_____

PHONE_____ BIRTH DATE_____

COMPANY_____ OCCUPATION_____

Test date: _____ Test Score: _____ Grader: _____

I have had the results of my written respirator training test reviewed with me and have had opportunity to have any questions answered.

Signature_____ Date_____

Classroom training complete_____
Date

Physical exam complete._____
Date

FIT TEST DATA

Respirator Manufacturer	Model	Size	Test Type (if quantitative, record PF)	Date	Health & Safety Tech. Signature

COMMENTS_____

_____

I authorize the above named individual to wear a respirator as required.

_____ _____
RSO, or designee Date

REQUALIFICATION
RESPIRATORY PROTECTION TRAINING, Form 012.0-2

The following personnel have received the Respiratory Protection Training, RS-012, requalification and fit test.

Name	Respirator Manufacturer	Model	Size	Test Type (if quantitative, record protection factor)	Written Exam Score

RADIOLOGICAL SURVEY AND SAMPLING PLAN

University of California, Berkeley Giannini Hall

Submitted to:
University of California, Berkeley
Environmental Health & Safety
317 University Hall
Berkeley, CA 94720-1150

James Reese, CHP	January 8, 2019
Developed By	Date
Clifton Gray	January 8, 2019
Reviewed By	Date
Ken Gavlik	January 8, 2019
Reviewed By	Date
Approved By	Date

Table of Contents

Acronyms and Abbreviations

AEC	Atomic Energy Commission
AHA	Activity Hazard Analysis
ALARA	as low as reasonably achievable
ALI	Allowable Limit of Intake
APIC	Association for Professionals in Infection Control and Epidemiology
CDPH	California Department of Public Health
C-14	Carbon-14
CHP	Certified Health Physicist
CFR	Code of Federal Regulations
cpm	Counts per Minute
D&D	Decontamination & Decommissioning
DAC	derived air concentration
DCGL	Derived Concentration Guideline Level
DOSH	Division of Occupational Safety and Health
DOT	U.S. Department of Transportation
dpm/100 cm^2	Disintegrations Per Minute Per 100 Square Centimeters
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
FSS	Final Status Survey
^3H	Hyrdrogen-3
HASP	Health and Safety Plan
HEPA	High Efficiency Particulate Air
HPT	Health Physics Technician
HSA	Historical Site Assessment
HVAC	Heating, Ventilation, and Air Conditioning
LBGR	Lower Bound of the Gray Region
LLRW	Low-Level Radioactive Waste
MARSAME	Multi-Agency Radiological Survey and Assessment of Materials & Equip
MARSSIM	Multi-Agency Radiological Survey and Site Investigation Manual
MDC	minimum detectable concentration
NIST	National Institute of Standards and Technology
NPE	Negative Pressure Enclosure
NRC	U.S. Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Commission Guidance Document
OSHA	Occupational Safety and Health Administration
PAPR	Powered Air Purifying Respirator
PACM	Potential Asbestos Containing Material
PF	Protection Factor
Philotechnics	Philotechnics, Ltd.
PM	Project Manager
PPE	personal protective equipment
QAP	Quality Assurance Plan
QC	quality control
RCT	Radiological Control Technician
RHB	Radiological Health Branch
RSP	Radiation Safety Plan

RSSP	Remediation Survey & Sampling Plan
RSO	Radiation Safety Officer
RWP	Radiological Work Permit
SSHP	Site Safety and Health Plan
SOP	Standard Operating Procedure
TLD	Thermo-luminescent Dosimeter
UCB	University of California, Berkeley
WAC	waste acceptance criteria
WMP	Waste Management Plan

1.0 Introduction

The Philotechnics-Tidewater team has prepared this Radiological Survey and Sampling Plan (RSSP) for detailing work activities to be conducted during the decontamination and decommissioning of Giannini Hall at the University of California, Berkeley (UCB). All on site activities will be done under the supervision of a Certified Health Physicist (CHP) and in accordance with the radiological program associated with Philotechnics California Radioactive Material License (#7754-37) and California Department of Public Health – Radiological Health Branch (CDPH-RHB) requirements. The intent is to successfully characterize and remediate Rooms 010, 010A through G, 020 (Hallway), 022, 022B, 023, 023A, 023B, 023BA, 023C, 023D, 024, 024A, 024B, 025, 026, 027, 027A, 028, 029, 030, and 122 of Giannini Hall to facilitate tenant improvements of these areas.

All remediation work will be performed under Philotechnics' California Radioactive Material License which authorizes remediation activities and possession of the radionuclides and quantities present at any temporary work locations in the State of California. This RSSP was developed using the guidance provided in NUREG 1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM) and NUREG 1575, Supplement 1, and the "Multi-Agency Radiation Survey and Assessment of Materials and Equipment" (MARSAME). This guidance provides the approach, methods, and techniques for the radiological remediation of the impacted areas.

1.1 General Site Description

Giannini Hall was built in 1930 and houses the College of Natural Resources. Radioactive materials were used in 5 rooms over the time period of 1963-2008. Today there are 5 Radiation Use Authorizations (RUAs) with active use in the building. One RUA involves the use of radioactive materials (U-238 in small amounts to stain slides for electron microscopy) and 4 RUAs authorize electron microscopes. Predominately the radiation use labs are located on the basement level but there is one room located on the first floor that was used in the past for radioactive material work.

Research activities in Giannini Hall Ground Floor Rooms 020, 022, 022B, 023, 023A, 023B, 023BA, 023C, 023D, 024, 024A, 024B, 025, 026, 027, 027A, 028, 029, and 030 have used long-lived radionuclides of H-3, C-14, Tc-99, Cl-36, Cs-137 and U-238 (in small amounts) that could still be present. There is a current need to demolish ground floor rooms by removing everything in the rooms including the floor tiles and ceilings to the original surface. Ground Floor Rooms 010B, 010C, 020, 022, 022B, 023, 023A, 023B, 023BA, 023C, 023D, 024, 024A, 024B, 025, 026, 027, 027A, 028, 029, and 030 will be renovated and demolished t. Ground Floor Rooms 010A, 010D, 010E, 010F, 010G, and First Floor Room and 122 will be remodeled, but will not need to be fully demolished. There is no history of known spills in these rooms although sink disposal of the radionuclides was permitted in the past and the sink traps and plumbing could have residual contamination. The work will include removing floor surfaces (tile or carpet) to expose the original surface so testing can be done for any residual radioactive contamination. In rooms with asbestos containing tiles, abatement of the asbestos tile and mastic must also be performed. In addition, walls, built-in benches, fume hoods, etc. must be tested for contamination. Duct work of chemical fume hoods must also be tested and drain traps and sink drains in lab sinks must be tested for contamination as per the MARSSIM protocol. The clean-up standard shall be indistinguishable from background.

1.2 Historical Site Assessment

The purpose of the historical site assessment (HSA) is to determine the current status of the site including potential, likely or known sources of radioactive contamination by gathering data from various sources. This data includes physical characteristics, site location and information found in operating records, including previous radiological surveys.

Research activities in Giannini Hall Ground Floor Rooms 020, 022, 022B, 023, 023A, 023B, 023BA, 023C, 023D, 024, 024A, 024B, 025, 026, 027, 027A, 028, 029, and 030 have used long-lived radionuclides of H-3, C-14, Tc-99, Cl-36, Cs-137 and U-238 (in small amounts) that could still be present. There is a current need to demolish ground floor rooms by removing everything in the rooms including the floor tiles and ceilings to the original surface. Ground Floor Rooms 010B, 010C, 020, 022, 022B, 023, 023A, 023B, 023BA, 023C, 023D, 024, 024A, 024B, 025, 026, 027, 027A, 028, 029, and 030 will be renovated and demolished to the extent indicated by the plans. Ground Floor Rooms 010A, 010D, 010E, 010F, 010G, and First Floor Room and 122 will be remodeled, but will not need to be fully demolished. There is no history of known spills in these rooms although sink disposal of the radionuclides was permitted in the past and the sink traps and plumbing could have residual contamination. This was verified in room 25 where the sink showed detectable levels of residual radioactivity. There is a current need to remodel these rooms by removing everything in the room including the floor tiles and ceilings to the original surface.

Table 1.1, Historical Use of Radioactive Material

Dates	PI/RUA	Location	Radionuclide	Amounts Used	Type research
7/29/1970-8/27/1984	Dr. Albert Weinhold, 510	Giannini 26	C-14, S-35, H-3, Tc-99, Cl-36, Pa-234, Cs-137, Cs- 131	50 uCi/experiment.	Labeling of plants and plant culture media. Procedures involved include the following: dilution, transfer, introduction through food material, incubation,
1/5/1966-9/17/1985	Dr. Joseph Hancock, 541	Giannini 25	Ca-45, S-35, C-14, H-3, Mn-54, Rb-86, Cl-36, AmBe- 241	50-200 uCi/experiment.	Labeling plant tissue. Procedures include dilution, transfers, extraction, ashing and LSC counting.
1/16/1963-1/7/1970	Dr. Thomas Mittler, 562	Giannini 122	C-14, P-32	1 mCi/experiment.	To determine the ingestion, absorption and excretion of plant sucking insects.
6/7/1972-3/13/1975	Dr. P.L. Gersper, 729	Giannini 10	P-32, C-14	5 uCi/experiment.	Add radioactive materials to plant culture solutions and soil cores. Perform chemical separations including sephadex column separation and kjeldahl digestion steps.

Dates	PI/RUA	Location	Radionuclide	Amounts Used	Type research
11/28/1978-08/30/1984	Dr. R.W. Schneider, 798	Giannini 30	AmBe-241	50 mCi (Sealed source, Agriculture Moisture Gauge, Portaprobe 503).	Moisture analysis.
12/4/2008-Current	Dr. Kent Mc Donald, 4121	Giannini 25, 26, 30	U-238	0.1 uCi/expt.	Use of uranyl acetate as a stain in the preparation of electron microscopy samples.

Based on the storage and use history of the facility, a potential exists for small amounts of long-lived radionuclides C-14, H-3, Tc-99, Cl-36, Cs-137, and U-238 to be present in inaccessible surfaces (under floor tiles, behind lab benches, within ducting and drains, etc.).

1.3 Project Specific RSSP

The CDPH-RHB requires the preparation of a RSSP for any project or activity involving the possession, use of, or work with materials with the potential for exposure to ionizing radiation. This site-specific RSSP complies with Philotechnics' policy and procedural requirements and provides the overall guidance to execute the scope of work in a manner that protects workers, the public, and the environment. Specific guidance for implementation of radiological safety operations is provided in Philotechnics' Standard Operating Procedures (SOP). Applicable SOPs are listed in Table A-1, "Philotechnics Standard Operating Procedures."

1.4 Worker Exposure - As Low As Reasonably Achievable (ALARA)

It is the Team's policy that all work with radioactive materials or ionizing radiation be purposeful and performed in a manner that protects workers, members of the public, and the environment. Work involving radiological hazards may not begin unless that work can be performed in a safe and compliant manner. Radiological work will be planned and performed in accordance with Philotechnics Procedure HPO-002, "Occupational Radiation Exposure Limits and the ALARA Program" to ensure worker's radiation exposures are maintained ALARA; to minimize the creation and spread of surface contamination; to minimize the creation and spread of airborne radioactive material; and to minimize the creation of radioactive waste. The project team endorses and applies ALARA principles to radiological work so that all exposures to radiation are maintained ALARA.

1.5 Scope of Work

The radiological scope of work involves the following activities:

- Task-specific radiological training of personnel
- Site controls and establishing of work zones at sites with, or having the potential for, the presence of radioactive material or radiological contamination
- Ordering, maintaining, function checking, and operating radiological survey instrumentation; returning instrumentation to manufacturer for repair and calibration

- Handling and management of radiologically contaminated surfaces and structures, or other radiologically contaminated material
- Remediating all surfaces and structures above the release criteria
- Perform final status surveys to ensure all impacted areas meet the release criteria
- Managing records for radiological data gathered during site operations
- Writing, reviewing, and maintaining plans, procedures, instructions, and other documents in support of the radiological scope of work

1.6 Quality Control and Auditing

To assure compliance and evaluate implementation of this RSSP, quality control (QC) measures including self-assessment and management reviews will be employed.

1.6.1 Self-Assessment, Management Reviews, and Audits

Periodic self-assessments and management reviews will include evaluation of exposure rates present during remediation, radiological monitoring data, and efficacy of established radiological work practices, ALARA practices, and use and effectiveness of personal protective equipment (PPE). Information regarding the audit and self-assessment program can be found in Philotechnics procedure HPCA-001, "Radiation Safety Program for California Licensed Activities".

1.6.2 Responses and Corrective Actions

Deficiencies identified during self-assessment, management review, or as the result of an audit shall be tracked and corrected. At a minimum, the corrective action shall be documented to close the self-assessment or management review, and the corrective action must be approved by the Project Manager (PM) Findings resulting from an audit require a formal response that includes identification of the root cause, immediate action(s) taken to correct the nonconforming condition, the corrective action proposed or taken to prevent a recurrence, and the schedule for completion of corrective action(s). Responses to findings must be submitted to the Radiation Safety Officer (RSO) for review and approval.

1.6.3 Daily Instrumentation Check

Laboratory and field radiological instrumentation will be used, operated, and maintained by project Health Physics Technicians (HPT) under the supervision of the PM. It is routine practice that each day a radiation instrument is used for making a field measurement; the instrument shall be checked for background and source response prior to use. Functional checks will be performed daily or prior to use in accordance with Philotechnics procedure, HPO-201, "Portable Instrument Calibration Requirements and Response Checks".

All instruments in use shall have current annual calibration in accordance with the manufacturer's recommendations employing standards and sources traceable to the National Institute of Standards and Technology. Copies of instrument calibration certificates shall be maintained on site.

1.6.4 Review of Radiological Records

Radiological instrumentation paperwork and radiological surveys will be reviewed by the CHP or designee for completeness and accuracy. Copies of the records generated by this work are maintained on site for the duration of project activities.

2.0 Project Management and Organization

The Team will perform all remediation and survey work under the direction of a PM. The onsite team will consist of the PM, a Radiological Engineer, HPTs, and Waste Technicians. All project team members will report to the PM. In addition, the project team will have full support of the corporate expertise available from Philotechnics and Tidewater's corporate offices. These include ta Certified Health Physicist, the Corporate Health and Safety Officer, and the Corporate Quality Assurance Manager.

2.1 Project Manager

The PM is in charge of all aspects of the project and is in direct contact with the designated client representative. The PM shall have the responsibility to ensure the clients project goals and milestones are met. Specific aspects of project management include:

- Ensuring safety and quality performance on the project
- Daily project coordination and direction
- Meeting client and SOP requirements
- Meeting scope, schedule and budget requirements
- Keeping UC Berkeley staff informed of our progress
- Control of project equipment and inventories
- Establishing performance measures and progress reporting
- Providing effective leadership in direction, coordination, planning and control of cost, schedules and resources through continuous communications with project team members and the client

Ken Gavlik will be the Project Manager. Mr. Gavlik is a veteran of the U.S. Navy Nuclear Power Program with a B.S. in Applied Science concentrating in Nuclear Engineering Technology and Radiation Protection, and a Master's degree in Business Administration. He has approximately two decades of experience in applied health physics and radiation protection, with over 15 of those spent managing MARSSIM decommissioning projects. Mr. Gavlik is the author of the Decommissioning Plan and Subject Matter Expert for NYC Office of Emergency Preparedness and Response Radiological Advisory Committee. Mr. Gavlik personally designed, planned and managed almost 100 radiological services projects, including facility release within the State of California, with many facilities released without question or comment from various regulatory authorities including Agreement States and the NRC. Projects include license termination and release for unrestricted use of two of the largest R&D facilities in the US, containing in excess of two million square feet of impacted areas each.

2.2 Radiological Engineer

Clif Gray will be the Radiological Engineer (RE). Mr. Gray is a Health Physicist, with extensive MARSSIM, decommissioning, and waste disposal experience. Over 20 years of practical experience in radiation safety, nuclear engineering, and environmental science with D&D experience, federal and commercial, covering nuclear reactors, laboratory decommissioning, hot cells, processing equipment and mixed waste sites. He has supervised radiation protection programs, environment compliance programs and occupational safety personnel with emphasis on strict compliance, and has extensive experience with State, Federal and DOD regulators in multi-disciplined areas.

The RE will also double as the Project Health and Safety Officer (PHSO). The RE is responsible for survey planning, implementation and documentation to ensure the survey meets all Data Quality Objectives (DQO)s. The RE is also responsible for the implementation of the Radiation Protection Program (RPP) at the project. Responsibilities may include but are not limited to the following:

- Assisting in developing detailed project-specific documents;
- Carrying out supervisory responsibilities in accordance with the organization's policies and applicable laws;
- Monitoring site conditions to ensure compliance with the RPP, Radioactive Materials License and protection of personnel, the environment and the public;
- Determining appropriate PPE;
- Ensuring that the California RSO is notified of conditions or situations that present a radiological hazard, concern, or exceed limitations set forth in the RPP or applicable procedures and work plans;
- Issuing Radiation Work Permits (RWP);
- Maintaining records related to the RPP in an auditable condition for the duration of the project;
- Conducting oversight and surveillance;
- Conducting daily tool box and weekly safety meetings;
- Ensuring appropriate monitoring of personnel exposures; and
- Determining appropriate instrumentation and ensuring its compliance.

In addition, as PHSO, they will ensure all elements of the Health and Safety Plan are implemented and enforced on site. The PHSO reports directly to the Project Manager and will implement and enforce site health and safety procedures in the field. The PHSO has full authority to issue stop work orders or evacuation orders where work operations or noncompliance(s) may threaten the health and safety of site workers or the public. The PHSO has the responsibility and authority to perform the following:

- Ensuring compliance with project plans by means of daily site inspections
- Investigating all accidents, injuries, illnesses, near-misses, and other incidents
- Ensuring that project personnel are trained on the risks of hazardous substances on the project, maintaining the Material Safety Data Sheet (MSDS) file to provide easy access to project personnel, and performing inspections to ensure that all waste containers are correctly labeled
- Ensuring that tailgate safety meetings are conducted on days that work is performed and that documentation of all meetings and any other additional training is completed
- Verifying that project safety equipment is properly inspected
- Coordinating site health and safety requirements with the PHSO
- Ensuring maintenance of all health and safety monitoring and personal protective equipment and directing site-monitoring activities
- Coordinating daily field activities with the PHSO
- Coordinating site safety and emergency response duties
- Verifying site communications system with site personnel

- Verifying that all personnel have the necessary training and medical clearance prior to entering controlled areas at the site
- Determining and posting routes to medical facilities and emergency telephone numbers and arranging for emergency transportation to medical facilities
- Maintaining training records and medical certifications for all on-site personnel
- Maintaining site control procedures
- Maintaining current records of certification for first aid and cardiopulmonary resuscitation (CPR) for project field personnel
- Ensuring that planning documents are current and controlled
- Attending required scheduled and unscheduled meetings

2.3 Health Physics Technicians (HPT's)

The HPTs will report to the Radiological Engineer. They will perform radiological surveys in support of the project; monitor all radiological work to ensure it is performed safely and in compliance with Radiation Work Permits (RWPs), Philotechnics' Radioactive Materials License, permits, plans, and procedures; maintain the radiological logbook; perform decontamination as necessary, perform other duties as assigned by the Radiological Engineer.

2.4 Waste Technicians

Performs disassembly, remediation, and waste packaging in compliance with the project specific RWP. This includes the removal and packaging of contaminated components, operation of remote demolition equipment, and size reduction of large components. Ensure that wastes are property segregated to minimize the generation of Low-Level Radioactive Waste (LLRW) and verify the wastes meet the designated processor waste acceptance criteria (WAC).

2.5 Offsite Support

The PM will have access to Philotechnics' and Tidewater's corporate support structure including waste management specialists.

3.0 Release Criteria

The United States Nuclear Regulatory Commission (NRC) states, in 10 CFR 20.1402, "A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and that residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."

Site-specific release criteria are derived on a risk or dose-based criterion (such as 25 mrem/year), and depend on modeling (e.g. RESRAD, D&D Code) to translate the dose criterion to a measurable guideline (dpm/100 cm^2 or pCi/g). UC Berkeley had conservatively selected indistinguishable from background as their release criteria. This limit was chosen to ensure that future students, faculty, and general members of the public occupying the rooms are not at risk due to exposure to residual radioactive materials.

Regulatory limits for total and removable surface contamination limits are provided by the State of California and the UCB Radiation Safety Manual (RSM). The goal for the impacted rooms is to return them to an "Unrestricted Area" status, or in other words, not statistically different than background. Background will be measured at a location designated by UCB, which was constructed at the same time using similar materials. Screening levels are given in **Table 3.1**, have been established in the RSM as guidance. These indicate that background needs to be taken into account for consideration in release of the item to the California standard. Our Team is committed to meeting all regulatory release limits.

Table 3.1, UC Berkeley Contamination Limits

TYPE OF SURFACE	Total (dpm/100cm^2) (Includes removable and fixed contamination)	Removable (dpm/100cm^2)		
		α emitters	β, X or γ emitters Radiotoxicity level 3, and 4 dpm/100cm^2	β, X or γ emitters Radiotoxicity level 1 and 2 dpm/100cm^2
Restricted and Controlled Areas				
Within posted radioactive materials zones	1,000 α 10,000 β, X or γ	200	2,000	10,000
Outside posted radioactive materials zones	100 α 1,000 β, X or γ	20	200	1,000
Skin, personal clothing, and protective clothing	Not statistically different from background* Typically this means less than twice the background count rate with an appropriate contamination survey instrument			
Unrestricted Areas[1]				
All surfaces, including items removed from restricted and controlled areas and "trash"	Not statistically different from background*[2]			

*Background radiation is ambient radiation from the cosmos, from rocks and soil, or from ^{40}K (radioactive potassium) in the body.
X = X-ray β, = beta α = alpha γ = gamma

[1]**Note:** Contamination found in unrestricted areas should be promptly decontaminated to background levels. In no case should contamination levels in excess of twice background, be permitted.

[2]**Note:** For the release of material, equipment, or laboratory facilities used with unsealed radioactive material and activation potential, surveys must be performed and documented that demonstrate the limits presented are indistinguishable from background. Any detectable contamination will be decontaminated to indistinguishable from background levels before unrestricted release. The HPT should be consulted for assistance in this area.

3.1 Potential Contaminants

Based on the characterization surveys performed by UCB, the radionuclides of concern identified at Giannini Hall are provided in **Table 3.2**.

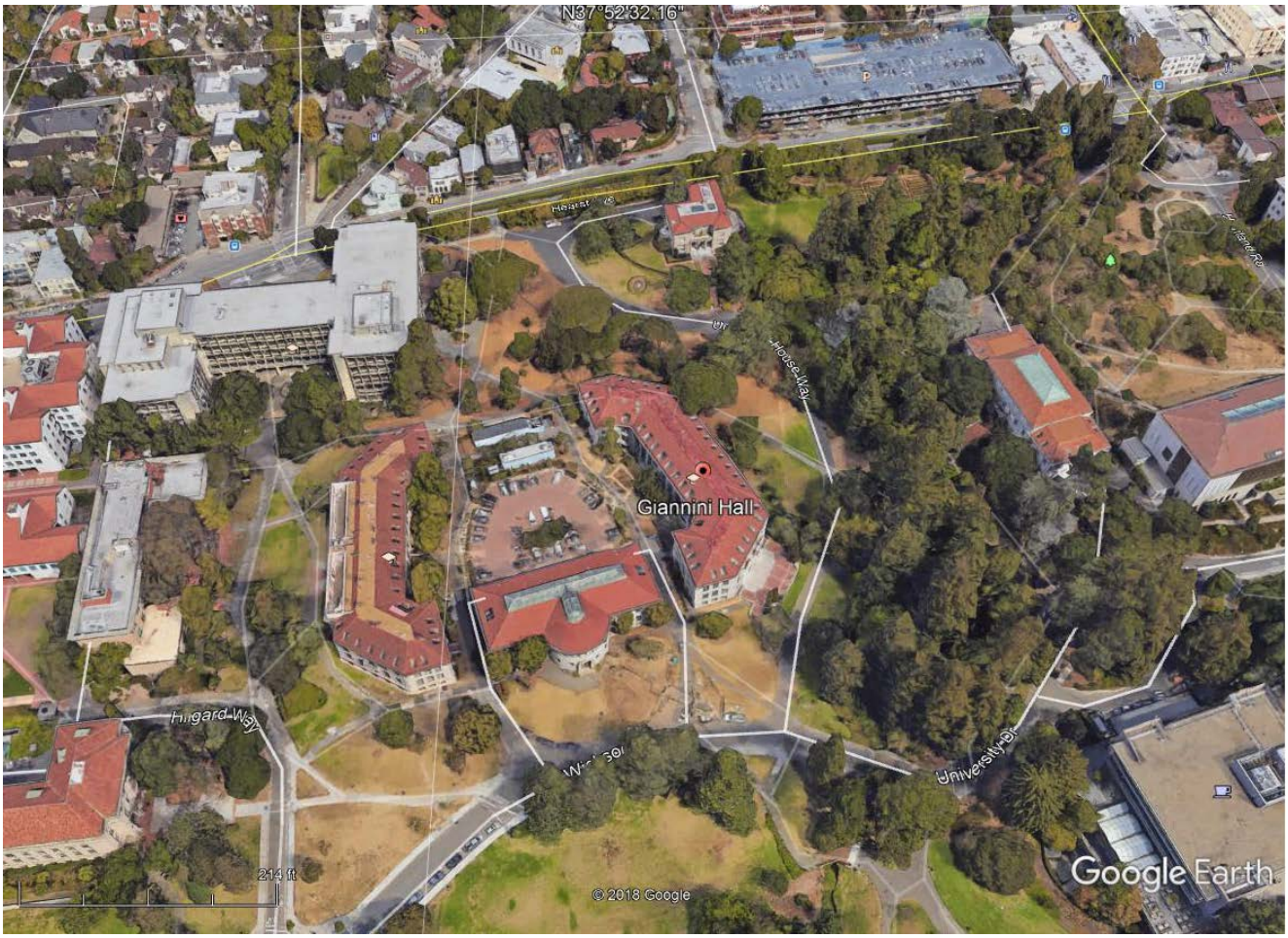
Table 3.2 – Radionuclides of Concern

Nuclide	Half-Life	Mode of Decay
Hydrogen-3	12.27 years	Beta
Carbon-14	5,730 years	Beta
Technicium-99	211,000 years	Beta
Clorine-36	301,000 years	Beta
Cesium-137	30 years	Gamma
Uranium --238	4.5 billion years	Alpha

3.2 Hard to Detect Radionuclides

Hard-to-detect nuclides (H-3) cannot be adequately surveyed using direct field measurements and are typically evaluated by removable activity only as analyzed by liquid scintillation counting (LSC). There was adequate justification to exclude H-3 as a ROC based on the DCGL relative to historical survey records. The Scoping survey indicated all tritium smears were less than MDC, however, as added conservatism; both fixed and removable H-3 activity surveys at 25% of all sample locations for areas of use are included in the FSS.

3.3 Site and Surrounding Areas



4.0 Safety Controls and Monitoring for Workers

All D&D activities will be conducted under Philotechnics California Radioactive Materials License #7754-37. Specifically, the scope of activities will be performed under Philotechnics Radiation Safety Program for California Licensed Activities and Philotechnics Health Physics Operations Procedures.

4.1 Radiation Work Permits

Specific RWP(s) will be developed for the project activities in accordance with Philotechnics' Health Physics Operations Procedures Manual and per Philotechnics procedure HPO-006, "Radiation Work Permits". The RWP will contain at least the following:

- Location of work
- Job description
- Unique RWP number
- Expected radiological conditions
- Effective dates/times of work
- PPE and dosimetry requirements
- Limiting conditions
- Special instructions

4.2 Air Sampling Program

Air sampling will be conducted in accordance with Philotechnics Health Physics Operations Procedures Manual. Air sampling is required to measure the radioactivity to which workers are exposed if worker intakes are expected to result in a committed effective dose of 100 mrem or more. Air samples are also required if respiratory protection is worn to reduce workers intakes of radioactive materials, and to verify the effectiveness of engineering controls.

General area air samples will be collected during aggressive remediation and dismantlement activities of contaminated equipment and structures. The samples will be analyzed by liquid scintillation counting or gross alpha/beta counter (as applicable) and compared to the applicable Derived Air Concentration (DAC) values of the nuclides of concern. The results will be forwarded to the Radiological engineer review and determination if continued sampling is required or if respiratory protection is required.

The PM will calculate the minimum volume necessary for air samples to ensure Minimum Detectable Concentration (MDC) is less than the applicable DAC, or use a time-weighted MDC, in accordance with HPO-106, "Workplace and Personnel Air Sampling" and NUREG 1400, Air Sampling in the Workplace. A spreadsheet has been developed to calculate and keep track of time-weighted air sampling.

4.3 Respiratory Protection Program

Philotechnics has developed a corporate respiratory protection program which describes training, fit tests, selection, use, and maintenance of respiratory protection devices. Certain activities during the remediation may require individuals to wear respiratory protection. These activities include aggressive decontamination and demolition of contaminated surfaces and structures. Prescribed respirators are

powered air purifying respiratory (PAPR) hoods providing a protection factor (PF) of 25 for particulate airborne radioactivity.

4.4 Internal Exposure Determination

Internal exposure may result from inhalation of radioactivity. All radionuclides will default to the DAC value associated with the most conservative solubility class. For the radionuclides present, the following DAC and allowable limit for intake (ALI) values will be used:

Table 4.1 – Internal Exposure Limits by Radionuclide

Nuclide	Class	Primary Mode of Decay	DAC (uCi/ml)	ALI (uCi)
Hydrogen-3	NA	Beta	2.0E-5	8.0E+4
Carbon-14	NA	Beta	1.0E-6	2.0E+3
Technicium-99	W	Beta	3.0E-7	7.0E+2
Clorine-36	D	Beta	1.0E-7	2.0E+2
Cesium-137	W	Gamma	6.0E-8	2.0E+2
Uranium --238	Y	Alpha	2.0E-11	4.0E-2

Based on the data in Table 4.1, the following will apply to all air samples collected during the project: Beta-gamma activity is assumed to be Cesium-137. Alpha activity will be assumed to be U-238.

4.5 External Exposure Determination

The likelihood of individuals receiving external radiation exposure at the site is small. In accordance with 10 CFR 20.1502, adults likely to receive, in one year from sources external to the body, a dose in excess of 10 percent of the limits in § 20.1201(a), are required to be monitored. An a priori assessment has been performed for this effort and determined that it is unlikely that workers will receive an external exposure in excess of 10 percent of the limits in § 20.1201(a), therefore personal dosimetry will not be issued.

4.6 Contamination Control Program

All work activities are performed under the guidance of an RWP. Many of the contamination control measures are discussed elsewhere in this document; however, a description of the methods used follows.

Removable contamination in areas accessible to personnel – such as high traffic areas and ingress/egress routes – is controlled by decontamination where practicable. In the event decontamination is not practicable, contamination is controlled through a combination of anti-contamination clothing and covering of surfaces, as appropriate. Anti-contamination clothing will be worn as specified in the RWP when working in contamination areas.

Simple wetting of surfaces is often sufficient to control the spread of contamination. Aggressive decontamination techniques such as scabbling will be done with negative ventilation attached to the tool. Ventilation will be drawn through a High Efficiency Particulate Air (HEPA)-filtered vacuum cleaner. A general area air sampler will be placed in the vicinity of the discharge.

Work areas and components will be monitored for contamination periodically during work activities to ensure radiological controls are adequate for the conditions.

Individuals exiting contamination areas are required to proceed to the nearest frisking station and monitor themselves for contamination. Contaminated individuals shall not exit the restricted area.

5.0 Planned Remediation Activities

The following sections will detail the order in which the radiological decontamination of the rooms will be performed. The Team will provide all personnel, equipment, and other required resources to fully implement this plan as approved by UCB in accordance with radioactive materials license requirements; applicable federal, state, and local regulations; and NRC guidance documents utilizing industry standard practices.

Operations will be compliant with Philotechnics corporate and project-specific plans and procedures as approved by the CDPH-RHB where applicable. Records will be maintained of all operations, activities, and personnel radiation exposures as required by 10 CFR 20, Subpart L, Records and Philotechnics radioactive materials licenses.

5.1 Pre-Mobilization Activities

The Team will prepare the required project plans and procedures, develop survey packages, procure equipment and supplies, and establish vendor accounts. Attachment A provides an example of the survey packages. Philotechnics will submit for approval by UCB this project-specific Radiological Survey and Sampling Plan. Other plans that will be developed include the Health and Safety Plan (HASP), Waste Management Plan (WMP), and Quality Assurance Plan (QAP).

5.2 Mobilization

The Team will mobilize the crew and equipment to the work site. General and project specific training will be conducted. The portable hand-held instruments will be set up, and initial and daily response check paperwork completed. All mobilization activities will be coordinated with the UCB. These activities will include arranging for security access for the crew and subcontractors; mobilization of support facilities, construction equipment and miscellaneous materials.

5.3 Radiation Safety Training

Team personnel and subcontractors who are subject to entering work areas shall receive job specific training by the Philotechnics PM or the Radiological Engineer. This training will include review of the HASP, tasks, hazards, associated precautions, procedures, emergency egress routes and assembly areas. The training will be based on Philotechnics procedure, "HPO-005, Radiological Training Requirements", which outlines the training required for individuals who may be occupationally exposed to radiation and individuals responsible for performing radiological surveys and oversight.

Each employee and subcontractor employee shall receive orientation training and acknowledge these requirements by signing the attendance sheet before working on the site. The job-specific orientation must be revised for any additional hazards identified during the course of the project. Additional topics to be covered during this training include the following:

- *Radiation Work Permits (RWPs) and Lockout/Tagout*: This training will encompass the purpose, applicability, specific requirements and individual responsibilities associated with the issuance, use and termination of these permits.
- *Access Control Points*: Personnel, other than qualified HPTs, shall be instructed in and required to demonstrate proper use of access control points. This will include

the use of step off pads, monitoring requirements and records requirements associated with the use and maintenance of the access control point.

- *Waste Handling, Segregation and Packaging*: Personnel shall be instructed in the identification, segregation and handling of radioactive and non-radioactive wastes. This will include radioactive survey requirements, maintenance/storage and disposition of different waste streams.
- *Employee Safety Concerns*: Project personnel shall receive training regarding the protocol for reporting and resolving safety issues. Emphasis shall be placed on the ability for any employee to stop work if he/she feels uncomfortable or that the work is progressing in an unsafe manner.

An RWP is required for any activity in a radiologically posted area. RWP's will follow the guidance in Philotechnics procedure, "HPO-006, Radiological Work Permits".

5.4 Lead, Mercury, and Asbestos Abatement

The first step of the remediation will be to remove all asbestos, lead, and mercury from the impacted areas. Our Team will provide all required radiological oversight while our sub-contractor (EcoBay) performs this work. Our team will ensure any noisy work is performed so as to minimize disturbance to occupied adjacent areas; will use electrical power tools in lieu of combustion engine; use equipment and methods that are the least disruptive to adjacent buildings, offices, or residences; and in a manner to minimize fugitive dust, smoke, aerosols, mist, and odors from the project site without posing or introducing additional hazards.

5.4.1 Asbestos

The Team will register with OSHA's Carcinogen Unit; notify the local Occupational Safety and Health Administration (OSHA) office; furnish UCB with a copy of the notifications; and submit its written respiratory protection program to UCB prior to commencing any asbestos abatement activities. The Team will document all activities, in sections as prescribed by UCB. The area will be posted with warning signs at sufficient distance to permit personnel to read the sign and take the necessary protective measures to avoid exposure; in high visibility locations near the work site.

5.4.2 Lead

The Team will make the necessary Lead Work Notification required by California Occupational Safety and Health Administration (Cal-OSHA) §1532.1 (p) where applicable. A copy of the notification, including the eleven items of information listed, will be provided to Cal-OSHA and to UCB's Real Estate Division's Project Manager and the Environmental Health & Safety Construction Health and Safety Specialist with 24 hours of providing to Cal/OSHA.

- We will also notify all other contractors and subcontractors on site of any upcoming work that will impact lead, or may generate levels of airborne lead at or above the Cal/OSHA PEL of 50 $\mu g/m^3$. They will also provide information on the control systems and adequate warnings.

5.4.3 Mercury

Mercury monitoring and abatement will follow and adhere to the guidance and regulation provided by the Team; both Federal OSHA and Cal-OSHA specifications, standards, and requirements; CDPH and the California Code of Regulation guidance and regulation; the USEPA standards and guidance documents; Bay Area Air Quality Management Division (BAAQMD) regulations; other appropriate environmental laws as applicable and relevant or appropriate requirements specified in decision documents for waste characterization, Land Disposal Restrictions, and waste handling, storage, and disposal; the Department of Transportation (DOT) guidance, regulation and requirements; and UCB mercury monitoring, remediation and reporting requirements to ensure compliance, and the safety of the workers and the public.

5.5 Removal of Furniture and Fixtures

It is probable that radioactive materials have migrated to inaccessible areas; therefore, dismantlement will be performed to assess the activity levels. However, we anticipate being able to free release the majority of the furniture and fixtures using MARSAME surveys. Any items that are distinguishable from background will be fully characterized, packaged, and sent out as radiological waste.

5.6 Removal of Duct Work

Our Team will take a conservative approach and remove all duct work in the impacted rooms dispose of it as radiological waste. It has been our experience it is very difficult to confidently determine that duct work is free of residual contamination and is more economical to remove and send out as radioactive waste than to perform MARSAME surveys. Exhaust ducts will be removed using heavy duty electric nibblers and/or reciprocating saws. The ducts will be cut just below ceiling level to maintain a negative pressure until other remediation activities are completed, and then the remaining ducts will be removed. The sections of duct work will be removed in manageable sections.

5.7 Removal of Fume Hood

Our base assumption is the fume hood is not contaminated based upon historical records and no removable contamination has been previously identified. However, we will remove it in order to survey the floor underneath. The Team will verify that Lockout/Tagout has been successfully accomplished before proceeding with any planned activities that may involve potential contact with any energized equipment. Fume hoods will be disassembled and size-reduced as appropriate for transfer to the shipping container and waste packaging. Some components will require cutting with electric saws, sheet metal shears or nibblers. Our Team does not plan to use open flame tools during this project. A plastic-lined laydown area will be established to perform size reduction operations to prevent cross-contamination.

5.8 Removal of Flooring

After dismantlement and post remediation surveys, floor coverings may need to be removed to assess the underlying floor surfaces for radioactive contamination. Once the asbestos, lead, and mercury abatement has been completed, we will begin removing the flooring down to the concrete subfloor. Radiological controls such as HEPA air scrubbers, polyethylene sheeting, and HEPA filtered scarifiers will be put in place to minimize fugitive dust and minimize waste generation. If concrete under the flooring is found to have radiological contamination it will be removed.

5.9 Remediation of Building Surfaces

Floor decontamination will be completed using various standard decontamination methodologies. Conventional non-aggressive methods will be used to initially decontaminate floor surfaces such as mopping, hand scrubbing, etc. For areas where more aggressive decontamination is required, concrete floor scabbling and/or scarifying shall be used. It may be also necessary to remove entire sections of the floor. Administrative and engineering controls shall be utilized as necessary, to prevent the spread of contamination and the release of airborne contamination.

Wall and ceiling decontamination activities shall be completed, as required, using conventional decontamination methodologies (i.e., hand wiping using mild detergent and disposable rags) to the extent practical. In the event these methods are unsuccessful, more aggressive decontamination techniques may be performed such as grit blasting, scabbling, paint gels, demolition, including using simple hand tools, electric concrete chipping hammers, jack hammers, etc. Administrative and engineering controls will be used to control the spread of contamination and the release of airborne contamination.

All remediation activities will be conducted in a manner to control the spread of contamination and keep personnel exposure ALARA. Engineering controls such as containments, glove bags and portable HEPA ventilation systems shall be used, as appropriate.

5.10 Erect Negative Pressure Enclosure

The crew will erect the Negative Pressure Enclosure (NPE) ensuring the NPE does not interfere with the use or access of occupied portions of the building and maintains all corridors, stairs, halls, and other exit-ways of occupied portions of Giannini Hall free of debris or obstruction. The Team will follow the guidelines in Infection Control Risk Assessment (ICRA) Precautions during Construction and Renovation Toolkit and matrix provided by The Association for Professionals in Infection Control and Epidemiology (APIC), the Center for Disease Control Barrier Guidelines, the State of California Department of Industrial Relations' Division of Occupational Safety and Health (DOSH), Cal/OSHA, and all pertinent UCB requirements. In addition, the Team will use 2,000 cfm HEPA filtered negative air machines to keep the area at a negative pressure; control fugitive hazardous dusts and Presumed Asbestos Containing Materials (PACM) as described below; and prevent the creation of air pollution and odors. Necessary precautions will be taken to prevent the migration of fugitive hazardous dusts and PACM to adjacent areas.

Only authorized, trained, protected, and qualified personnel will be allowed into the restricted/controlled areas. Eating, drinking, smoking, or chewing of gum or tobacco will be prohibited in the restricted/controlled area. Due to pest control concerns, food will only be consumed in a designated area, with refuse being deposited in closed-lid containers until collection.

Heating, Ventilation, and Air Conditioning (HVAC) units, windows, doors, hallways, skylights and lighting fixtures will be secured prior to commencing work Secured doorways will be sealed with double entrance and exit door, to include the Aire Guardian Door Guard or equivalent, to allow access, and provide the necessary emergency exits.

All materials and equipment will be cleaned and removed prior to the start of the project if possible. Those items that are not removed will be cleaned and covered with polyethylene sheets SAFE FLEX

barrier sheeting or equivalent, to provide a barrier to protect adjacent surfaces from cross-contamination. Barrier will be taped securely with tape capable of sealing joints of adjacent barrier sheets and attaching barrier sheets to existing surfaces. These covers will not be removed until the work is completed. Restricted/Controlled areas will be sealed with at least 6 millimeter fire retardant polyethylene barrier sheeting, (i.e., critical barriers), with no gaps, and demarcated with applicable warning signs.

A decontamination facility and an equipment area will be constructed of polyethylene sheeting with double entrance and exit doors, should it be necessary for PACM abatement. In addition to step-off pads and a wet wiping station (all materials, equipment, and wheels will be wet wiped to remove dust prior to being removed from the restricted/controlled area), a personnel and equipment radiological monitoring/frisking stations and control point will be established at exits.

A load out chamber will be constructed with double entrance/exit doors, as described above. The load out chamber and disposal containers will be located in such a manner that handling and movement of hazardous and/or contaminated materials will be minimized. All hazardous and/or radioactive materials will be disposed of in properly labeled, sealable, impermeable containers.

2,000 cfm HEPA filtered negative air machines will be utilized within the restricted/controlled area to create a negative air pressure with respect to outside areas and of sufficient quantity of negative pressure to provide a minimum of four (4) air changes per hour. Air samples will be collected daily to evaluate the efficiency of the filtration device filter system. HEPA-filtered units will be exhausted out-of-doors through 6 mil (minimum) disposable duct whenever possible. The effectiveness of the NPE will be smoke tested, continuously monitored by the field crews and visually inspected to verify its integrity.

Emergency and fire exit procedures will be established in the HASP. Emergencies have priority over all other operations, and will be detailed in Activity Hazard Analysis (AHA).

Hazardous and/or radioactive materials with removable, or potential to become removable, contamination, will be sprayed with a fixative agent, a wetting agent, covered and sealed, or decontaminated. A fine spray will be applied to reduce dust and/or fiber generation during the removal or size reduction process, to reduce emissions as much as practicable.

All personnel, without exception, will:

- Prior to entry into the work area, personnel will don disposable coveralls with built in hoods and attached booties with reinforced non-skid soles, appropriate footwear, and respiratory protection.
- Personnel will remove coveralls, head covers, footwear covers, and respirator (if necessary) prior to exiting the work area.

Decontamination of the work area will be performed prior to dismantling the NPE, and area clean up performed at the end of each shift. Personnel will clean surfaces in the area and/or HEPA-filtered vacuum the areas. HEPA-filtered exhaust units will continue to operate.

The NPE will remain under negative pressure until all remediation results are less than the derived concentration guideline level (DCGL) and indicate the area is free from residual radioactive

contamination and meets the proposed release criteria. If PACM Abatement was performed, concentrations of airborne fibers will be reduced to a level at or below either the limits prescribed in California Regulations or the level identified from the baseline air sample, whichever is lower.

For manual activities, HEPA Vacuums will be used during any decontamination, abatement, or clean-up activities. The Team will maintain good housekeeping, and ensure the area and surrounding areas are not encumbered with materials and equipment, and are free from accumulation of excess dirt, waste materials, and rubbish on a daily basis.

In the event the NPE is compromised; fails to maintain negative pressure; or materials and debris that may contain lead are noticed outside of the restricted/controlled area, work will be stopped immediately, and the PM and UCB representative notified.

5.11 Equipment Decontamination

Equipment, tools, and other items being removed from radiological areas will be surveyed for removable and total contamination prior to removal from the restricted area. Smear sampling for removable contamination will be performed in accordance with Philotechnics procedure HPO-105, "Contamination Surveys". Frisking and static measurements for total contamination will be performed with an instrument that is appropriate for the surface to be surveyed in accordance with Philotechnics procedure HPO-105. Items that exceed the release limits or cannot be adequately surveyed shall be controlled as radioactive material.

Decontamination will be performed at a dedicated decontamination pad located inside the contamination area. Where practical, dry removal techniques (e.g., wiping with disposable moist towels or rags) will be used for decontamination purposes. Wet decontamination (if necessary) will be performed on the dedicated decontamination pad; and the rinse water will be collected and sampled to facilitate proper disposal. All liquid waste originating from a radiological work area will be handled as radioactive waste.

Equipment or materials that cannot be easily or cost-effectively decontaminated will be evaluated for possible limited use in radioactive material use areas, or disposed of as radioactive waste.

5.12 Personnel Decontamination

Frisking personnel for surface contamination will be performed using a Ludlum Model 12 ratemeter with a GM probe (or equivalent instrument). The Radiological Engineer will be notified upon detection of contamination on personal clothing or skin. Notification of the PM by the Radiological Engineer of a personnel contamination event will be made as soon as practical. Notification by the PM to the Project RSO is required within the same work shift and sooner if practical. Notification to the UCB RSO will be made.

Decontamination to minimize exposure and prevention of the spread of contamination is the first priority of the Radiological Engineer. On-scene control and decontamination direction and oversight will be provided by the Radiological Engineer or designee. The need for off-site resources will be determined by the Radiological Engineer. The PM will be apprised of the results of the decontamination process.

5.13 Effluent Monitoring

In order to demonstrate compliance with dose limits to members of the public, general area air samples that are collected during remediation activities will be compared to the effluent release limits specified in Table 4.1.

6.0 Radioactive Waste Management

All waste will be packaged in appropriate DOT compliant packaging and staged for subsequent shipment to licensed processor or disposal facility at a later date by UC Berkeley. Some waste may require size reducing for packaging. All waste will be stored in one of the impacted rooms being remediated until it has been transferred to UCB's authorized waste storage area. Radioactive waste will be subdivided into categories based on types of material and processing methods. Radioactive subdivisions include metals, DAW/combustible, and PACM.

Any employees and/or subcontractors involved in the packaging of radioactive materials for shipment or transport will have current training in accordance with the requirements of Subpart H, Training, of 49 CFR 172.

7.0 Survey Instrumentation

The following sections outline the instrumentation and survey methodology that will be used at Giannini Hall.

7.1 Instrument Calibration

Laboratory and portable field instruments will be calibrated at least annually with National Institute of Standards and Technology (NIST) traceable sources, and to radiation emission types and energies that will provide detection capabilities similar to the nuclides of concern.

7.2 Functional Checks

Functional checks will be performed at least daily when in use. The background, source check, and field measurement count times for radiation detection instrumentation will be specified by procedure to ensure measurements are statistically valid. Background readings will be taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions. If an instrument fails a functional check, all data obtained with the instrument since the last satisfactory check will be reviewed by the PM and the Radiological Engineer to determine whether or not it is valid.

7.3 Determination of Minimum Detectable Concentrations

Minimum counting times for background determinations and counting times for measurement of total and removable contamination will be chosen to provide MDCs that meet the data quality objectives (DQOs) specified in this plan. MARSSIM equations relative to building surfaces have been modified to convert to units of dpm/100cm^2. Count times and scanning rates are determined using the following equations:

7.3.1 Static Counting

Static counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is an expansion of NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100cm^2}}$$

Where:

MDC_{static}	=	minimum detectable concentration level in dpm/100cm^2
B_r	=	background count rate in counts per minute
t_b	=	background count time in minutes
t_s	=	sample count time in minutes
E_{tot}	=	total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and 0.25 surface efficiency for beta emitters <400 keV max)

A = detector probe area in cm^2

7.3.2 Ratemeter Scanning

Scanning Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation which is a combination of MARSSIM equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p}\cdot E_{tot}\cdot\frac{A}{100cm^2}}$$

Where:

MDC_{scan} = minimum detectable concentration level in dpm/100 cm^2
d' = desired performance variable (1.38)
b_i = background counts during the residence interval
i = residence interval
p = surveyor efficiency (0.5)
E_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and 0.25 surface efficiency for beta emitters <400 keV max)
A = detector probe area in cm^2

7.3.3 Smear Counting

Smear counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{smear} = \frac{3+3.29\sqrt{B_r\cdot t_s\cdot(1+\frac{t_s}{t_b})}}{t_s\cdot E}$$

Where:

MDC_{smear} = minimum detectable concentration level in dpm/smear
B_r = background count rate in counts per minute
t_b = background count time in minutes
t_s = sample count time in minutes
E = instrument efficiency for radionuclide emission of interest

7.3.4 Counting Uncertainty

The counting uncertainty for both total and removable measurements will be calculated using equation 6-15 from MARSSIM, reproduced below:

$$\sigma_R = \sqrt{\frac{C_{s+b}}{T_{s+b}^2} + \frac{C_b}{T_b^2}}$$

Where:

σ_R	=	statistical counting uncertainty
C_{s+b}	=	gross counts of the sample (cpm)
T_{s+b}	=	Sample time (minutes)
C_b	=	Gross background counts (cpm)
T_b	=	Background count time (minutes)

7.3.5 Uncertainty Propagation and Confidence Interval

Because calculations to determine the final static measurement results are based on dividing the net count rate by total efficiency, the uncertainty propagation formula to be used is as follows (MARSSIM Section 6.8.3):

$$\sigma_A = u\sqrt{\left(\frac{\sigma_{R_b}}{R_b}\right)^2 + \left(\frac{\sigma_E}{E}\right)^2}$$

Where:

σ_A	=	Measurement propagated error or total uncertainty
u	=	Final result in dpm/100 cm^2
σ_{R_b}	=	Standard deviation of the net count rate
R_b	=	Net count rate
σ_E	=	Standard deviation of the instrument efficiency
E	=	Instrument efficiency

Referring to MARSSIM Table 6.9, a *k* value of ±1.96 represents a confidence interval equal to 95 percent about the mean of a normal distribution. All total activity measurements will be presented as the final result in dpm/100 cm^2 ± $1.96\,\sigma_A$.

7.3.6 Instrumentation Specifications

The instrumentation that will be used during the project is summarized in the following tables. **Table 7.1** lists the standard features of each instrument such as probe size and efficiency. Alternate or additional instrumentation with similar detection capabilities may be utilized as needed for survey requirements with the PM's approval.

Table 7.1 – Instrumentation Specifications

Detector Model	Detector Type	Detector Area	Meter Model	Window Thickness	Typical Total Efficiency
Ludlum 43-37-1	Gas Flow Proportional	821 cm^2	Ludlum 2350-1	1.2 mg/cm^2	**30% (Pu-239) 30 % (C-14)**
Ludlum 43-68	Gas Flow Proportional	126 cm^2	Ludlum 2350-1	0.8 mg/cm^2	**20% (Pu-239) 20 % (C-14)**
Ludlum 44-110 (open window)	Gas Flow Proportional	126 cm^2	Ludlum 2350-1	None	**25 % (H-3)**
Ludlum 44-10	NaI	2-inch	Ludlum 2221	N/A	**900 cpm/uR/hr (Cs-137)**
Ludlum 43-10-1	Dual Phosphor Scaler	N/A	3030E	0.8 mg/cm^2	**40% (Pu-239) 20 % (C-14)**
Beckman LS6000	**Liquid Scintillation**	**N/A**	**N/A**	**N/A**	**40% (H-3)* 80% (C-14)***

8.0 Characterization Surveys

The survey protocol for building surfaces and structures will include surface scanning, surface activity (static) measurements, exposure rate measurements and sample collection (smears). The purpose of scanning is to identify locations of elevated activity. Where elevated activity is identified, a static measurement and smear will be taken at the location of highest activity identified during the scan. Where elevated activity is identified, the boundary of the elevated area will be marked to aid in locating the area for remedial actions.

Each survey unit will have an independent survey package that has specific survey instructions. Attachment A provides an example of the survey packages. The survey package will contain, at a minimum:

- Survey Unit number (e.g., Building and Room Number, System Number, etc.),
- Percentage of surface requiring scan surveys,
- Number of total and removable contamination measurements,
- Instrumentation to be used with static count times and scan rates,
- Any additional specific survey instruction,
- Maps of the survey unit surfaces, with pictures.

If the initial characterization survey results indicate that contamination is not present in excess of the release criteria, then data from the survey may be used as part of the final status survey.

9.0 Remedial Action Surveys

Remedial action surveys are conducted in support of remediation activities to help determine when the area is ready for a final status survey (FSS) and to provide updated estimates for FSS planning. Remedial action surveys serve to monitor the effectiveness of decontamination efforts and ensure that surrounding areas are not cross-contaminated from remediation actions.

Remedial action surveys consist of scan surveys, direct measurements and removable contamination measurements. These will be conducted following remediation activities to establish the success or failure of the efforts to decontaminate the applicable survey area. Results of the survey will be the decision basis for continued remediation or conduct of FSS. The survey documentation resulting from remedial action surveys will be maintained with the original characterization survey package.

Remedial action surveys will be designed to meet the DQOs of the FSS. To the extent allowed by MARSSIM, the results of the remedial action surveys will be used to supplement the FSS.

10.0 Design and Performance of Final Status Surveys

FSS are performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use. The final status survey will be conducted using the DQO process. Characterization and remedial action survey data will be used as FSS data to the maximum extent possible in order to minimize overall project costs.

FSS will be conducted by performing required scan surveys, total direct surveys, removable contamination measurements and solid sampling as discussed further in this section. All survey data shall be documented on survey maps and associated data information sheets.

10.1 Data Quality Objectives

Data Quality Objectives were developed to define the purpose of the field sampling, clarify what data should be collected to satisfy the purpose, and specify the performance requirements for the quality of information to be obtained from the data. These outputs were used to develop a survey design for data collection.

Table 10.1Data Quality Objectives

DQO Step	Giannini Hall
State the Problem	The problem is described as evaluating if residual radioactivity in statistically distinguishable from background *The planning team*: Philotechnics is responsible for the development of this RSSP. Information on current and past activities at these sites was provided by UCB. The primary decision maker for the survey work is the UCB RSO and State regulators.
Identify the Decision to be Made	Determine whether or not the residual radioactivity at Giannini Hall is statistically distinguishable from background. *Alternative Actions* If the residual radioactivity exceeds background, then remediation will be required to reduce the levels to below this level. If no residual radioactivity is detected greater than background then the area may be released for unrestricted use.
Identify Inputs to the Decision	California Department of Public Health – Radiological Health Branch (CDPH-RHB) recommendations – "***the site will be remediated to a level in which survey readings, and residual surface contamination in disintegrations per minute (dpm), are not statistically distinguishable from mean reference area background values plus three (3) standard deviations and As Low as Reasonably Achievable (ALARA)***". Static measurements for alpha and beta radiation. Scanning measurements for beta radiation. Swipe samples analyzed by liquid scintillation or alpha/beta scalers.
Boundaries of the Study	Giannini Hall ground floor rooms 010B, 010C, 020, 022, 022B, 023, 023A, 023B, 023BA, 023C, 023D, 024, 024A, 024B, 025, 026, 027, 027A, 028, 029, and 030 will be renovated and demolished to the extent indicated by the approved plans. Ground Floor Rooms 010A, 010D, 010E, 010F, 010G, and First Floor Room and 122 will be remodeled, but will not need to be fully demolished. These rooms delineate the bounds for the survey at Giannini Hall. The decision will be made for each individual survey unit. **Practical Constraints** Building Structure may obstruct sample locations may be moved or not collected.

DQO Step	Giannini Hall
Decision Rules	**Static Measurement Decision Rules** Static measurements will be collected and compared to the DCGL If any static measurement exceeds the DCGL the PM will be notified. **Scanning Measurement Decision Rules** Scanning will be conducted at a rate to achieve an MDCscan of not more than the applicable limit shown in Table 3.1. Scans indicating contamination in excess of MDA will be investigated and remediated. **Swipe Sample Decision Rules** If any removable contamination is detected which exceeds the applicable removable activity screening value, the survey unit is determined not to meet the release criterion. However, if all removable contamination measurements are less than the removable screening values, then compliance shall be determined based on total activity measurements. **Survey Unit Release Decision Rules** If the residual radioactivity is not in excess of the DCGL then the site will be released for unrestricted use.
Tolerance Limits on Decision Errors	*Define the Baseline Condition and Both Types of Decision Errors* The null hypothesis (baseline condition) is that the site residual radioactivity is statistically distinguishable from background. The alternative hypothesis (alternative condition) is that the site residual radioactivity is not statistically distinguishable from background. Two types of decision errors may occur: *Type I – False Positive (Rejection) Error*—The decision-maker determines that the true concentration of target radionuclides present is not greater than or equal to the DCGL, when in fact the analyte exceeds the DCGL. The consequence of this decision is that the target analyte concentration may lead to increased human health and/or environmental risk. *Type II – False Negative (Acceptance) Error*—The decision-maker determines that the true concentration of a target analyte is greater than the DCGL when it is not. The consequence of this decision is unnecessary remediation activities resulting in greater cost and additional time spent to verify the site is clean. *Define the Gray Region* The gray region is the range of possible parameter values near the DCGL where the cost of determining that the alternative condition is true outweighs the expected consequences of a decision error. In statistical language, the gray region is one component of the quantitative decision performance criteria that is specifically used to limit impractical and infeasible number of samples based on the Type I and Type II error values. The gray region is where large error rates are acceptable and is bounded by the lower bound of the gray region (LBGR) where Type II errors (b) are controlled and the upper bound of the gray region DCGL, where Type I errors (a) are controlled. For this scenario (Scenario A), the LBGR will be established as 50% of the DCGL. *Define Tolerable Decision Error* Type I (false positive [rejection] error) and Type II (false negative [acceptance] error) rates have been established at 5%.
Sample Design	Static measurements and swipe samples will be collected from the survey units at locations selected based systematic sampling and biased sampling based on results from previous studies. *Define the key assumptions supporting the sampling design* All survey units will be classified as a MARSSIM Class 2 survey unit.
DQO = data quality objective	

10.2 Background Determination for Surfaces and Structures

The use of reference background areas or paired background comparisons is not necessary for the purposes of this plan. The best approach for this survey will be to determine compliance with the

established DCGLs following subtraction of the mean of a reference material background. This decision is based on the guidance provided in Section 12 of NUREG-1505, "*A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys*." This section states that better precision is possible if the average of the measurements made on the reference material is subtracted from each measurement made on that material.

Our Team will collect background measurements in an area which was built around the same time using similar building materials. A reference background in counts per minute, for each instrument type on each material type, will be established by calculating the mean of multiple measurements. The established mean background values will be subtracted from the applicable FSS gross measurement count rates (in cpm) to determine the net measurement count rate.

Professional judgment will be used to select locations of similar construction materials correlating to the building materials. These locations will be selected in areas that were not impacted by the use of radioactive materials. Initially, ten measurements for each surface material will be collected and evaluated for statistical confidence as described below.

NUREG 1505 does not provide a statistical method for calculating the variance of the background samples used to calculate N as described in Section 12 of NUREG-1505. Therefore, the t-statistic test as described in NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination," will be used to establish the methodology for determining the reference material variance to be used for calculating N as discussed in Section 12.0 of NUREG-1505.

This calculation is performed to ensure the mean of the background measurements meets statistical requirements of a +/- 20 percent accuracy at the 95 percent confidence interval. The following formula (t-statistic test) is used to calculate the number of measurements needed to establish the desired accuracy of the mean.

$$n_b = \left[\frac{t_{95\%,df} \times S_x}{0.2, X_{B_m}}\right]^2$$

where:

n_b = the number of background measurements needed to meet the accuracy requirements

$t_{95\%.,df}$ = t statistic for 95 percent confidence interval with df degrees of freedom

S_x = the standard deviation of the initial background measurements

X_{Bm} = mean of the initial background measurements

The Team will collect a total of 10 reference measurements for each media to be characterized. If the calculated value n_b is less than ten, then no further background measurements are required. If the calculated value n_b is greater than ten, then additional measurements will be performed until the n_b value is less than the actual number of measurements collected.

10.3 Area Classifications

Initial classifications have been determined based on the previous characterization data.

10.3.1 Non-Impacted Area

Non-impacted areas are areas without residual radioactivity from licensed activities and are not surveyed during FSS. For the purpose of this plan, the following are initially classified as non-impacted:

- Some ceilings

10.3.2 Impacted Areas

Impacted areas are those areas that have potential for containing contaminated material – are further subdivided into one of three classifications (NRC 2000a). Impacted areas are subdivided into Class 1, Class 2 or Class 3 areas. Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey using a graded approach, followed by Class 2, and then by Class 3. Impacted sub-classifications are defined, for the purposes of this plan, as follows:

10.3.3 Class 1 Area

Areas that have, or had, a potential for radioactive contamination or known contamination. Examples of Class 1 areas include: (1) site areas previously subjected to remedial actions; (2) locations where leaks or spills are known to have occurred; (3) former burial or disposal sites, and (4) waste storage sites.

10.3.4 Class 2 Area

These areas have, or had, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$.

10.3.5 Class 3 Area

Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a very small fraction of the $DCGL_W$, based on site operating history and previous radiological surveys.

10.3.6 Survey Units

A survey unit is a geographical area of specified size and shape for which a separate decision will be made whether or not that area meets the release criteria. A survey unit is normally a portion of a building or site that is surveyed, evaluated, and released as a single unit. For the purposes of this plan, areas of similar construction and composition will be grouped together as survey units and tested individually against the DCGLs and the null hypothesis to show compliance with the release criteria. Survey units will be homogeneous in construction, contamination potential, and contamination distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity exists within a survey unit does not depend on the survey unit size. However, the sampling density should reflect the potential for small elevated areas of residual radioactivity. Survey units will be sized according to the potential for small elevated areas of residual radioactivity. Recommended maximum survey unit sizes for from MARSSIM are provided in **Table 10.2**.

Table 10.2 – Recommended Maximum Survey Unit Size Limits

Type of Survey Unit	Class 1	Class 2	Class 3
Structures	Up to 100 m^2	100 m^2 to 1,000 m^2	No Limit
Open Land	Up to 2000 m^2	2,000 m^2 to 10,000 m^2	No Limit

Initial Survey units for the facility are summarized in **Table 10.3**. **Figures 1-3** show the survey units.

Table 10.3: Giannini Hall Unit Summary

Survey Unit	Description	Classification	Area (sq ft)
1	20	2	375
2	22, 22b	2	125
3	023a	2	200
4	24. 24a, 24b	2	300
5	25	2	280
6	26	2	215
7	27, 27a	2	255
8	28	2	205
9	29	2	305
10	30	2	320
11	10, 10a, 10b, 10c, 10d, 10e, 10f, 10g	2	2,165
12	122	2	270

10.4 Scan Surveys for Building Surfaces and Structures

The use of reference background areas or paired background comparisons is not necessary for the purposes of this plan. The best approach for this survey will be to determine compliance with the established DCGLs following subtraction of the mean of a reference material background. This decision is based on the guidance provided in Section 12 of NUREG-1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys." This section states that better precision is possible if the average of the measurements made on the reference material is subtracted from each measurement made on that material.

Scanning is used to identify locations within the survey unit that exceed the investigation level. These locations are marked and receive additional investigations to determine the concentration, area, and extent of the contamination. Scanning surveys are designed to detect small areas of elevated activity that are not detected by the measurements using the systematic pattern. For this reason, the measurement locations and the number of total surface activity measurements may need to be adjusted based on the sensitivity of the scanning technique. **Table 10.4** summarizes the percentage of accessible building structural surfaces to be scanned based on classification.

Table 10.4 – Scan Survey Coverage by Classification

Classification	Recommended Scan Coverage	Plan Coverage
1	100%	100%
2	10-100% (Judgmental)	>50%
3	Judgmental	>25%

For the purposes of the FSS planning, Class 1 survey units will receive a 100% scan survey of all accessible surfaces. Class 2 survey units will receive a minimum scan survey of >50% of all accessible surfaces. Class 3 survey units, will have received a minimum scan survey of >25% of all accessible surfaces. For Class 2 and Class 3 survey units, the sensitivity for scanning techniques is not tied to the area between measurement locations as they are for Class 1 areas. The scanning techniques selected will represent the best reasonable effort based on the survey data quality objectives

The percentage of survey area scan surveyed may be increased based on suspected elevated activity. For all classes, the surfaces to be scan surveyed will be those with the highest potential to contain residual contamination. Floor areas near building entrances and exits will receive a 100% scan survey regardless of the area classification. These surveys will provide indications of potential migration of residual contamination to the outside grounds.

If elevated activity is detected during the scan surveys, then the location shall be marked and total and removable surface activity measurements will be taken to quantify the activity. However, these total surface activity measurements are in addition to the static measurements required for the statistical test.

10.5 Outside Surfaces and Structures

Outside surfaces and structures are not included in this scope of work; however, we will pay special attention to all entrances, exits, and area access locations during the scan portion of the surveys to ensure materials were not inadvertently tracked to unrestricted areas.

10.6 Total Surface Activity Measurements

Direct surveys (static measurements) will be taken on building surfaces and system internals to the extent practical in impacted areas utilizing instrumentation of the best geometry based on the surface at the survey location. Additionally, locations of elevated activity identified and marked during the scan survey will also require total activity measurements.

Total surface activity measurements shall be taken at each determined sample location. Scaler count times will be determined based on the MDC_{static} of the applicable survey instrument.

10.7 Determining the Number of Samples

A minimum number of samples are needed to obtain sufficient statistical confidence that the conclusions drawn from the samples are correct. The number of samples will depend on the relative shift (the ratio of the concentration to be measured relative to the statistical variability of the contaminant concentration). Initial calculations have been performed to determine an estimated standard deviation and Lower Bound of the Gray Region (LBGR) for determination of the relative shift.

The survey design for surfaces and structures will be based on the Sign test. The minimum number of samples is obtained from MARSSIM tables or calculated using MARSSIM Equation 5-2.

10.8 Determination of Relative Shift

The number of required samples will depend on the ratio involving the activity level to be measured relative to the variability in the concentration. The ratio to be used is called the Relative Shift, Δ/σ_S and is defined in MARSSIM as:

$$\Delta / \sigma_S = \frac{DCGL - LBGR}{\sigma_S}$$

Where:

DCGL	derived concentration guideline level
LBGR	concentration at the lower bound of the gray region. The LBGR is the average concentration to which the survey unit should be cleaned in order to have an acceptable probability of passing the test
σ_S	an estimate of the standard deviation of the residual radioactivity in the survey unit

For the purpose of this plan, an estimated standard deviation will be pre-determined based on the expected total activity levels at the time of the FSS. The LBGR will initially be set at one-half of the most restrictive $DCGL_W$.

10.9 Determination of Acceptable Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by failing a unit that should pass (β decision error) or passing a unit that should fail (α decision error). MARSSIM uses the terminology α and β decision errors; this is the same as the more common terminology of Type I and Type II errors, respectively. The decision errors are 0.05 for Type I errors and 0.05 for Type II errors.

10.10 Determination of Number of Data Points

The number of direct measurements for a particular survey unit, employing the Sign Test, is determined from MARSSIM Table 5.5, which is based on the following equation (MARSSIM equation 5-2):

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4\left(SignP - 0.5\right)^2}$$

Where:

N	= number of samples needed in the survey unit

$Z_{1-\alpha}$ = percentile represented by the decision error α

$Z_{1-\beta}$ = percentile represented by the decision error β

SignP = estimated probability that a random measurement will be less than the DCGL when the survey unit median is actually at the LBGR

Note: SignP is determined from MARSSIM Table 5.4

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. MARSSIM Table 5.5 values include an increase of 20% of the calculated value.

10.11 Determination of Sample Locations

Determination of Class 1 survey unit sample locations is accomplished by first determining sample spacing and then systematically plotting the sample locations from a randomly generated start location. The random starting point of the grid provides an unbiased method for obtaining measurement locations to be used in the statistical tests.

Similar systematic spacing methods are used for Class 2 survey units because there is still some probability of small areas of elevated activity. The use of a systematic grid allows the decision-maker to draw conclusions about the size of the potential areas of elevated activity based on the area between measurement locations.

Class 3 survey locations are determined from computer-selected randomly generated x and y coordinates. Survey protocols for all areas are summarized in **Table 10.5**

Table 10.5 – Survey Sample Placement Overview

Survey Unit Classification		$DCGL_w$ Comparison	Elevated Measurement Comparison*	Measurement Locations
Impacted	Class 1	Yes	N/A	Systematic random
	Class 2	Yes	N/A	Systematic random
	Class 3	Yes	N/A	Judgmental
Non-Impacted		None	None	None

- - The elevated measurement comparison is not used in California.

Additional total surface activity measurements will be collected at each area of elevated activity identified during the scan surveys. These are in addition to the systematic measurements.

10.12 Determination of Class 1 Sample Locations

In Class 1 survey units, the sampling locations are established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L = sample spacing interval

A = the survey unit area

N = number of samples needed in the survey unit

Maps will be generated of the survey unit's permanent surfaces included in the statistical tests (floors, walls, ceilings, fixed cabinetry, etc.) and folded out in a 2-dimensional view. A random starting point is determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid is plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location is plotted at each intersection of the grid plot.

10.13 Determination of Class 2 & 3 Sample Locations

Class 1 survey units generally consist of one or two rooms or areas. Class 2 and Class 3 survey units generally consist of many rooms or areas. All Class 1 rooms will be a scale drawing in a "folded-out" view to show all surfaces presents, while Class 2 and Class 3 drawings will not display a "folded-out" view. The process to identify, map and locate measurement coordinates in survey units with many rooms is complicated due to the noncontiguous nature of the survey unit once walls are "folded-out".

10.13.1Determining Class 2 Sample Locations

In Class 2 survey units, the sampling locations are established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L = sample spacing interval

A = the survey unit floor area

N = number of samples needed in the survey unit

Maps will be generated of the survey unit's permanent surfaces included in the statistical tests. Only horizontal surfaces (e.g., floors, countertops, etc.) are included in the statistical tests. A random starting point is determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid is plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location is plotted at each intersection of the grid plot.

10.13.2Determining Class 3 Sample Locations

For Class 3 areas, maps will be generated of the survey unit floor surfaces and applicable permanent equipment and/or furnishings. Sample locations will be chosen on floor, lower wall, upper wall and permanent equipment surfaces at the discretion of the survey technician. Measurement locations will be biased towards areas with the highest potential of residual contamination. Each chosen location will be plotted on the applicable survey map.

10.14 Removable Contamination Measurements

Removable contamination measurements (smears) will be collected at each static measurement location. All smears used to survey for removable contamination will be dry smears and the same procedure will be used for collecting both general and tritium smears. The amount of removable radioactive material per 100 cm^2 of surface area will be determined by wiping an area with filter or soft absorbent paper, applying moderate pressure, and accessing the amount of radioactive material on the wipe with an appropriate equipment of known efficiency. General smears will be counted onsite using a Ludlum 3030 Scaler connected to a 43-10-1 planchet counter, or equivalent.

10.15 Surface of Building Mechanical System Internals

Surveys of various building system components will need to be performed. The survey design for these systems is out of the scope of MARSSIM. For the purposes of identifying potential residual contamination within these systems, a survey protocol has been established and is presented in the following sections.

10.16 Ventilation Systems

All of the duct work in the impacted rooms and associated hallway will be removed and sent out as radioactive waste. Normally, we would survey the duct work following the guidance of MARSAME. However, since the rooms are being scheduled for tenant improvements, we have taken a conservative approach and will remove all of it. Components will be de-energized prior to access. Lock-out/Tag-out procedures will be initiated prior to any access to mechanical or electrical components.

10.17 Drain Systems

Surveys of building drain system internals will consist of surveys of accessible sink drains, sink drain traps, floor drains and collection points such as sumps and outfalls. Prior to surveying the drains for radioactivity, they will be surveyed for mercury utilizing a Jerome Mercury Analyzer. Removable contamination surveys of sink drains sink drain traps and floor drains will be collected, since scan surveys and static measurements are not practical due to their small geometry. The frequency of the survey effort will be dependent on the classification of the surrounding area. Drain system initial survey requirements are summarized in **Table 10.6.**

Table 10.6 – Drain System Survey Requirements

Component(s)	Classification of Area in Which Components Exist	Survey Requirements	
		Scan Surveys and Static (Total Activity) Measurements	Removable Contamination Measurements
Drain system inlets	Class 1	N/A[1]	At least one smear on the internal surfaces of 100% of the existing sink drains, traps, and floor drains[2].
	Class 2	N/A[1]	At least one smear on the internal surfaces of 50% of the existing sink drains, traps, and floor drains[2].
	Class 3	N/A[1]	At least one smear on the internal surfaces of 20% of the existing sink drains, traps, and floor drains[2].
Drain system collection points such as accumulator tanks, sumps and outfalls	All	Scan surveys, total surface activity measurements and removable contamination measurements will be collected in sumps and at drain system outfalls as applicable. Sediment samples will be collected at these locations, if possible.	

[1] Scan surveys and static measurements are not practical for these locations due to the small geometry of the drain system components.
[2] Some disassembly of system components may be necessary to complete these surveys.

The mechanical system survey frequencies described above are the minimum survey requirements. Additional surveys may be necessary to adequately access internal contamination levels. If additional survey locations are determined to be necessary, the survey package instructions will provide guidance.

If contamination is detected during the previous survey schemes, then additional surveys or removal of components may be required at various locations. This may require disassembly of components downstream of the affected location. Additional instruction will be provided in the survey package instructions.

10.18 Investigation Levels for Surfaces and Structures

For Class 1 areas, measurements approaching or exceeding the $DCGL_W$ are not unexpected. However, a discrete measurement that is much higher than all the other discrete measurements might be considered unusual and warrant further investigation. For Class 2 or Class 3 areas, neither measurements above the $DCGL_W$ nor areas of elevated activity are expected. Because the design for Class 2 and Class 3 is not driven by the elevated measurement comparison, a 100% scan is not required and will not likely be performed. For this reason, any indication of residual activity during the scan survey would warrant further investigation and possible reclassification.

Due to the relatively low release criteria established for the project and expected variations in background, realistic investigation levels for direct measurements on surfaces and structures have been determined. The chosen investigation levels will ensure that the areas have been properly classified and that the initial assumptions used in the survey design are adequate.

The survey investigation levels for surface and structure measurement are listed by classification in **Table 10.7.**

Table 10.7 – Survey Investigation Levels

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	> DCGL	> DCGL
Class 2	> DCGL	> DCGL
Class 3	>2x BKG	>2x BKG

10.19 Final Status Survey Quality Assurance

The following sections outline our quality assurance protocols for surfaces and structures.

10.19.1Surfaces and Structures

The number of required samples will depend on the ratio involving the activity level to be measured relative to the variability in the concentration. Duplicate surveys and/or samples shall be collected as specified in the QAP. This duplicate data shall be compared to the original survey as a quality control check.

This includes reproducing a minimum of 5% of the scan surveys, total activity measurements, and removable activity measurements performed for final status survey of surfaces and structures. The QA surveys will be performed by different technicians than those performing the original final status survey. In addition, different instruments than those used for the original survey will be used for the QA surveys. The QA surveys results are directly compared to the initial survey results. The goal of this comparison is to determine if the same decision would be made for the survey unit.

10.19.2Data Validation

Field data will be reviewed and validated to ensure:

- Completeness of forms and that the type of survey has correctly been assigned to the survey unit.
- The MDCs for measurements meet the established data quality objectives; independent calculations will be performed for a representative sample of data sheets and survey areas.

Instrument calibrations and daily functional checks have been performed accurately and at the required frequency.

11.0 Data Quality Assessment (DQA)

The statistical guidance contained in Section 8 of MARSSIM will be used to determine if areas are acceptable for unrestricted release and whether additional surveys or sample measurements are needed.

11.1 Preliminary Data Review

A preliminary data review will be performed for each survey unit to identify any patterns, relationships or anomalies. Additionally, measurement data is reviewed and compared with the $DCGL_W$(s) and investigation levels to identify areas of elevated activity and confirm the correct classification of survey units. If an area is misclassified with a less restrictive classification, the area will be upgraded and surveyed accordingly.

The following preliminary data reviews will be performed for each survey unit:

- Calculations of the survey unit mean, median, maximum, minimum, and standard deviation
- Comparison of the survey unit mean and median to the $DCGL_W$
- Identification of each individual measurement that is above the applicable $DCGL_W$
- Comparison of survey data with applicable investigation levels

The PM will review the electronic sample data to ensure chain of custody has been preserved, verify all samples taken having corresponding results, the limits of detection are at or below specified criteria, peak identification is correct (i.e. the radionuclides identified is associated with the energy line in the spectrum), calculations for peak quantification are accurate and no quality control issues exist.

11.1.1 Removable Measurements on Surfaces and Structures

For surfaces and structures, removable contamination measurements will be compared directly to the removable activity release criterion (see Section 3.0). No contingency is established for elevated levels of removable contamination. If any removable contamination is detected which exceeds the applicable removable activity screening value, the survey unit is determined not to meet the release criterion. However, if all removable contamination measurements are less than the removable screening values, then compliance shall be determined based on total activity measurements.

11.1.2 Total Activity Measurements on Surfaces and Structures

For Class 1 areas, if it is determined that all total surface activity measurements are less than the applicable $DCGL_W$, then no further statistical tests are required. The survey unit meets the release criterion provided that all removable contamination measurements are less than the surface screening values. If the average of the activity results is greater than the $DCGL_W$, then the survey unit fails and the null hypothesis is not rejected. Additionally, if any area of elevated activity is identified that exceeds the adjusted maximum surface screening value, then the survey unit fails and the null hypothesis is not rejected.

Class 1 survey units with activity results greater than the $DCGL_W$ but less than the adjusted maximum screening value, will be evaluated to determine whether the average concentration in the survey unit as a whole is below the $DCGL_W$. This will be accomplished by analyzing activity measurements using the Sign Test and further investigations as to the areal extent of the elevated activity.

For Class 2 and Class 3 areas, data results are initially compared to the investigation levels. These investigation levels are provided to help ensure that proper classification has been assigned. If all data results in Class 2 or 3 areas are less than the investigation levels and all removable contamination measurements are less than the removable screening values, then the survey unit is determined to meet the release criterion. If the investigation levels are exceeded, then an investigation is performed to verify the initial assumptions for classification and determine the appropriate resolution.

Class 2 survey units with activity results that exceed the $DCGL_W$ will require reclassification to Class 1. This will likely involve the division of the survey area into multiple Class 1 survey units and re-surveys. Class 3 survey units, by definition, are not expected to contain residual activity above a small fraction of the screening values. Therefore, if activity is detected exceeding the screening values, then reclassification is required. The PM will evaluate the survey results, and determine the proper classification and survey requirements.

11.1.3 Mechanical Systems Survey Data Analysis

If any measurement exceeds the applicable DCGL, then the survey unit does not meet the release criterion and is considered contaminated. Remediation or removal of the affected system components may be required. If all measurements are less than the applicable DCGL, then the system meets the release criterion and is considered releasable. Results of mechanical system surveys will be compared directly with the DCGL. This comparison will consider the applicable DCGL as a maximum value, rather than an average.

If any measurement exceeds the applicable DCGL, then the survey unit does not meet the release criterion and is considered contaminated. Remediation or removal of the affected system components may be required. If all measurements are less than the applicable DCGL, then the system meets the release criterion and is considered releasable.

12.0 Quality Assurance Program

Philotechnics will submit a project-specific QAP utilizing the guidelines of MARSSIM Section 9. The QAP will be reviewed and approved by UC Berkeley prior to commencing decontamination and decommissioning (D&D) operations. The QAP will incorporate at a minimum, the following:

- Description of the Quality Assurance and Quality Control goals, DQO, procedures, and plans to be implemented for all D&D activities.
- Description of the methodology to ensure that all radiological survey data meet the 95% confidence level.
- Description of the sampling and analysis requirements, and on-site waste packaging and storage location, for each waste stream on site.

The QAP will be developed and organized with emphasis given to maximizing worker safety, minimizing/eliminating off-site releases and minimizing overall project costs. The quality control program will control all quality documents during the performance of D&D operations. Quality documents include, but are not limited to:

- Training Records
- Survey Records
- Instrument Records
- Work Permits
- Medical Surveillance Records
- Audit Reports
- Shipping Records
- Work Procedures and Plans

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13.0 Final Report

A Final Report summarizing D&D activities performed at Giannini Hall shall be prepared and submitted to the Radiological Health Branch using the guidance provided in NUREG 1757. The Final Report will include, at a minimum:

- An overview of the results of the FSS
- A summary of the screening values for the facility (if screening values are used)
- A discussion of any changes that were made in the FSS from what is proposed in this plan
- A description of the method by which the number of samples was determined for each survey unit
- A summary of the values used to determine the number of samples and a justification for these values
- The survey results for each survey unit including the following:
  - The number of samples taken for the survey unit;
  - A description of the survey unit, including (a) a map or drawing showing the reference system and random start systematic sample locations for Class1 and 2 survey units and reference area, as applicable, the random locations shown for Class 3 survey units and reference areas, (b) discussion of remedial actions and unique features, and (c) areas scanned for Class 3 survey units and reference areas;
  - The measured sample concentrations, in units comparable to the screening values;
  - The statistical evaluation of the measured concentrations;
  - Judgmental and miscellaneous sample data sets reported separately from those samples collected for performing the statistical calculations;
  - A discussion of anomalous data including any areas of elevated activity detected during scan surveys that exceeded the investigation levels or any measurement locations in excess of the screening values; and
  - A statement that a given survey unit satisfies the screening values and the elevated measurement comparison if any sample points exceeded the screening values
- A description of any changes in initial survey unit assumptions relative to the extent of residual activity (e.g., material not accounted for during site characterization)
- A description of how ALARA practices were employed to achieve final activity levels.

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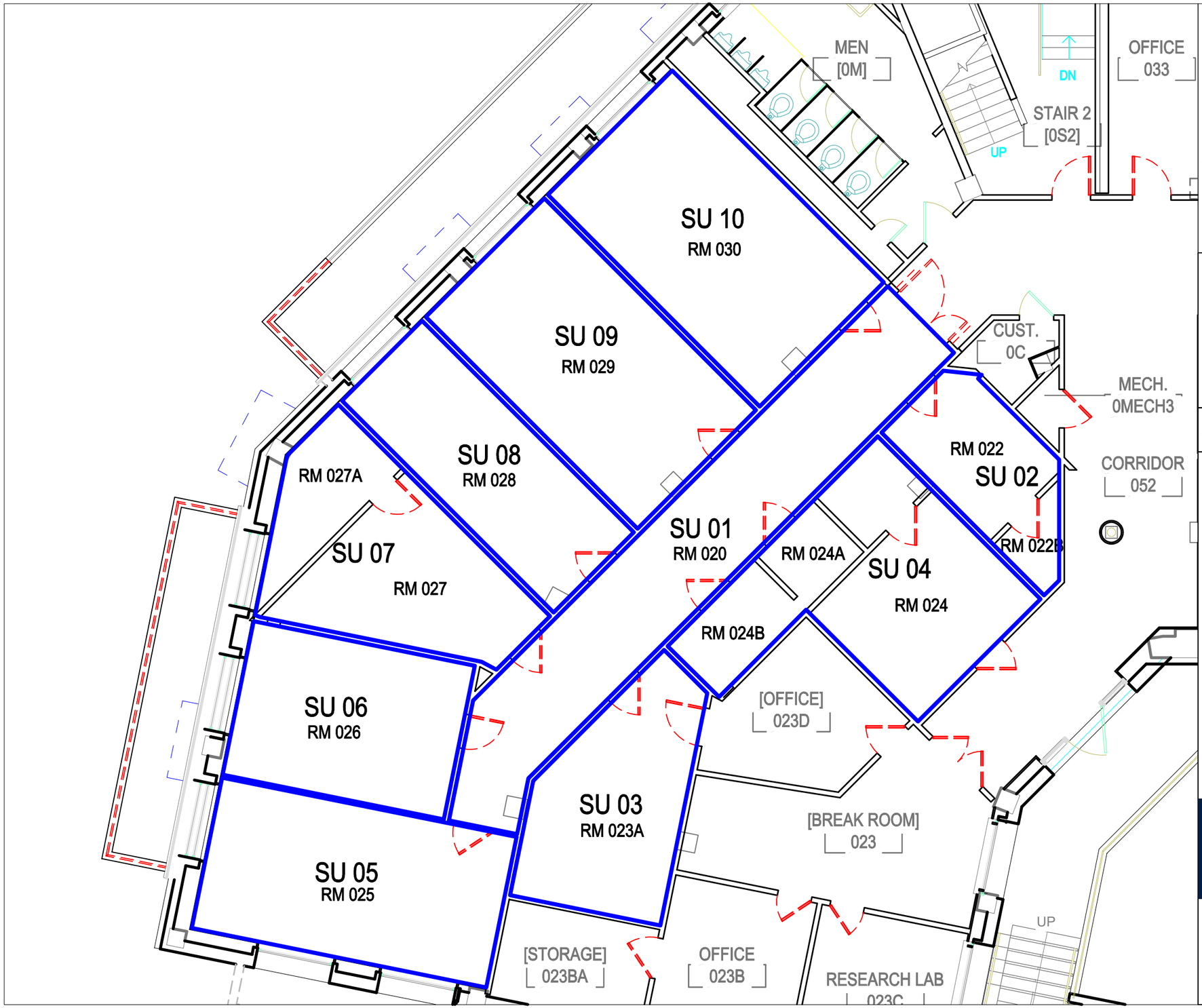
14.0 References

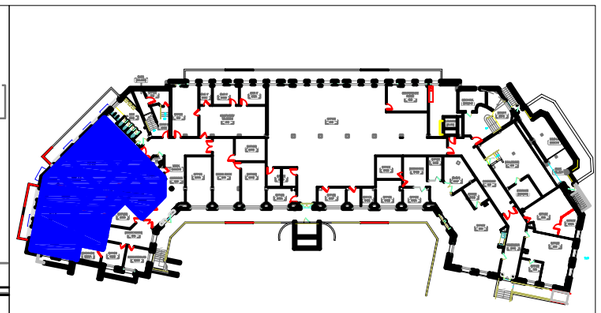
- NRC Regulations 10 CFR 20 Subpart E
- NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM)
- NUREG 1575 Supp. 1, "Multi-Agency Radiation Survey of Material and Equipment Manual" (MARSAME)
- NUREG-1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys"
- NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions"
- NUREG 1757, Volumes 1-3 "Consolidated NMSS Decommissioning Guidance,"
- California Code of Regulations, Title 17, Division 1, Chapter 5, Subchapter 4, Radiation, November 12, 2010.
- Code of Federal Regulations (CFR), Title 10, Part 20, Standards for Protection Against Radiation, U.S. Nuclear Regulatory Agency, U.S. Government Printing Office, June 11, 2010, Washington, D.C., (August 2011).
- CFR, Title 29, Part 1910, Occupational Safety and Health Standards, U.S. Government Printing Office, Washington, D.C., July 1, 2003.
- CFR, Title 49, Part 172, Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans, Subpart H, Training, U.S. Department of Transportation, U.S. Government Printing Office, Washington, D.C., March 11, 2011, (August 2011).
- Philotechnics procedure, "Radiation Protection Program for California Licensed Activities", HPCA-001.
- Philotechnics procedure, "Occupational Radiation Exposure Limits and the ALARA Program", HPO-002.
- Philotechnics procedure, "Radiological Training Requirements", HPO-005.
- Philotechnics procedure, "Radioactive Material Security", HPO-101.
- Philotechnics procedure, "Radiological Work Permits", HPO-006.
- Philotechnics procedure, "Exposure Investigations", HPO-011.
- Philotechnics procedure, "Radioactive Material Security", HPO-101.
- Philotechnics procedure, "Contamination Surveys", HPO-105.
- Philotechnics procedure, "Workplace and Personnel Air Sampling", HPO-106.
- Philotechnics procedure, "Portable Instrument Calibration Requirements and Response Checks".
- Philotechnics procedure, "Brokerage of Low-Level Radioactive Waste", PES-02.

Table A-1
Philotechnics, Ltd. Standard Operating Procedures

Procedure Number	Procedure Title
HPO-002	Occupational Radiation Exposure Limits and the ALARA Program
HPO-005	Radiological Training Requirements
HPO-006	Radiological Work Permits
HPO-011	Exposure Investigations
HPO-101	Radioactive Material Security
HPO-105	Contamination Surveys
HPO-106	Workplace and Personnel Air Monitoring
HPO-201	Portable Instrument Calibration Requirements and Response Checks
HPCA-001	Radiation Protection Program for California Licensed Activities
HPCA-006	Dose Limits to Members of the Public
PES-02	Brokerage of Low-Level Radioactive Waste

FIGURES





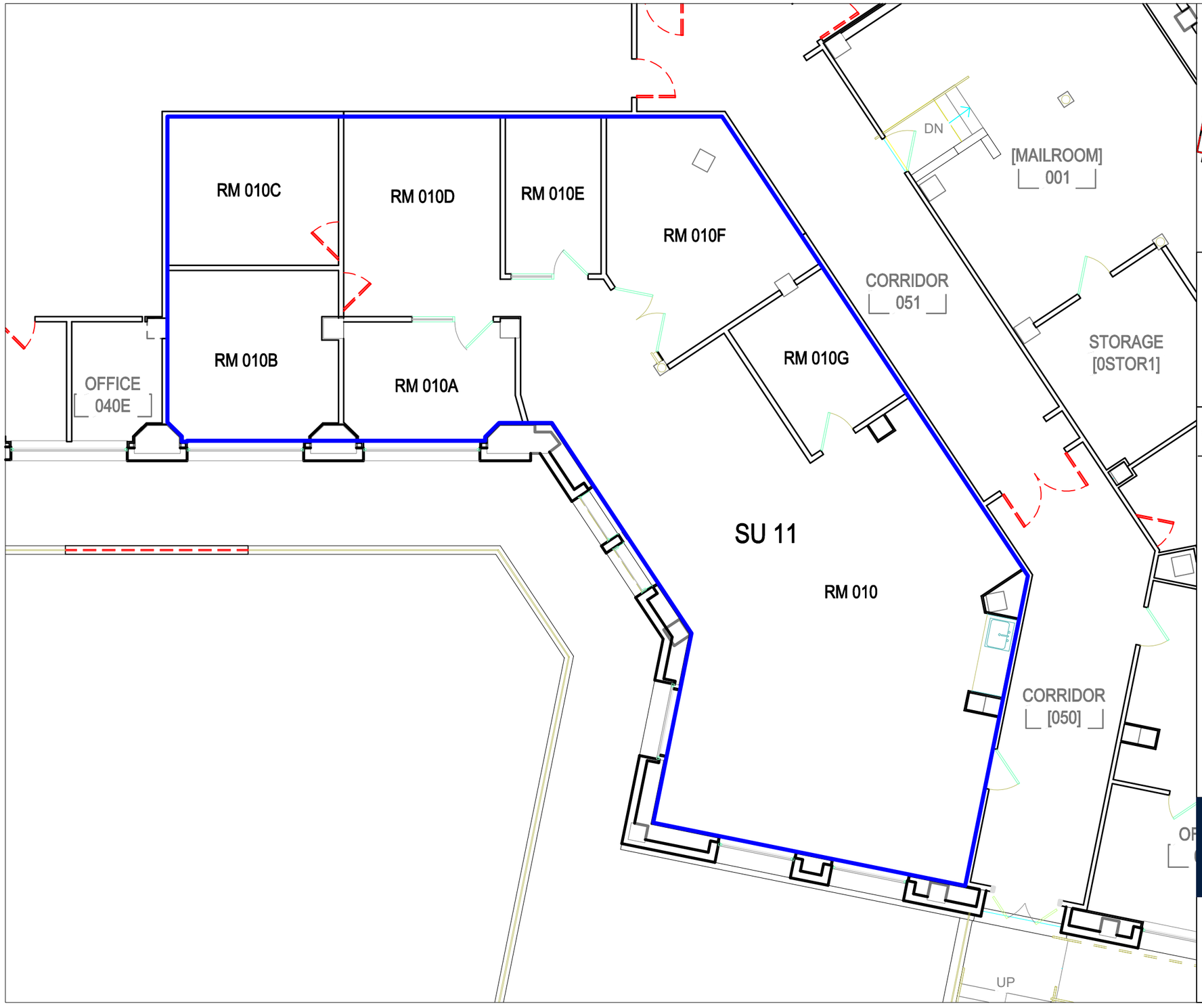
Project Name:	UC Berkeley Giannini Hall Radiological Decommissioning
Contractor:	Philotechnics, Ltd./Tidewater, Inc.
Project Manager:	Ken Gavlik
Project HP:	James Reese, CHP

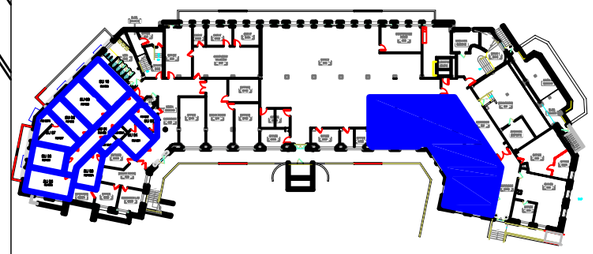
Survey Unit	Room	Class	Area (ft^2)
1	20 (Hallway)	2	375
2	22, 22b	2	125
3	023a	2	200
4	24. 24a, 24b	2	300
5	25	2	280
6	26	2	215
7	27, 27a	2	255
8	28	2	205
9	29	2	305
10	30	2	320

0 10′ 20′

Berkeley
UNIVERSITY OF CALIFORNIA

Figure 1.
UC Berkeley -Giannini Hall
Ground Floor (West Wing) Survey Units





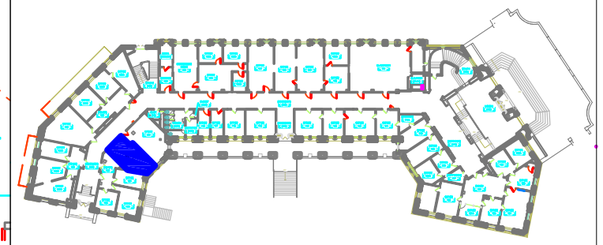
Project Name:	UC Berkeley Giannini Hall Radiological Decommissioning
Contractor:	Philotechnics, Ltd./Tidewater, Inc.
Project Manager:	Ken Gavlik
Project HP:	James Reese, CHP

Survey Unit	Room	Class	Area (ft^2)
11	10, 10A - 10G	2	2,165

0 10′ 20′

Berkeley
UNIVERSITY OF CALIFORNIA

Figure 2.
UC Berkeley -Giannini Hall
Ground Floor (East Wing) Survey Units



Project Name:	UC Berkeley Giannini Hall Radiological Decommissioning
Contractor:	Philotechnics, Ltd./Tidewater, Inc.
Project Manager:	Ken Gavlik
Project HP:	James Reese, CHP

Survey Unit	Room	Class	Area (ft^2)
12	122	2	270

0 10′ 20′

Berkeley
UNIVERSITY OF CALIFORNIA

Figure 3.
UC Berkeley -Giannini Hall
1st Floor (West Wing) Survey Units

Attachment A
Example Survey Packages

RM 026

SU 05

RM 025

[STOR

023E

2'-4"

4'

3'-6"

1'

Label	Matrix	Result
SU05-1		
SU05-2		
SU05-3		
SU05-4		
SU05-5		
SU05-6		
SU05-7		
SU05-8		
SU05-9		
SU05-10		
SU05-11		
SU05-12		
SU05-13		
SU05-14		
SU05-15		
SU05-16		
SU05-17		
SU05-18		
SU05-19		
SU05-20		
SU05-21		
SU05-22		
SU05-23		
SU05-24		
SU05-25		
SU05-26		
SU05-27		
SU05-28		
SU05-29		
SU05-30		
SU05-31		
SU05-32		
Meter		
S/N		
Detector		
S/N		
Date		
Tech		

RM 026

Lane 1

Lane 2

SU 05

Lane 3

RM 025

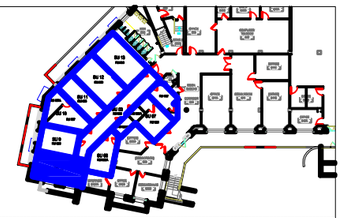
Lane 4

Lane 5

2'-6"

[STOR

023E



Label	Min	Max
Lane 1		
Lane 2		
Lane 3		
Lane 4		
Lane 5		

Meter	
S/N	
Detector	
S/N	
Date	
Tech	

Radiation Work Permits

Approval:		Concurrence:	
	5-10-2019		5-10-2019
Radiation Safety Officer	Date	Quality Assurance	Date

1.0 SCOPE

1.1 The purpose of this procedure is to provide the requirements associated with an administrative process to control radiological work, i.e. the Radiation Work Permit (RWP). Work must be controlled to minimize occupational radiation exposure, and to prevent the uncontrolled spread of radioactive materials or release of radiation to areas where a member of the public could be affected.

1.2 RWPs will provide a mechanism for notification, planning, and approval of work involving radiation exposure or use of radioactive material during a specific period of time. RWPs also identify the radiological conditions associated with the job and prescribe the limits, monitoring requirements, and protective measures applicable to the work in progress. The information on the RWP is made available to the worker for reference prior to the radiological work activity.

2.0 REFERENCES

2.1 Radiation Safety Plan, RSP-001.

2.2 10 CFR 20

3.0 DEFINITIONS

Access Control: A location or locations at the perimeter of controlled areas through which all normal personnel entries are made, and where actions are taken to control the spread of radioactive contamination to adjacent uncontaminated areas and to control personnel exposure to radiation, radioactive materials, airborne radioactivity and contamination, as well as the act of controlling access to the work area.

As Low As is Reasonably Achievable (ALARA): Making every effort to maintain exposure to radiation and radioactive materials as far below the limits specified in the State or Federal Requirements For Protection Against Radiation as is reasonable consistent with the purpose with which the licensed activity is undertaken, and taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other socioeconomic considerations.

Radiation Work Permit: A document which authorizes personnel to perform identified tasks based on radiological considerations in areas containing or suspected to contain radiation and/or radioactive material. The document describes the work to be done, known or suspected area radiological conditions, and prescribes limits and precautions to be taken while work is in progress.

Radiologically Controlled Area (RCA): An area established with controlled access to provide for occupational radiation exposure and contamination control.

4.0 RESPONSIBILITIES

4.1 The Radiation Safety Officer (RSO), or designee, is responsible for the preparation and update of this procedure. The RSO is also responsible for the following:

4.1.1 Ensuring personnel are trained in the use of RWPs;

4.1.2 Reviewing RWPs and ensuring that radiological conditions are accurately documented and that appropriate monitoring and protective measures are included;

4.1.3 Approving the RWP, when satisfied that the following conditions have been met;

4.1.4 The intended work activity has been approved by an appropriate representative of operations management;

4.1.5 The individuals performing the activity, as indicated on the RWP, are trained and qualified radiation workers and will not exceed any radiation exposure limits, during the planned evolution;

4.1.6 Radiological Safety Technicians (RST) are assigned to perform the necessary radiological surveillance and monitoring;

4.1.7 The availability of equipment, facility, and conditions will all result in a safe and controlled performance of the activity, during the proposed time period;

4.1.8 Development and coordination of any non-radiological safety permits necessary to perform the work, (i.e., confined space entry permits, hot work permits, chemical hygiene permits, etc);

4.1.9 Development of personal protective clothing and/or respiratory protection requirements for the RWP that address non-radiological safety concerns;

4.1.10 Verifying that the planned work activity complies with applicable quality requirements.

NOTE: The RSO may delegate the above responsibilities to another member of the Tidewater organization. The person, to which this authority is delegated, cannot have functional responsibility for the performance of the tasks, other than radiation protection.

4.2 The Project Manager (PM) is responsible for the intended work activity and also responsible for defining the RWP work scope. He/she shall approve the RWP after the following conditions have been met:

4.2.1 The intended work activity is necessary for facility operation;

4.2.2 The personnel assigned to perform the activity, are trained and qualified in the performance of radiological work for the specific task to be accomplished;

4.2.3 Approved plans or procedures, addressing the intended work activity, are available for use;

4.2.4 The accumulated radiation exposure to assigned personnel will not exceed the radiation exposure guidelines of Reference 2.1. Otherwise, the RWP must be accompanied by a request for extension of the exposure guideline in accordance with the Reference 2.1.

4.3 The assigned RST is responsible for development of the RWP and to ensure that appropriate instrumentation, equipment and supplies are available for performing the prescribed radiological surveillance and monitoring. He/she is also responsible for the following:

4.3.1 Ensuring that the necessary radiological instrumentation is calibrated and checked for proper operation, prior to the commencement of work;

4.3.2 Verifying the radiological conditions at the work site, and identifying any variation from those indicated on the RWP;

4.3.3 Conducting the ALARA briefing for the individuals performing the work activity under the RWP;

4.3.4 Preparing personnel exposure record forms for the individuals involved in the work activity after verifying their current cumulative exposure;

4.3.5 Establishing the necessary barriers, postings, and equipment to support normal access and egress to the work area;

4.3.6 Documenting the results of measurements and samples taken in support of the work activity.

4.4 The individual(s) performing the work activity is responsible for being approved on an RWP before any work involving the use of radiation or radioactive materials is performed. He/she is also responsible for the following:

4.4.1 Verifying that the radiological conditions, indicated on the RWP, are currently applicable;

4.4.2 Adhering to the requirements of the RWP in regard to the prescribed personnel radiation detection devices and protective clothing and equipment;

4.4.3 Maintaining his/her own radiation exposure ALARA, consistent with performance of the assigned tasks;

4.4.4 Notifying the RSO or assigned RST of any change in the work scope or radiological conditions, associated with the work activity prior to continuing work.

5.0 PROCEDURE

5.1 General Requirements

5.1.1 A RWP is required for any work involving occupational radiation exposure or the potential spread of contamination. All work performed in the RCA shall be performed under the direction of an approved procedure, work instruction, and/or a RWP.

5.1.2 Each RWP shall be approved by the following individuals or their delegated representative:

- The Project Manager;
- The Radiation Safety Officer;
- Telephone approval is authorized if documented on the RWP.

5.1.3 The typical RWP is issued for duration of the work activity. The RWP shall be voided if either the work scope or the radiological conditions in the work area change significantly.

5.1.4 A pre-job ALARA briefing is normally held prior to beginning work performed under a plan, procedure, work instruction, and/or RWP. Typical items discussed include the following:

- Work scope;
- Radiological conditions;
- Dosimetry and protective clothing requirements;
- Limiting and Back-out conditions;
- Emergency actions.

5.1.5 All personnel performing work under the conditions of a RWP shall sign the RWP ALARA Briefing Form to indicate an understanding of the information contained in the briefing.

5.1.6 The RSO or his designee shall maintain an indexed RWP log (form RS-005.0-1). The log shall include the unique RWP number (e.g. 01-001), date of issuance, date of termination, and reason for the RWP (work scope).

5.2 Initiating the RWP

5.2.1 A RWP (form RS-005.0-2) can be requested by anyone responsible for the work activity and shall provide following information:

- The exact location of the work activity;
- The nature of the work activity.
- And for special RWPs:
- Expected duration of the work activity;
- Names of the personnel that will perform the work activity;
- The written procedure(s) that will govern the planned work.

5.2.2 The RSO or designee shall complete the following where applicable, to determine the following and enter the information on the RWP:

- Radiation levels in and around the work area;
- Surface contamination levels in the work area;
- Airborne radioactivity levels in the work area;
- Requirements for protective clothing and equipment;
- Workplace and worker monitoring requirements;
- Limiting conditions and stay-times;
- Special precautions and instructions that are required by the job;
- Current radiation exposure for the individuals involved.

5.2.3 After the information indicated above has been entered, the RST shall forward the RWP to the RSO for review and approval.

5.2.4 The RSO or his designee will review the RWP and verify that the information and the prescribed conditions are adequate to ensure personnel safety. If satisfied, the RSO or his designee will approve the RWP and forward to the appropriate personnel for review.

5.2.5 The approved RWP shall be added to the indexed RWP log, and the original document maintained on file.

5.2.6 A copy of the original approved RWP will be forwarded to, and maintained at the primary access control point, where the pre-job ALARA briefing can be performed by the RST.

5.2.7 Upon completion of the pre-job ALARA briefing, individuals will sign the pre-job ALARA briefing form and sign the RWP sign-in log when entry is made.

5.2.8 The RST shall ensure appropriate personnel protective equipment and monitoring devices are available and issued to the personnel performing the work activity and/or installed at the workplace.

5.3 Distribution of Approved RWPs

5.3.1 The approved RWP shall be distributed at a minimum to each of the following individuals/locations:

- Original - retained in the RWP file by the RSO;
- One copy - retained at the entrance/exit to the work area (usually the primary access control point).

5.4 Terminating an RWP

5.4.1 An RWP shall be terminated as follows:

- By the RST or other responsible individual - when an unanticipated change in radiological conditions occurs. Under such conditions, the RWP shall be suspended, the radiological conditions reevaluated, and a new RWP initiated, in accordance with 5.2 above;
- By the PM - at the conclusion of work or in the event of a significant change in work scope;
- By the PM, or RSO - at expiration of the RWP, (i.e. one year for a Standing RWP or see above for a Special RWP).

5.4.2 The person responsible for terminating the RWP will sign the RWP form and return the control point copy, with supporting documentation to the RSO.

6.0 RECORDS

6.1 Control and Accounting

6.1.1 The RSO or his designee shall be responsible for maintaining a working file of active and terminated RWPs issued during the current and previous calendar quarter. This file contains the following information:

- The first section of the file shall contain the RWP index log with a chronological listing of the previously issued (terminated) RWPs;
- The second section of the file shall contain the original copy of those RWPs that are active. These too shall be maintained in chronological order;
- The third section of the file shall contain the previously approved/inactive RWPs that have been terminated. These shall also be maintained in chronological order, with the latest issued at the front.

6.2 Retention of Terminated RWPs

6.2.1 Terminated RWPs shall be retained in the RWP file for at least one calendar quarter after they have been terminated. Terminated RWPs may then be transferred to Radiological Safety Records for retention.

7.0 REVISION HISTORY

REVISION HISTORY		
Revision Number	**Issue Date**	**Reason for Change**

RWP LOG
Form RS-005-1

RWP #	Issue Date	Termination Date	Work Scope

RADIATION WORK PERMIT (RWP)
Form RS-005-2

RWP #	Date Initiated:
RWP Title:	Initiated By:
Location:	Date Terminated:
	Terminated By:
Work Scope:	

APPROVAL SIGNATURES	
Operations Manager	
Radiation Safety Officer	
Quality/Safety Manager (as required)	

MINIMUM REQUIREMENTS FOR WORKING IN THIS AREA

Protective Clothing (Anti-C's)

Head Covering		**Body Covering**		**Hands**		**Feet**	
	Hood		Coveralls		Surgical Gloves		Shoe Covers
	Cap		Doubles		Rubber Gloves		Rubbers
	Other:		Plastic Suit		Other		Other
			Other				

Dosimetry		**Respiratory Protection**				**Other Requirements**
	TLD/OSL		Particulate		Half Face	
	SRD		Chemical		Full Face	
	Other		Combo		Hood	
			Other		PAPR	
					Suit	

Safety

	Safety Shoes		Safety Glasses		Hard Hat	Other:

RWP #
RWP Title:

RADIATION/CONTAMINATION CONDITIONS IN THE WORK AREA

General Area Radiation Levels		Hot Spots	
Dose Rate	Location	Dose Rate	Location
mR/hour		mR/hour	
mR/hour		mR/hour	

Fixed Contamination Levels (dpm/100 cm^2)		Loose Contamination Levels (dpm/100 cm^2)	
βγ	α	βγ	α
βγ	α	βγ	α

Airborne Levels (µCi/ml)	
Average:	
Maximum:	

Comments:

Radiation Safety Survey References:

_____

_____

_____

_____

_____

RADIATION WORK PERMIT SIGN-IN/OUT LOG

RWP Title _____ **RWP No.**_____ Page 3 of 4

Signing this RWP indicates that you have participated in the associated pre-job briefing, have read the RWP, and fully understand the requirements related to this job.

DATE	NAME (PRINT)	SIGNATURE	TLD/OSL or SSN	TIME IN	SRD IN	TIME OUT	SRD OUT	DOSE (mrem)

RADIATION WORK PERMIT ALARA BRIEFING FORM

Page 4 of 4

RP/ALARA

☐ Work Scope: _____

☐ Radiological conditions

Dose Rates: _____

_____

Contamination Levels: _____

Airborne Radioactivity: _____

_____

☐ ALARA/RWP requirements/Protective clothing required:

_____

_____

☐ Dosimetry requirements/ Placement: _____

_____

☐ Estimated Accrued Dose: _____

High Noise Area? Y N

☐ Use of LDWAs _____

☐ HEPA, Respirator, Face Shield Requirements _____

_____

☐ RP Job coverage & HRA key/boundary control _____

_____

☐ Abort criteria (document) _____

_____

_____

☐ What can go wrong? _____

_____

_____

☐ Operating experience: _____

_____

_____

☐ Dose reduction strategy: _____

_____

_____

☐ REMIND WORKERS:

☐ Check ED/SRD every 10-15 minutes

☐ Place work in safe condition and exit area when 80% of Estimated Accrued Dose is received.

Comments:

_____

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_____

I have been briefed on the specific task described above and have had the opportunity to ask clarifying questions.

Worker's Printed Name	Signature	TLD/OSL Or SSN #

Contamination Control

Approval:	5-10-2019	**Concurrence:**	5-10-2019
Radiation Safety Officer	**Date**	**Quality Assurance**	**Date**

1.0 PURPOSE AND SCOPE

1.1 Radioactive material released as airborne contamination or deposited as surface contamination on facility surfaces, equipment, materials, and personnel must be controlled to minimize occupational exposure to radiation, and to prevent the uncontrolled spread of radioactive materials to areas where a member of the public could be affected. The purpose of this procedure is to provide specific requirements and methods to achieve an acceptable level of control for contamination.

1.2 This procedure includes methods for controlling contamination, requirements for monitoring for surface contamination, acceptable limits for surface contamination, and actions to be taken when decontamination is necessary. The procedure also addresses criteria for unrestricted release of materials into the public domain. Monitoring for airborne radioactive material, acceptable limits, and actions is addressed in Radiological Safety Procedure RS-008-0, Air Monitoring.

2.0 REFERENCES

2.1 Radiation Safety Plan, RSP-001.

2.2 USNRC Regulatory Guide 8.21, Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants

3.0 DEFINITIONS

Access Control: A location or locations at the perimeter of a controlled area through which all normal personnel entries and exits are made, and where action is taken to control the spread of radioactive contamination to adjacent uncontaminated areas. It is also used to control personnel exposure to radiation, radioactive materials, airborne radioactivity and contamination, as well as the act of controlling access to the work area.

Contamination Area: An area having loose (removable) contamination on exposed surfaces that exceed the acceptable levels given in Appendix A.

Frisk: The procedure in which an appropriate radiation detection probe is passed over the surface of interest to determine the presence of radioactive contamination. Frisking is most typically performed on personnel prior to exiting a controlled area.

Radiation Work Permit (RWP): A document which authorizes personnel to perform identified tasks based on radiological considerations in areas containing or suspected to contain radiation and/or radioactive material. The document describes work to be done, known or suspected area radiological conditions, and prescribes limits and precautions to be taken while work is in progress.

Radiologically Controlled Area (RCA): An area established with controlled access to provide for occupational radiation exposure and contamination control.

Restricted Area: An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted areas do not include residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Step-Off Pad: A point which separates two areas in which contamination control considerations differ (e.g., protective clothing, personnel frisking requirements).

Survey: An evaluation of the radiological conditions and potential hazards. Such an evaluation may include a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Unrestricted Area: An area to which access is neither limited nor controlled by the licensee.

Unrestricted Use: Use without restriction for radiation protection purposes.

4.0 RESPONSIBILITIES

4.1 The Radiation Safety Officer (RSO) is responsible for the preparation and maintenance of this procedure. He/she is also responsible for the following:

4.1.1 Ensuring that personnel are trained in the proper actions to take regarding contamination control.

4.1.2 Maintaining the materials and equipment necessary to perform surveillance and monitoring for surface contamination.

4.1.3 Oversight of the contamination control program to insure compliance with applicable regulations and license conditions.

4.2 The Project Manager, having supervisory responsibility for work activity at the project site, is responsible for ensuring that personnel under his/her control understand and follow the requirements of this procedure.

4.3 The Radiological Safety Technicians (RST's) are responsible for surveillance and monitoring of areas, materials, equipment, vehicles, and personnel for contamination. In addition, the RST is responsible to assist in decontamination.

4.4 The individual(s) performing work in the RCA or with radioactive materials are responsible for their individual actions to prevent personal skin or clothing contamination, an intake of radioactive material, or the spread of contamination from areas established to control contamination. Additionally, all personnel are responsible for compliance with posted instructions, procedural requirements, and applicable permits with regard to contamination control.

5.0 PROCEDURE

5.1 General Requirements for Contamination Control

5.1.1 Engineering controls such as containment and ventilation shall be used to the extent practical to ensure radioactive material is contained at the source, and release to the work environment or spread beyond contamination control barriers or boundaries is minimized. Movement of air should always be from an area of lower to an area of higher contamination potential.

5.1.2 Administrative controls such as training, posting, established boundaries, procedures, and work planning will be used as supplementary actions to control

contamination spread by personnel, vehicles, equipment, or radioactive material moving across boundaries.

5.1.3 Where practical, radioactive material shall be drained, purged, flushed, or otherwise removed from a process vessel, container, or system prior to disassembly or repair to limit radiation exposure and the possibility of spills or releases.

5.1.4 All work performed in the RCA or which involves the potential spread of contamination shall be performed under the direction of an approved procedure, work instruction, or a RWP.

5.1.5 Personnel working in areas where a potential for skin or personal clothing contamination or an intake of radioactive material exists shall wear appropriate protective clothing and equipment as identified in applicable RWPs.

5.1.6 Smoking, eating, drinking, chewing, shall not be permitted in the RCA. Prescription medications may be taken under approved and controlled conditions. Hands should be kept away from the face, nose, mouth, and ears while in an area controlled for contamination.

5.1.7 Routine airborne and surface contamination surveys shall be performed at the facility to detect off-normal trends, identify equipment failures or leaks, and prevent unnecessary exposure to radiation or radioactive materials. Survey frequency and types are identified in Radiological Safety Procedure RS-010.1, Radiation and Contamination Surveys.

5.1.8 All personnel shall perform personal whole body monitoring immediately upon exiting the RCA. Frisking the whole body with special attention to hands, feet, and other contact points is also required upon exit of a contamination area where background radiation levels permit.

5.1.9 Personnel contamination detected in excess of acceptable limits during exit monitoring shall be reported to the on-shift RST, appropriate records generated, further reports made, and decontamination initiated, Appendix A, and B

.

5.1.10 All equipment, supplies, vehicles, and other materials exiting the RCA shall be surveyed and determined to be less than acceptable limits prior to removal from the area for unrestricted use. Surveys for release from contamination areas are also required where background radiation levels permit.

5.1.11 Items with inaccessible surfaces for survey purposes shall not be released for unrestricted use except under authorization of the RSO. Material or equipment which has been painted or otherwise sealed to fix contamination shall not be released for unrestricted use unless the covering is removed, and the contamination levels are verified to be less than unrestricted release limits.

5.2 General Requirements for Controlling Contamination During Work

5.2.1 Work with radioactive materials, or on potentially contaminated equipment or facility surfaces shall be planned and implemented in such a manner as to control contamination at the source. These requirements will be documented in a procedure, work instruction, or a RWP.

5.2.2 Ventilated enclosures shall be used where practical around potentially contaminated equipment during disassembly or maintenance work with the potential to significantly increase airborne or surface contamination. Pre-fabricated glove-bags, drape containment, and clear plastic sheeting with slits for insertion of the workers arms provide options for different applications. Elevated external radiation fields may preclude the construction and installation of a containment device in the interest of ALARA.

5.2.3 Local exhaust ventilation shall be used where practical to provide immediate capture of contaminants during a work evolution where the generation of airborne radioactive material is likely. A capture velocity of 500 fpm should be maintained by holding the end of a flexible ventilation duct or shroud adapter within six inches of the contamination source.

5.2.4 Used HEPA filters (and pre-filters) shall be removed from the filter housing by bagging out into a pre-mounted bag, or placed directly into plastic bag upon removal. Where possible, negative pressure shall be maintained on the ventilation system during filter replacement, or when the ventilation system is opened for any reason.

5.2.5 The technique of misting shall be used to prevent the re-suspension of surface deposited contamination during a work evolution where practical. A mixture of white wood glue and water applied liberally with a spray bottle during an airborne

radioactivity generating work evolution is quite effective in preventing contamination spread.

5.2.6 Drip pans, funnels, buckets, sheet plastic, herculite, spill control pillows, or equivalent devices shall be used to contain leaks of radioactive liquids during a work evolution where spillage is likely. Contaminated liquids shall be captured in a container where practical, and if released to the work environment, cleaned up as soon as possible by wet vacuuming, hosing, or mopping to prevent migration from the immediate area.

5.2.7 Where possible, tools, supplies, and equipment shall be dedicated to an area established for contamination control. A hot tool locker with tools painted magenta and labeled in accordance with Radiological Safety Procedure RS-004, “Control and Storage of Radioactive Material”, shall be maintained in the RCA for use in potentially contaminated areas. Work shall be planned so that the need to cross contamination control boundaries with materials is avoided where possible.

5.2.8 Hoses, airlines, electrical cords, and the like that must extend across contamination control boundaries shall be secured, and tagged as potentially contaminated at the point at which the item crosses the boundary. An alternative would be to sleeve the portion of the item in the area controlled for contamination with plastic tubing.

5.2.9 At the completion of a work evolution, all materials, supplies, tools, and equipment shall be returned to proper storage. Temporary containment and other devices used to control contamination shall be removed, and the area decontaminated. Prior to removal of upgraded postings and barriers established to restrict access to the area, radiological surveys shall be performed to verify return to pre-job conditions.

5.3 Personnel Requirements for Entry/Exit of Areas Established for Contamination Control

5.3.1 All personnel entering an area established for contamination control purposes (RCA, Contamination Area, Airborne Radioactivity Area) shall do so under the terms and conditions of a RWP. Protective clothing, equipment, and monitoring requirements shall be identified on the permit.

5.3.2 Appropriate protective clothing and equipment for the area to be entered shall be obtained either at the primary access control point or the satellite clothing area in the process facility. Protective clothing and equipment as described on the RWP shall be donned prior to entry into the area in question, worn according to the permit requirements, and doffed upon exit.

5.3.3 For individuals who will be entering an area requiring anti-contamination clothing, personal clothing should be removed and stored in the designated area. A modesty garment (shorts, tee shirt, or hospital scrubs) and shoes shall be worn through the primary control point to the satellite clothing storage area, where the anti-contamination clothing can be obtained.

5.3.4 For individuals who will be entering only the RCA, personal clothing or work clothes (coveralls) can be worn as an outer garment. For contamination control purposes, company provided (non-anti-contamination) coveralls shall be

considered personal clothing. In addition, a lab coat and shoe covers may be required for entry into the process area laboratory.

5.3.5 Protective clothing and equipment shall be removed prior to crossing a contamination control boundary. Disposable anti-contamination clothing, trash, and non-reusable cartridge filters from respirators shall be segregated from reusable or washable protective clothing and equipment, and disposed of in their respective containers.

5.3.6 Hard hats, gloves, aprons, and other specialty protective clothing items are available in the satellite clothing storage area and shall be removed at the respective contamination control boundary, and either disposed of, laundered, or stored for reuse, depending on the items value. Reusable hard hats, gloves, etc. that have been used in areas established for contamination control shall be dedicated for hot use, stored in the RCA, and not brought across contamination control boundaries.

5.3.7 Required respiratory protection equipment cannot be reused once removed. At the completion of the shift or the work activity, whichever comes first, the equipment shall be disassembled, disposed of in the receptacle at the control point for refurbishing, if applicable, or in the radioactive waste receptacle if disposable. Respirators used voluntary at the users discretion may be reused.

5.3.8 Specialty items like air supplied respirator lines, regulators, battery packs, support belts, etc. shall be sleeved, wrapped, or protected in a manner to prevent contamination while in an area established for contamination control. After use the items shall be stripped, and stored for reuse in the RCA.

5.3.9 After doffing of all protective clothing and equipment, personnel exiting a Contamination Area shall step across the contamination control boundary onto the step-off pad one foot at a time while removing the inner shoe cover. All personnel shall immediately frisk with a rate meter equipped with an appropriate detector. If the ambient radiation levels are prohibitive, personnel shall proceed to the nearest frisking station where background levels permit and complete the whole body survey.

5.3.10 When frisking for beta/gamma contamination, personnel shall move the detector probe slowly over the body with the probe within about one-half inch of the body surface, giving special attention to the hands, feet, and other contact points at a rate not to exceed 2 inches per second. When frisking for alpha contamination, the probe shall be maintained in light contact with the body.

5.3.11 All personnel exiting the RCA shall monitor at the primary access control point. After successfully monitoring, personnel shall step over to the clean side of the RCA boundary to exit the primary access control point.

5.3.12 In the event personnel contamination is detected, personnel are required to notify the RST. The RST shall make appropriate notification and proceed with decontamination in accordance with Section 5.4.

5.3.13 All personnel are required to survey hand carried items with a frisker when exiting areas controlled for contamination purposes. This includes TLDs, SRDs,

air sampling devices, tools, hats, gloves, clipboards, paperwork, etc. Vehicles, equipment, supplies, vendor's tools, etc. shall be surveyed for unrestricted release from the RCA by the RST. Unnecessary items should not be taken into these areas to preclude the need to perform a release survey.

5.4 Decontamination Requirements

5.4.1 The presence of personnel contamination in excess of release limits has more than one implication.

- The individual may have had an intake of radioactive material,
- Others in the area may have become contaminated,
- The work area may be contaminated,
- The work may not have been performed in accordance with procedures,
- The engineered barriers and administrative controls prescribed for the work evolution were inadequate.

5.4.2 In the event an individual is determined to be contaminated, actions shall be taken to isolate the radioactive material (contamination), prevent further spread of contamination from the control point, and determine if others are affected. Those actions should be accomplished concurrently.

5.4.3 A detailed personnel survey shall be performed by the RST to determine the location, magnitude, and extent of contamination on the individual(s). An accurate record including a map shall be maintained to facilitate further exposure calculations. Provide details using the Personnel Contamination Report form in Appendix B.

5.4.4 Personnel decontamination shall be accomplished in accordance with the decontamination instructions given in Appendix B to this procedure. Care should be taken not to abrade the skin or spread the contamination further. If the contaminated area is localized, and actions can be taken to wrap the area to prevent contamination spread, move the individual(s) to a designated shower or sink and proceed with decontamination. Complete the Personnel Contamination Report in Appendix B to document the event.

5.4.5 Solid and liquid waste generated by the decontamination process shall be saved, if possible, pending the completion of the investigation, and exposure calculations. Samples of the material may need to be analyzed to identify the contaminant.

5.4.6 A path of travel survey shall be performed by the RST to determine the original source of the contamination event and any spread of contamination by the individual(s) during travel to the control point where the contamination was identified. Areas determined to be contaminated above acceptable surface contamination limits (Appendix A) shall be cordoned off, posted according to Radiological Safety Procedure RS-002, "Zoning and Posting Restricted Areas", decontaminated, resurveyed, and down-posted to the original status.

5.4.7 Facility decontamination shall be accomplished by cleaning from less contaminated to more contaminated surfaces. Care should be taken not to spread contamination to uncontaminated surfaces, or generate unnecessary

secondary waste. In some cases, adhesive tape, solvents, chemical detergents, or mechanical removal may be required to achieve desired results.

5.4.8 If there is no provision at the facility for the decontamination of personal clothing, the following shall be performed. If applying masking tape, to the affected area will not remove the contamination; the item shall be confiscated, bagged, and tagged as radioactive material. Depending on its value, further actions may be taken to decontaminate the item. Previously contaminated personal clothing must be surveyed and determined to meet the unrestricted release limits of Appendix A before return to the owner.

5.4.9 After the immediate actions are complete to secure the area, decontaminate the individual, and restore the area to the original contamination status..

5.5 Material and Equipment Release Survey Requirements

5.5.1 All equipment and material removed from the RCA shall be surveyed for surface contamination prior to unrestricted release. Only material meeting the release limits given in Appendix A will be allowed to exit the RCA without restriction.

5.5.2 Equipment and materials that are candidates for unrestricted release shall be staged at the RCA boundary for survey by the RST. The item shall be surveyed and released by the RST before it can be moved across the RCA boundary.

5.5.3 Equipment and materials with inaccessible surfaces shall be disassembled where practical for survey access. Items with inaccessible surfaces that cannot be disassembled shall be considered to be contaminated, and shall not be released for unrestricted use. The item may be released, however, under certain restrictions with the approval of the RSO.

5.5.4 Material and equipment which have been painted or otherwise sealed to fix contamination shall be stripped of the paint or covering to enable the release survey to be performed. The item shall not be released without restriction until the contamination levels on the original surface have been demonstrated to be less than the release limits of Appendix A.

5.5.5 A release survey shall be conducted by first performing a fixed contamination survey by scanning the surface of the item with a count rate meter and appropriate detector at a scan rate capable of meeting the detection requirements consistent with the release criteria. A scaler equipped detector shall be used along with a statistically valid survey plan approved by the RSO if greater sensitivity is required.

5.5.6 Typically a 100% surface scan is required for items; however, the RSO may designate alternative survey requirements (e.g., representative surface scans for certain items, which have never been located within a contamination area and where likelihood of contamination is remote). Such plans should be prepared as an Operating Instruction.

5.5.7 Direct frisking with a count rate meter shall be done in a low background area with an instrument meeting the detection capability of the release criteria. Scaler

equipment shall be used in a low background area and shall also have a detection level meeting the release criteria.

5.5.8 A survey shall subsequently be conducted by swiping the item for removable contamination. The smears shall be counted on an appropriate portable survey instrument, or a low background laboratory instrument to obtain better measurement sensitivity.

5.5.9 Vehicles that will remain on-site can be surveyed for a restricted release from the RCA if necessary. A restricted release survey shall ensure that accessible surfaces like tire surfaces, floors, seats, controls, etc. are free of loose contamination, and that plans for the vehicle do not include abrasive or intrusive actions that would dislodge fixed contamination from the vehicle. A restricted release vehicle shall be tagged as radioactive material, and cannot leave the restricted area.

5.5.10 Under special circumstances, provision to extend an area not controlled for contamination into the RCA (with appropriate barriers and postings) can be made by unrolling a covering material onto the RCA surface. This action will permit a vehicle to enter the RCA without physically coming into contact with the RCA surface. Under these conditions, the vehicle will not require a release survey.

5.5.11 Bulk materials or large amounts of homogenous materials that has either not been subjected to contamination, been decontaminated with a method that removed the entire surface that was contaminated, or only suspected of being contaminated shall be released only with a specially approved survey plan. This plan must be specific to the material in question and be approved by the RSO.

6.0 RECORDS AND REPORTS

6.1 Record Maintenance

Records associated with the contamination control program, decontamination of personnel or facilities, or the unrestricted release of materials from the facility shall be maintained.

6.2 Record Forms

The information associated with this procedure shall be maintained in a legible manner on approved standard forms. These records will contain all the information necessary to demonstrate compliance with applicable federal and state regulations for protection against radiation.

6.3 Retention of Records

The records associated with this procedure shall be retained in accordance with the RSP.

6.4 Reports

Reports shall be made as required by Radiation Safety Plan, RSP-001.

7.0 REVISION HISTORY

REVISION HISTORY		
Revision Number	**Issue Date**	**Revision Description and Reason for Change**

APPENDIX A

ACCEPTABLE CONTAMINATION LEVELS FOR MATERIAL RELEASE

Nuclides[a]	Average[b c]	Maximum[b]	Removable[b d]
U-235, U-238, transuranics and associated decay products,	100 dpm/100 cm^2	N/A	20 dpm /100^2
Th-nat	1000 dpm/100 cm^2	N/A	200 dpm/100 cm^2
Beta-gamma emitters	5,000 dpm/100 cm^2	N/A	1,000 dpm/100 cm^2

[a] - Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the [a] Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for both alpha and beta-gamma emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] For objects of less surface area, the average should be derived for each such object.

[d] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter paper or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped

APPENDIX B

PERSONNEL DECONTAMINATION INSTRUCTIONS

Mild soap and cold or tepid water should be utilized for most decontamination efforts. Warm or hot water will tend to open the pores of the skin and make decontamination more difficult. The liquids used in decontamination must be treated as radioactive material. Therefore, the shower, sink or container used for decontamination, must be equipped to retain the used liquids, pending analysis.

Strong detergents or abrasives should not be used on the skin.

Contaminated personnel must not be allowed to eat, drink, or smoke during the decontamination process.

Use the following approach to remove contamination from the skin:

- Locate, quantify, and identify the extent of the contaminated area;
- If the affected area is relatively small; apply tape over the area using light pressure. Remove the tape and re-survey. If the area is relatively large or the application of masking tape does not remove the contamination, proceed to next step;
- Prepare a mild soap and water solution. Dampen a soft cloth or sponge, in the water, and lightly wipe the contaminated area. Do not scrub or abrade the area. Use a motion that starts at the edge of the contamination and work toward the center. Avoid spreading contamination to other areas of the skin;
- Typically, no more than three washings, with soap and water, will be required to remove the contamination. If the contamination is not removed in three to four washings with mild soap and water, other actions may be warranted.

Use the following approach to remove contamination from the hair:

- If possible, isolate the strands of hair that are contaminated and decontaminate them separately from the rest of the hair;
- Do not wash the hair in a shower! Such action would tend to spread the contamination to other parts of the body;
- Prepare a solution of mild soap and tepid or cool water in a contained basin or pan;
- Dip a soft cloth or sponge, into the solution, and press a portion of the contaminated hair between layers of the cloth or sponge. Start near the roots of the hair and work toward the tips. Hold the individual's head over the basin or pan, so dripping will flow back into the basin. Repeat this process, on other segments of hair, until all the contaminated hair is treated;
- Re-survey the affected area and repeat the entire process until the contamination is removed;
- If the contamination is not removed, after three or four washings, other actions may be necessary.

There is increased concern over the presence of contamination in the ears, eyes, nose or mouth. The threat of internal contamination is more imminent and decontamination more difficult. Use the following approach to remove contamination from the ears, eyes, nose or mouth:

- Initial decontamination may be performed by using a soft cotton swab that has been wetted with clean water. Pass the swab gently over the area of suspected contamination. Always work the swab from the inside to the outside surfaces, and replace it frequently.

- Do not irrigate these areas with water! Such action may tend to force the contamination farther into the affected canal.

- In most cases, a physician should be present for decontamination efforts beyond the use of a wetted cotton swab.

- Any individual that has been contaminated in the eye, ear, nose or mouth must receive a whole body count following the decontamination effort. This will provide an indication of the effectiveness of the decontamination as well as provide the necessary information for assessing his/her radiation exposure.

Personnel Contamination Report

Name:_____Date _____

SS # _____ Employee # _____Time: _____

Address: _____
City *ST* *Zip*

Complete the following Information:

1. Pre-decontamination conditions:

Contaminated Body Areas	Survey Results (dpm/100 cm^2)
Is a skin dose calculation required?	Yes ☐ No ☐
	If yes record results in Section 8.

2. Method of Decontamination: _____

_____

_____

3. Final decontamination results:

Body Areas	Survey Results (dpm/100 cm^2)

4. Bioassay performed? Yes ☐ No ☐

5. Whole Body Count performed? Yes ☐ No ☐

6. Description of events: _____

_____

_____

_____

_____

Completed by:_____ Date:_____

7. Investigation Results: _____

_____

_____

8 Skin Dose calculation results_____ mrem by_____

RSO Review: _____**Date** _____

Original: Individuals Exposure History File
CC: Project Files

Radiation and Contamination Surveys

Approval:		Concurrence:	
	5-10-2019		5-10-2019
Radiation Safety Officer	**Date**	**Quality Assurance**	**Date**

1.0 SCOPE

1.1 Radiological surveys are performed, as necessary, to identify and control potential sources of occupational exposure to radiation and/or radioactive material, and to prevent the uncontrolled spread of radioactive materials to areas where a member of the public could be affected. Radiological surveys are also used to document conditions in the workplace and demonstrate compliance with applicable regulations and license conditions. The purpose of this procedure is to provide specific requirements and methods for the conduct of radiological surveys.

1.2 This procedure includes methods for the performance of area radiation and surface contamination surveys. Unrestricted release of materials and release surveys for vehicles into the public domain are addressed in Radiological Safety Procedure RS-006, Contamination Control. Surveys of radioactive material shipments are addressed in Radiological Safety Procedure RS-018, Transportation of Radioactive Materials.

2.0 REFERENCES

2.1 Radiation Safety Plan, RSP-001.

2.2 10 CFR 20

2.3 USNRC Regulatory Guide 8.21, Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants.

3.0 DEFINTIONS

Access Control: A location or locations at the perimeter of controlled areas through which all normal personnel entries and exits are made, and where action is taken to control the spread of radioactive contamination to adjacent uncontaminated areas and to control personnel exposure to radiation, radioactive materials, airborne radioactivity and contamination, as well as the act of controlling access to the work area.

Accessible Area (for personnel control): Denotes a space, zones or surface capable of being reached by personnel which would not require tools, machinery, unusual force or agility for access.

Background Radiation: Radiation from cosmic sources, naturally occurring radioactive materials, including radon (except as a decay product of source or Special Nuclear Material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. Background radiation does not include radiation from source, by-product or Special Nuclear Material.

Bi-Weekly: At least once every two calendar weeks.

Calendar Quarter: Not less than 12 consecutive weeks or more than 14 consecutive weeks. The first calendar quarter shall begin in January and subsequent calendar quarters shall be such that no day is included in more than one calendar quarter or omitted from inclusion within a calendar quarter (see Quarterly).

Check Source: A radioactive source, not necessarily certified, which is used to confirm the continuing satisfactory operation of an instrument.

Contamination Area: An area having loose (removable) contamination on exposed surfaces that exceeds 1000 dpm/100 cm^2 beta/gamma or 20 dpm/100 cm^2 alpha radioactivity.

Daily: At least once each calendar day (24 hours).

High Radiation Area: An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 millirem in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

Monitoring: The measurement of radiation levels, airborne radioactivity concentrations, surface area concentrations or quantities of radioactive material; and the use of the results of these measurements to evaluate potential exposures and doses on a continuing basis.

Monthly: At least once each calendar month, not to exceed 5 weeks.

Quarterly: At least once each calendar quarter (Jan.-Mar.; Apr.-June; July-Sept.; Oct.-Dec.).

Radiation Area: An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 millirem in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

Radiation Work Permit (RWP): A document which authorizes personnel to perform identified tasks based on radiological considerations in areas containing or suspected to contain radiation and/or radioactive material. The document describes work to be done, known or suspected area radiological conditions, and prescribes limits and precautions to be taken while work is in progress.

Radiologically Controlled Area (RCA): An area established with controlled access to provide for occupational radiation exposure and contamination control.

Restricted Area: An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted areas do not include residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Semiannual: At least once every six months, not to exceed seven (7) months.

Smear (swipe): A procedure in which a piece of absorbent material is rubbed on a surface with moderate pressure and its radioactivity measured to determine if the surface is contaminated with loose radioactive material.

Temporary Boundary: A boundary of rope, tape, ribbon, chain or other temporary device used to designate a controlled or restricted area.

Step-Off Pad: A point which separates two areas in which contamination control considerations differ (e.g., protective clothing, personnel frisking requirements).

Survey: An evaluation of the radiological conditions and potential hazards. Such an evaluation may include a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Unrestricted Area: An area to which access is neither limited nor controlled by the licensee.

Weekly: At least once each calendar week.

4.0 RESPONSIBILITIES

4.1 The Radiation Safety Officer (RSO) is responsible for the preparation and maintenance of this procedure. He/she is also responsible for the following:

4.1.1 Insuring that personnel are trained in the requirements and proper methods for performing radiological surveys;

4.1.2 Maintaining the materials and equipment necessary to perform radiological surveillance and monitoring;

4.1.3 Oversight of the surveillance and monitoring program to insure compliance with applicable regulations and license conditions.

4.2 The Project Manager, having supervisory responsibility for work activity at the facility, is responsible for insuring that personnel under his/her control understand and follow the requirements of this procedure.

4.3 The Radiological Safety Technician (RST) is responsible for surveillance and monitoring of areas, materials, and equipment for radiation or contamination in accordance with this procedure. The RST is also responsible for maintaining documentation of radiological conditions in the workplace, and communication of those conditions to the workers via the RWP program requirements.

4.4 All personnel performing work in the RCA or with radioactive materials are responsible for compliance with posted instructions, procedural requirements,

and applicable permits with regard to radiation or contamination control. Personnel are also responsible for maintaining their individual exposure ALARA through a current knowledge of radiological conditions in the workplace.

5.0 PROCEDURE

5.1 General Requirements for Radiological Surveys

5.1.1 Radiation and surface contamination surveys shall be performed to:

- Prevent unnecessary exposure to radiation or radioactive materials;
- Detect changes or trends in radiological conditions in the workplace;
- Identify equipment failures or leaks;
- Identify areas requiring posting;
- Verify the effectiveness of engineering and process controls in containing radioactive material and reducing radiation levels.

5.1.2 Special radiological surveys shall be performed to:

- Characterize the radiation and/or contamination levels in a designated work area in support of operational or maintenance work planning and RWP development;
- Surveillance and monitoring required by RWP during an ongoing work activity;
- Investigate the radiological conditions in the facility after an incident involving radiation or radioactive materials;
- Authorize the down-posting of an area after de-contamination or close-out of an operations or maintenance special RWP.

5.1.3 All radiological surveys shall be conducted by personnel trained and qualified in accordance with Radiological Safety Procedure RS-014, Radiation Safety Training and Qualification.

5.1.4 Routine radiological surveys shall be conducted in accordance with the schedule provided in each project specific plan. Surveys should be recorded on a Survey Form such as found in Appendix B, or similar form. Surveys shall be sequentially numbered and recorded in the Survey Log, Appendix C.

5.1.5 Instruments used for radiological surveillance and monitoring shall be:

- Periodically maintained and calibrated on an annual frequency, and after any required maintenance;
- Appropriate for the type, level, and energy of radiation encountered in the workplace;
- Appropriate for the ambient environmental conditions in accordance with limitations listed in the instrument operations manuals;

- Routinely tested for operability (on a daily basis when used) by battery tests, response to a check source, etc.

5.1.6 Instruments that appear to be damaged, malfunctioning, or when checked, do not respond within the acceptable range of the expected value shall be taken out of service and tagged for repair.

5.1.7 A survey of an area for either radiation or surface contamination shall include a sufficient number of survey points to characterize the radiological conditions and verify posted boundaries.

5.1.8 All surveys performed shall be documented on approved forms (Appendix B) and maintained in accordance with the record keeping requirements in Section 6.0.

5.1.9 Radiological surveys shall be reviewed by the RSO or designee to ensure all that the documentation is accurate and complete.

5.1.10 Current radiological survey results shall be available, preferably posted, in the workplace to inform personnel of the radiation and contamination levels in the area to be accessed.

5.2 Radiation Survey Requirements

5.2.1 Personnel performing radiation surveys shall avoid unnecessary radiation exposure by practicing good ALARA principles (minimizing time, maximizing distance, and use of shielding).

5.2.2 The surveyor shall be aware of the anticipated range of the radiation exposure rate in the area to be surveyed, and select a radiation survey instrument accordingly.

5.2.3 Prior to entering an area to be surveyed, the radiation detection instrument shall be checked to be sure it has a current calibration sticker, an acceptable battery condition, and responds appropriately to a check source used to simulate the type and energy of radiation to be measured.

5.2.4 When entering a known or suspected High Radiation Area, an instruments range selector shall be initially set to the highest range, and stepped down through the lower ranges until the meter indicates an on-scale reading.

5.2.5 Contact exposure rate measurements shall be taken at a distance of less than one inch from the source of radiation or from the surface through which the radiation penetrates.

5.2.6 Care should be taken when performing radiation surveys in an area with removable surface contamination to avoid cross-contaminating the survey instrument detector. Care should also be taken when taking beta radiation measurements to avoid damage to the mylar window.

5.2.7 General Area gamma exposure rate measurements used to estimate Whole body, skin, or lens of the eye exposure rates shall be measured at a distance of 30 cm (one foot) from the source of radiation or from the surface from which the radiation penetrates.

5.2.8 Gamma radiation measurements shall be recorded in units of uR/hr, mrem/hr or rem/hr, and beta radiation measurements in units of mrad/hr or rad/hr. Numerical values shall not be recorded at less than one-half the smallest meter increment.

5.2.9 Perform a general area gamma exposure rate survey in accordance with the following steps:

- Select an appropriate gamma sensitive instrument (e.g., ion chamber, a GM detector, calibrated µR meter) with an appropriate range;
- Hold the instrument with the long axis perpendicular to the source, beta window closed, and slowly move the detector to find the highest reading;
- Determine the highest reading at that location;
- Record the reading in units of uR/hr, mrem/hr or rem/hr as appropriate;
- Randomly select other general area survey points to include normally occupied areas or traffic areas.

5.2.10 Record the survey information on a “Radiation Survey Report” form. The following information shall be recorded as applicable:

- Date of the survey;
- Location of the survey to include building or area designator;
- RST name performing survey;
- Instrument and detector identification to include model, serial number, calibration date, and background radiation levels;
- Survey data to include survey point identification, specified distance from source and height relative to floor, location, corrected exposure/dose rate with window closed/open, as applicable, and supporting information like maps, postings, and backup calculations.

5.3 Surface Contamination Survey Requirements

5.3.1 Personnel performing contamination surveys shall follow RWP requirements for protective clothing to avoid unnecessary radiation exposure or contamination spread. Gloves need not be worn in

uncontrolled areas if contamination is not expected.

5.3.2 The surveyor shall be aware of the anticipated range of the surface contamination levels in the area to be surveyed, and select a radiation survey instrument accordingly.

5.3.3 A survey instrument equipped with a GM detector shall be used to perform surface contamination surveys for beta/gamma radiation for RWP generation, job coverage, area, item, or personnel contamination surveys. Contamination surveys for alpha radiation shall be performed with a proportional or scintillation type detector.

5.3.4 Prior to entering an area to be surveyed, the radiation detection instrument shall be checked to be sure it has a current calibration sticker, an acceptable battery condition, and responds appropriately to a check source used to simulate the type and energy of radiation to be measured.

5.3.5 When making a surface contamination measurement on a known or suspected contaminated surface with a count rate meter, the instruments range selector shall be initially set to the highest range, and stepped down through the lower ranges until the meter indicates an on-scale reading.

5.3.6 Surface contamination measurements for beta/gamma radiation shall be taken at a distance of less than one inch from the surface on which the contamination is being measured. Alpha radiation shall be measured at a distance of not more than 0.5 inch from the surface being surveyed.

5.3.7 Fixed surface contamination levels may be measured directly by either scanning the surface at a set scan rate (typically no greater than 1 detector width per second) with a count rate meter, or, if greater measurement sensitivity is desired, by stationary counting with a scaler equipped meter for a designated count time (count time varies depending on desired measurement sensitivity, but a typical count time is one minute). Due to variable active detector surface area, correcting to a standard reporting value of 100 cm^2 is typically required.

5.3.8 Quantitative measurement of loose (removable) surface contamination is performed by swiping a surface area of 100 cm^2 with a dry, soft, adsorbent material while applying moderate pressure, and counting the swipe (smear) with an appropriate detector. If the surface area being measured is less than 100 cm^2, the entire surface area should be swiped, and the contamination level reported proportionally.

5.3.9 Large area swipes can be taken as a qualitative measurement of surface contamination in an area by swiping the surface with an adsorbent material (masslin cloth, or laboratory grade tissue) and counting with an

appropriate detector.

5.3.10 Dry swipes are normally used to measure loose surface contamination, since the results are more representative of personnel brushing past a contaminated surface than if wet swipes are used. When measuring for alpha radiation, water can shield the radiation from the detector; therefore wet swipes must be dried prior to counting.

5.3.11 Alpha, beta, and gamma surface contamination measurements shall be recorded in units of dpm/100 cm^2. Numerical values shall not be recorded at less than one-half the smallest meter increment.

5.3.12 If no meter response occurs on the lowest scale of a count rate meter, record the reading as less the minimum sensitivity of the detector

5.3.13 When searching for fixed contamination, or when trying to locate the most highly contaminated section of an area or an item being surveyed, earphones or the audible instrument should be used. Visual count rate meter indications typically respond slower than the audible indication.

5.3.14 Perform a scan survey for fixed plus removable beta/gamma surface contamination in accordance with the following steps:

- Select a count rate meter equipped with a pancake GM detector;
- Determine the background count rate for the survey area by making a measurement in the general area (away from influence by the surface to be measured or other significant sources) with the range selector set to the lowest scale possible;
- Compare the background reading to the maximum values in Appendix A, and if necessary, use a shielded detector, or if possible, move the item to an area with a lower background radiation level;
- Move the detector at a scan rate of 3 cm/sec across the area to be surveyed at approximately 2 inch from the surface being measured;
- Listen for an audible increase in the count rate while scanning the surface;
- Stop scanning when the count rate increases, and perform a static measurement,
- Determine the net count rate by subtracting the predetermined background count rate from the static measurement;
- Convert the net count rate to dpm/100 cm^2 by multiplying by the beta efficiency correction factor for the instrument.

5.3.15 Perform a scan survey for fixed plus removable alpha surface contamination in accordance with the following steps:

- Select a count rate meter equipped with an alpha proportional or scintillation detector;
- Determine the background count rate for the survey area by making a measurement in the general area (away from influence by the surface to be measured or other significant sources) with the range selector set to the lowest scale possible;
- Move the detector at a scan rate of 3 cm/sec across the area to be surveyed at approximately 3 inch from the surface being measured;
- Listen for an audible increase in the count rate while scanning the surface;
- Stop scanning when the count rate increases, and perform a static measurement,
- Determine the net count rate by subtracting the predetermined background count rate from the static measurement;
- Convert the net count rate to dpm/100 cm^2 by multiplying by the alpha efficiency correction factor for the instrument.

5.3.16 Perform a static survey with a scaler for either fixed plus removable alpha or beta/gamma surface contamination in accordance with the following steps:

- Select a scaler instrument equipped with a pancake GM detector or a scintillation or proportional type detector for beta/gamma or alpha measurements respectively;
- Establish a count time for each measurement and start the scaler count accordingly;
- Determine the background count for the survey area by making a measurement in the general area (away from influence by the surface to be measured or other significant sources);
- Compare the background reading to the maximum values in Appendix A, and if necessary, take action to lower the background radiation level;
- Make static measurements at a predetermined number of locations representative of the general surface area and contamination level for the area or item being surveyed;
- Determine the net count by subtracting the predetermined background count from the static measurement;
- Convert the net count to dpm/100 cm^2 by multiplying by the respective alpha or beta/gamma efficiency correction factor for the instrument, and correcting for the active surface area of the detector being used.

5.3.17 Perform a swipe sample (smear) survey for either alpha or beta/gamma removable surface contamination in accordance with the following steps:

- Select either a scaler or a count rate instrument equipped with a pancake GM detector or a scintillation or proportional type detector for beta/gamma or alpha measurements respectively;

- Obtain a sufficient number of clean dry paper or cloth smears;
- If using a scaler, establish a count time for each measurement and start the scaler count accordingly;
- Determine the background count, or count rate if using a count rate meter, for the survey area by making a measurement in the general area (away from influence by the surface to be measured or other significant sources);
- Compare the background reading to the maximum values in Appendix A, and if necessary, take action to lower the background radiation level;
- Take a swipe sample using standard swipe techniques;
- Place the swipe sample an appropriate distance from the detector for the type of radiation being measured, and make a measurement of `the radioactivity deposited on the swipe;
- Determine the net count or count rate by subtracting the predetermined background count or count rate from the swipe measurement;
- Convert the net count or count rate to dpm/100 cm^2 by multiplying by the respective alpha or beta/gamma efficiency correction factor for the instrument;
- Repeat the procedure at a sufficient number of locations to be representative of the removable contamination in the area or on the item being surveyed.

5.3.18 Record the survey information on a Survey Form. The following information shall be recorded as applicable:

- Date of the survey;
- Location of the survey to include building or area designator;
- RST name performing survey;
- Instrument identification to include model, serial number, type of meter and detector, calibration date, background radiation levels;
- Survey data to include type of survey, survey point identification, location, results in dpm/100 cm^2, and supporting information like maps, postings, backup calculations, etc.

5.3.19 Identify any survey data points in excess of the values in Appendix A for the respective facility radiological zones for the contaminants listed, and report to the RSO. Additional surveys, posting, decontamination, or other follow-up actions may be required.

6.0 RECORDS AND REPORTS

6.1 Record Maintenance

Records associated with radiological surveillance and monitoring shall be maintained as required by RS Procedure RSP-001, Radiation Safety Plan.

6.2 Record Forms

The records associated with this procedure shall be maintained in a legible manner on approved standard forms. These records will contain all the information necessary to demonstrate compliance with 10 NYCRR 16.

6.3 Retention of Records

The records associated with this procedure shall be retained in a readily retrievable manner as required by RS Procedure RSP-001, “Radiation Safety Plan”.

6.4 Reports

Reports of abnormal conditions or conditions exceeding any site or regulatory requirements shall be reported immediately to the RSO. The RSO shall inform appropriate site and client management and prepare appropriate regulatory reports.

7.0 REVISION HISTORY

REVISION HISTORY		
Revision Number	**Issue Date**	

APPENDIX A

Acceptable Material and Equipment Release Limits

Nuclides[a]	Average[b c]	Maximum[b]	Removable[b d]
-235, U-238, transuranics and associated decay products,	100 dpm/100 cm^2	N/A	20 dpm /100^2
Th-nat	1000 dpm/100 cm^2	N/A	200 dpm/100 cm^2
Beta-gamma emitters	5,000 dpm/100 cm^2	N/A	1,000 dpm/100 cm^2

a - Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for both alpha and beta-gamma emitting nuclides should apply independently.

b - As used in this table, dpm (disintegration's per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c - Measurements of average contaminant should not be averaged over one (1) square meter. For objects of less surface area, the average should be derived for each such object.

d - The maximum contamination level applies to an area not more than 100 cm^2.

e - The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter paper or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

APPENDIX B
RADIATION PROTECTION SURVEY FORM **Sheet_____ of_____**
Form 010.1-1

R.P Tech (print):			Location:	RWP #:	
Instruments Used			Comments or Purpose of Survey	Date:	
Model	S/N	Cal. Due		Time:	
				Survey #	
				Air Sample #	
				Results:	µCi/cc (β,γ)
				Results:	µCi/cc (α)
			All dose rates in mR/hr unless otherwise noted.	Survey Pt #	Contamination (dpm/100 cm^2)
				1	
				2	
				3	
				4	
				5	
				6	
				7	
				8	
				9	
				10	
				11	
				12	
				13	
				14	
				15	
				16	
				17	
				18	
				19	
				20	
Note: A/S = air sample; # = Direct frisk; LAS = Large Area Smear; K = 1000 x/y refers to x = contact/ y = 30cm; xx = RCA Boundary; H = Head Level; F= foot level; O = Smear Location					

Performed By: _____Date: _Reviewed By: _____Date: _____

CONTINUATION RADIATION PROTECTION SURVEY FORM Sheet _____ of _____
Form 010.1-2

R.P Tech (print):		Location				RWP #	
						Survey #	
Survey Pt #	Contamination (dpm/100 cm^2)	Survey Pt #	Contamination (dpm/100 cm^2)	Survey Pt #	Contamination (dpm/100 cm^2)	Survey Pt #	Contamination (dpm/100 cm^2)

Performed By/Date:__________________/_____Reviewed By/Date:__________________/____

APPENDIX C
SURVEY LOG
Form 010.1-3

Survey #	Date	Initials	RWP #	Location	Description

Radiation Safety Incident Reports

Approval:		Concurrence:	
5-10-2019		5-10-2019	
Radiation Safety Officer	**Date**	**Quality Assurance**	**Date**

1.0 SCOPE

This document describes the responsibilities and follow-up actions required after the occurrence of an abnormal or unusual event related to radiation safety and to ensure the timely notification to management and provide sufficient information to employees and subcontractors to prevent recurrence of the event.

Prior to initiating timely notification the following items should be considered

Stop work,
Warn others of potential dangers,
Isolate the area and affected individuals,
Make immediate call to 911, if needed.

Secure the accident/incident site after the immediate rescue/medical and damage/spill control needs are complete. Provide all necessary assistance to protect the workers, public and the environment.

2.0 REFERENCES

2.1 RSP-001, Radiation Safety Plan

2.2 10 CFR 20 Subpart M

3.0 DEFINITIONS

Accident or Incident - Any abnormal or unusual circumstances resulting in personal injury, unplanned exposure to a radiological or chemical hazard, property damage, loss of assets, fire or explosion, spill, release, regulatory violation or adverse publicity. Any circumstance narrowly avoiding an accident or incident shall be treated as an incident although the investigation may not be as extensive.

Affected Employee – The person directly involved in or injured as a result of an abnormal occurrence or circumstance.

Chemical Hazard - Material which due to its chemical properties has the potential to cause harm or damage to people, equipment, or the environment. Such materials generally exhibit one or more of the following characteristics which make them hazardous:

Ignitability
Corrosivity
Reactivity
Toxicity

Causative Factors - Factors, which are self-evident or readily deduced from the observed facts as the immediate reason(s) the accident or incident, occurred, e.g., foreign body in eye,

injured party not wearing eye protection. The causative factor would be, failure to use eye protection.

Contributing Factors - Factors that may either underlie the causative factor(s) or combine with them in ultimate causation

Cognizant - Having knowledge of or being aware of an abnormal or unusual event or circumstance.

Note: Routine or intentional leakage to a drip pan or sump is not considered a spill; for example the drip from the water seal on a pump, the intentional draining of a hose to a sump or similar containment, or spills contained in a secondary containment.

Radiological Hazard - The existence of radiation or radioactive material that has the potential to cause or contribute to unplanned exposure, exposure or contamination exceeding applicable administrative and/or regulatory limits, and/or loss of control of radioactive material

Release - Any unplanned escape of vapor, aerosol, or gas from its primary container

Root Cause - The underlying reason(s) why an accident/incident occurred, these may not be readily apparent and are the object of the investigation.

Spill - Any unplanned escape of material (solid or liquid) from its primary container, vessel or tank, etc. regardless of quantity

4.0 RESPONSIBILITIES

4.1 The Radiation Safety Officer (RSO) reviews findings and completes all necessary notifications

4.2 The Project Manager (PM) is responsible for reviewing the incident report and reporting findings to the Radiation Safety Officer.

4.3 All employees are responsible for reporting radiological incidents/accidents immediately to the Project Manager

5.0 PROCEDURE

5.1 Initial Reporting Requirements

5.1.1 All incidents shall be reported and classified using the “Incident Classification and Reporting Guide” (Appendix A). If in doubt about the level of reporting necessary, select the higher classification and reporting requirements.

5.1.2 The cognizant employee shall verbally report all accidents/incidents to their immediate supervisor as soon as reasonably possible and complete the applicable documentation outlined in Step 5.6.

5.1.3 The immediate supervisor shall verbally report the accident/incident to the PM. The verbal report shall be followed by the submission of the written Incident Report (IR) (Form 016.0-1) including any required documentation and pictures. The PM shall review and forward the documentation to the RSO.

5.1.4 The RSO shall make notifications to regulatory agencies as required by regulatory requirements.

5.2 Accident/Incident Investigation

NOTE: The purpose of an accident/incident investigation is to determine the root causes, casual and contributory factors of the accident/incident to initiate and implement appropriate corrective action to prevent recurrence.

5.2.1 Each accident/incident shall be investigated to determine the causative and contributing factors, and to recommend corrective actions to be taken. The immediate supervisor shall initiate the investigation. Depending upon the severity of the accident/incident, the RSO, or a designee may assign additional investigating responsibilities to another individual or an investigation team.

5.2.2 A written report, identifying the causative and, if applicable, the contributory factors and recommended corrective actions to be taken to the PM.

5.3 Investigation Procedure

5.3.1 Secure the accident/incident site after the immediate rescue/medical and damage/spill control needs are complete.

5.3.2 Interview witnesses and participants as soon as practical after the occurrence. For a Class II/III accident/incident the investigator shall obtain a written statement (signed and dated) from each witness and participant. Witnesses and participants shall be identified by name, title or job responsibility, and affiliation.

5.3.3 Prepare a chronological sequence of events. This document shall become part of the written documentation.

5.3.4 Record location, movement, displacement, liquid levels, sounds, noises, smells, and/or any other sensory perception experienced by the participants or witnesses. When applicable, note the distances of travel, displacement and/or weight of items displaced.

5.3.5 If the occurrence involves a spill outdoors or a release indoors or outdoors, record the weather data for the immediate area.

5.3.6 Record the location and position of all equipment/machinery switches, controls, etc., and verify the condition of safety devices.

5.3.7 Appropriately tag and/or secure, to prevent movement, any equipment involved in a Class II/III occurrence.

5.4 Preparation of the Incident Report (IR)

5.4.1 The immediate cognizant supervisor shall initiate an IR (Form 016.0-1) for all incident/conditions meeting the conditions defined in Section 3.0.

5.4.2 The affected employee must complete Section A of the IR form by providing all of the information requested in a brief, concise and legible (printed) manner.

5.4.3 The immediate cognizant supervisor shall complete Section B of the IR form after evaluation of the incident cause and corrective actions required has been completed. This form will then be forwarded to the PM for review and tracking.

5.4.4 The PM shall complete Section C of the IR form to document the notifications.

5.4.5 The PM shall issue an IR Number for tracking that the progress of proposed Corrective Actions has been completed. An IR log shall be maintained by the PM. The IR Number will begin with the last two digits of the year of issuance, followed by a three digit sequential number.

5.4.6 Upon closeout of the IR the RSO shall review and approve that adequate corrective actions have been implemented to ensure the condition/incident does not reoccur. The facility/project manager shall insure all employees and subcontractor under their control have reviewed and understand the IR and the required corrective actions. This shall be documented by cognizant facility/project manager's signature in Section C of the IR form.

5.4.7 The RSO shall review the IR for completeness and accuracy, and will indicate completion by signing and dating the IR form.

6.0 RECORDS

6.1 FORM RS-016-1 "Incident Report"

6.2 Completed and reviewed documentation shall be retained as a legal record.

7.0 REVISION HISTORY

REVISION HISTORY		
Revision Number	**Issue Date**	**Reason for Change**

Appendix A
INCIDENT CLASSIFICATION AND REPORTING GUIDE

Class I	Class II	Class III
♦ First Aid injury ♦ Near Miss Incidents ♦ Minor damage to property (greater than $500/less than $1000 ♦ Any spill as defined in Section 3.0. ♦ A less than reportable quantity (R.Q.) spill shall be determined by the RSO or designee	♦ Spills equal to or exceeding reportable quantity (R.Q.) limits ♦ All releases ♦ Explosions ♦ Highway accident involving injury or damage to vehicle or property ♦ Personal injury (more than first aid) ♦ Non-WCS personnel injury or incident ♦ Insurance company involvement ♦ Notification of regulatory agencies involved ♦ Damage to property exceeding $1000	♦ Hospitalization of one or more persons ♦ Death ♦ Regulatory response to incident site ♦ On-site or departmental personnel need response guidance (P.R., legal, technical, etc.) ♦ Evacuation of community personnel ♦ Multiple injury of personnel ♦ Publicity
Class I Reporting Requirements	**Class II Reporting Requirements**	**Class III Reporting Requirements**
♦ Immediate verbal report to the PM by the personnel/supervisor ♦ PM verbal report to RSO as soon as possible ♦ Written report by supervisor within one work week	♦ Immediate verbal report to PM by personnel/supervisor ♦ PM verbal report to RSO as soon as possible ♦ Written report by supervisor within 72 hours. Follow-up reports by supervisor within 10 work days	♦ Immediate verbal report to PM by personnel/supervisor ♦ PM verbal report to RSO as soon as possible ♦ Written report by supervisor next work day (24 hours). Follow-up report by supervisor within 5 work days

IR No. _____

Accident Type:
Injury:_____
Illness:_____
Fatality:_____
Property:_____
MV Acc:_____
OSHA

Form RS-016-1
Incident Report (IR)

Department:_____

Location:_____

A. TO BE PROVIDED BY AFFECTED EMPLOYEE:

Name:_____SS # :_____

Home Address:_____

Street City State Zip

Age:_____Sex: M / F Phone number: _____

Occupation (title):_____Years experience in occupation:_____

ACCIDENT/ILLNESS/INJURY INFORMATION: (ATTACH ADDITIONAL PAGE IF NECESSARY)

Date of accident:_____Time of accident:_____AM/PM

Place where accident/illness/injury occurred: _____

_____

_____

Employee activity at time of accident/illness/injury:_____

_____

_____

_____

Names of others involved and/or witnesses: _____

_____

_____

If accident, how did it occur:_____

_____

_____

Description of property damage/injury or illness (body part affected):_____

_____

Accident First Reported To Whom: _____When:_____

Was First Aid or medical treatment provided? Yes/No Was Hospitalization required? Yes/No

Describe medical treatment provided: _____

_____

_____

If medical treatment was required, complete the following:

Name of Doctor/Hospital:_____Telephone #:_____

Address:_____

Street City State Zip

Employee Signature _____**Date:** _____

Supervisor Signature _____**Date:** _____

B. TO BE PROVIDED BY AFFECTED EMPLOYEE'S SUPERVISOR:

What was the basic cause(s) of the accident/illness/injury:_____

_____

_____

Was an unsafe condition involved? Yes / No If yes, identify:_____

_____

_____

Was condition reported previously? Yes / No If Yes, by whom/when?

_____

_____

Corrective action(s) taken:_____

_____

_____

Use additional paper if additional space is required to answer completely.

Supervisor's Name:_____ **Date:**_____

C. TO BE COMPLETED BY THE PM.

List all notifications made: V = Verbal W = written

Person Notified:_____ V / W Date/Time_____

Person Notified:_____ V / W Date/Time_____

Person Notified:_____ V / W Date/Time_____

Person Notified:_____ V / W Date/Time_____

Corrective Action Complete? YES / NO

Required Notifications Complete YES / NO

PM Review: _____ **Date:** _____

Have all regulatory reports been made? Y / N

Person Notified:_____ V / W Date/Time_____

Person Notified:_____ V / W Date/Time_____

RSO Review:_____ **Date:** _____

Additional Comments:

_____

_____

_____

_____

Internal Dosimetry

Approval:		Concurrence:	
	5-10-2019		5-10-2019
Radiation Safety Officer	**Date**	**Quality Assurance**	**Date**

1.0 SCOPE

1.1 Tidewater is committed to maintaining an internal dosimetry program compliant with all applicable regulations and license conditions. The purpose of this procedure is to provide the policies, requirements and methods for monitoring, tracking, and recording personnel exposure from intakes of radioactive material. Tidewater policies for personnel monitoring are designed to maintain internal radiation exposure As Low As Reasonably Achievable (ALARA).

1.2 This procedure and its requirements apply to any individual involved in work under the Tidewater Radioactive Materials License that could potentially result in an intake by inhaling, ingesting, or absorbing radioactive material. This includes radiation workers, general employees, contract workers, and visitors to facility.

2.0 REFERENCES

2.1 Radiation Safety Plan, RSP-001.

2.2 10 CFR 20.1204

2.3 NRC Regulatory Guide 8.9, Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program.

2.4 NRC Regulatory Guide 8.20, Applications of Bioassay for I-125 and I-131.

2.5 NRC Regulatory Guide 8.26, Applications of Bioassay for Fission and Activation Products.

2.6 NRC Regulatory Guide 8.32, Criteria for Establishing a Tritium Bioassay Program.

3.0 DEFINITIONS

Access Control: A location or locations at the perimeter of controlled areas through which all normal personnel entries and exits are made, and where action is taken to control the spread of radioactive contamination to adjacent uncontaminated areas and to control personnel exposure to radiation, radioactive materials, airborne radioactivity and contamination, as well as the act of controlling access to the work area.

Adult: An individual 18 or more years of age.

As Low As is Reasonably Achievable (ALARA): Making every effort to maintain exposure to radiation and radioactive materials as far below the limits specified in 10 NYCRR 16.6 and 16.7 reasonable and consistent with the purpose for which the licensed activity is undertaken, and taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other socioeconomic considerations.

Action Level (or investigation level): A level established for the quantities used in the course of implementing the safety and environmental programs, whether or not there are limits for these quantities. An action level is not a limit, but rather is used to determine a course of action when the value of a quantity exceeds or is predicted to exceed the selected value. The action initiated might range from simply recording the information, through investigating causes and consequences, to intervening measures.

Airborne Radioactivity Area: An area in which airborne radioactivity, composed wholly or partly of licensed material, exists in concentrations: In excess of the amounts specified in excess of the DACs specified in 10 NYCRR 16.6 (c) or to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in any week, an intake exceeding 0.6% of the annual limit on intake (ALI) or 12 DAC hours.

Annual Limit on Intake (ALI): The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in 10 CFR 20, Appendix B.

Bioassay: The identification and determination of concentration of radioactive material in the human body, whether by direct measurement (in vivo) or by analysis and evaluation of materials excreted or removed from the body (in vitro).

Calendar Quarter: Not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter shall begin in January and subsequent calendar quarters shall be such that no day is included in more than one calendar quarter or omitted from inclusion within a calendar quarter (see Quarterly).

Derived Air Concentration-Hour (DAC-hour): The product of the concentration of radioactive material in air [expressed as a fraction or multiple of the derived air concentration (DAC) for each radionuclide] and the time of exposure to that radionuclide in hours. 2,000 DAC-hours is equivalent to one ALI and is equivalent to a committed effective dose equivalent of 5 rem (0.05 Sv).

Minor: An individual less than 18 years of age.

Monitoring: The measurement of radiation levels, airborne radioactivity concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses on a continuing basis.

Monthly: At least once each calendar month, not to exceed 5 weeks.

Occupational Dose: The dose received by an individual in a radiological area or in the course of employment in which the individuals assigned duties involve exposure to

radiation and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or another person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

Radiation Worker: An individual receiving or expected to receive an occupational exposure in the course of accomplishing his/her work assignment.

Radiation Work Permit (RWP): A document which authorizes personnel to perform identified tasks based on radiological considerations in areas containing or suspected to contain radiation and/or radioactive material. The document describes work to be done, known or suspected area radiological conditions, and prescribes limits and precautions to be taken while work is in progress.

Radiologically Controlled Area (RCA): An area established with controlled access to provide for occupational radiation exposure and contamination control.

Respiratory Protective Device: An apparatus, such as a respirator, used to reduce an individuals intake of airborne radioactive materials.

Restricted Area: An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted areas do not include residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Unrestricted Area: An area to which access is neither limited nor controlled by the licensee.

4.0 RESPONSIBILITIES

4.1 The Radiation Safety Officer (RSO) is responsible for the preparation and update of this procedure. He/she is also responsible for the following:

- Administering the internal dosimetry program in accordance with applicable regulatory requirements and license conditions;
- Ensuring that personnel are trained in and understand the requirements for internal radiation exposure monitoring;
- Maintaining the materials, equipment, and support contracts necessary to perform internal radiation exposure monitoring;
- Reviewing and maintaining information with regard to the internal radiation exposure received by personnel;
- Ensuring internal radiation exposures are maintained ALARA.

4.2 The Project Manager responsible for work with radioactive materials (RAM), is also responsible for:

- Ensuring that personnel assigned to work with RAM follow the internal radiation monitoring requirements of this procedure;
- Ensuring that work activities are sufficiently planned and carried out in a manner that precludes unnecessary internal radiation exposure;
- Understanding the current internal radiation exposures received by employees under their charge.

4.3 Radiological Safety Technicians are responsible for determining internal radiation monitoring requirements in accordance with procedures and survey data, documenting requirements on RWPs, performing surveys in support of the internal dosimetry program, maintaining monitoring equipment, and exposure records.

4.4 All personnel performing work with RAM are responsible for limiting their individual exposure to ionizing radiation. In addition, all personnel are responsible for following the monitoring requirements of this procedure.

5.0 PROCEDURE

5.1 General Internal Dosimetry Requirements

5.1.1 For purposes of monitoring potential intakes of radioactive material, the following personnel shall participate in the internal dosimetry program:

- Adult radiation workers who under typical conditions are likely to receive an intake of radioactive material in excess of 0.1 ALI in a year;
- Declared pregnant workers who are likely to receive from an intake of radioactive material a committed effective dose equivalent to the embryo/fetus in excess 0.05 rem during the entire pregnancy;
- Minors likely to receive in a year, from an intake of radioactive material, a committed effective dose equivalent in excess of 10% of the adult radiation worker limit given above;

5.1.2 Personnel bioassay, air sampling, and internal dosimetry modeling shall be adequate to demonstrate compliance with the dose limits10 CFR 20.1204, and will conform to the requirements of the regulatory guidance referenced in Section 2.0.

5.1.3 Bioassay appropriate to the type of internal radiation hazard (specific radioactive material and its' characteristics) present in the work area shall be provided to individuals with the potential to exceed the threshold values given above. This includes urinalysis, fecal analysis, in-vivo monitoring, nasal swabs, or sputum samples, as appropriate.

NOTE: Under no circumstances will bodily excreta samples be collected within the RCA, while wearing anti-contamination clothing, or before performing personnel monitoring**.**

5.1.4 Baseline bioassay is required for applicable individuals before work in designated areas can be conducted. Routine bioassays will be required at specific frequencies designated by the RSO for long term assignments (more than six months). Incident bioassays may be required by the RSO in the event of unusual or unexpected worker or workplace monitoring results as a diagnostic tool to evaluate the significance of an intake of radioactive material. Termination bioassay is required upon completion of employment, or a work assignment, as appropriate.

5.1.5 Concentrations of radioactive materials in air, as measured by the airborne radioactivity monitoring program, may be used in lieu of bioassay measurements to determine internal radiation exposure if bioassay data is unavailable, inadequate, or the air sampling data is demonstrated to be more accurate.

5.1.6 Excreta samples will be submitted under controlled conditions to prevent extraneous contamination from sources of radioactive material outside the submitting individual's body. Samples shall preferably be submitted off-site, and returned to the facility for processing. In-vivo counts shall be performed at an off-site location after the individual has showered to remove any low-level skin contamination.

5.1.7 Confirmed measurements of deposition of radioactive material in the body, or excretion of radioactive material from the body exceeding established action levels shall be evaluated using standard bio-kinetic models to estimate the intake of radioactive materials, and the resulting CEDE.

5.1.8 An intake resulting in a CEDE in excess of pre-determined administrative control levels during a monitoring period will be verified if possible, investigated as to the cause, and corrective actions taken as appropriate.

5.1.9 If internal radiation monitoring is not provided, documentation, including calculations, surveys, historical monitoring results, or other supporting information will be maintained to demonstrate that a dose in excess of 10% of 10 CFR 20.1204 limits is unlikely.

5.1.10 In the event internal radiation monitoring is not conducted, and personnel are suspected to have received a dose in excess of 10% of 10 CFR 20.1204, all methods used to determine final dose will be documented, signed by the individual involved, and approved by the RSO.

5.2 In-vivo Counting Requirements

5.2.1 The most common means for determining an individual's intake of radioactive material at the facility will be the in-vivo count. Primarily, the stand-up whole body scan will be employed; however, an intake of certain

radionuclides may require specific organ counts,. An approved vendor will be used to provide selected in-vivo services.

5.2.2 In-vivo counts will be performed as directed by the RSO.

5.2.3 Personnel exposure records shall be maintained in accordance with Section 6.0 below.

5.3 Excreta Sample Requirements

5.3.1 Due to the chemical characteristics of certain radioactive contaminants, and their behavior after an intake has occurred, sampling bodily excreta is the bioassay of choice. Depending on the material and the circumstances of the intake, this bioassay may be performed on a sample of a workers urine, feces, saliva, or mucus. An approved off-site vendor laboratory will be used for bioassay analysis.

5.3.2 Excreta sampling and analysis will be performed as directed by the RSO.

5.3.4 An individual who has been administered a radioactive isotope for medical diagnostic purposes is waived from submitting a bioassay sample until the material is eliminated from the body to the extent that it will not affect the measurement. The individual is restricted from entering any area where monitoring is required. The RSO and the PM will determine an appropriate work assignment until the individual can be released from the restriction.

5.3.5 Personnel exposure records shall be maintained in accordance with Section 6.0 below.

5.4 Internal Dosimetry Limits and Administrative Control Levels

5.4.1 A record of internal radiation exposure from an intake of radioactive material shall be maintained to demonstrate compliance with the conditions of Reference 2.2. These records shall be specific to each individual monitored.

5.4.2 The legal limit for occupational exposure to an individual worker is 5 rem Total Effective Dose Equivalent (TEDE) in a calendar year. Since TEDE is the sum of Deep Dose Equivalent (DDE) from external radiation exposure, and Committed Effective Dose Equivalent (CEDE) from an intake of radioactive material, the annual limit for an intake is 5 rem CEDE less any DDE incurred by the worker.

5.4.3 Members of the public are limited to 2% of the occupational limits (0.1 rem), in a calendar year. Visitors and contract workers not trained as Radiation Workers are considered members of the public.

5.4.4 Individuals under the age of 18 shall not exceed 10% of the occupational limits for adult radiation workers, or 0.5 rem in a calendar year.

5.4.5 A Declared Pregnant Female worker shall not exceed 0.5 rem during the entire period of the pregnancy. If, when the mother declares her pregnancy, the radiation exposure to the embryo/fetus is found to be 0.45 rem or greater, the additional dose received during the pregnancy cannot exceed 0.05 rem.

5.4.6 When an intake of radioactive material results in an internal exposure of 0.1 rem CEDE (40 DAC-hours), no entry into a Contamination Area or an Airborne Radioactivity Area will be permitted pending an internal dosimetry evaluation and corrective action to prevent recurrence.

5.5 Actions in Response to Elevated Internal Radiation Exposure

5.5.1 Areas suspected to be associated with an intake of radioactive material (and subsequent internal radiation exposure) in which levels of loose surface or airborne contamination exceed the posting requirements of RS-002, Zoning and Posting Restricted Areas shall be posted accordingly.

5.5.2 Engineering controls shall be used to the extent practical to prevent an individual from being exposed to internal radiation levels in excess of the regulatory limits.

5.5.3 Special diagnostic bioassays may be required by the RSO in response to unusual or unexpected monitoring results or an event that indicates an intake may have occurred. Examples of situations that may require special follow-up bioassay include:

- A positive routine bioassay measurement;
- The presence of unusually high levels of skin contamination, especially in the facial area;
- Entry into a posted airborne radioactivity area without appropriate controls;
- Loss of systems or container integrity;
- CAM alarm in an occupied area;
- An incident that results in a contaminated wound, skin absorption, or an ingestion of radioactive material.

5.5.4 An unplanned exposure to airborne radioactivity with an estimated intake of greater than 8 DAC-hours shall be investigated as to cause and corrective actions. An incident resulting in a potential unplanned intake of greater than 40 DAC-hours will result in a work restriction pending an investigation, and include follow-up diagnostic bioassay.

5.5.5 When respiratory protection is used to control worker intake, appropriate respiratory protection factors may be taken into consideration for intake estimates where applicable.

6.0 RECORDS AND REPORTS

6.1 Records

6.1.1 Records of radiation exposure shall be maintained for all personnel that have been provided dosimetry. The official and permanent record of internal radiation exposure resulting from an intake of radioactive material shall be obtained from the interpretation of bioassay and/or air sampling results.

6.1.2 Records of internal radiation exposure received during operations conducted under Tidewater's radioactive materials license shall be maintained in a form that provides all the required information and Procedure RSP-001, Radiation Protection Plan. Such records shall contain the following as a minimum:

- The individual's full name, social security number, and birth date;
- A chronological listing of all intakes resulting in internal exposure;
- The dates during which the exposures occurred;
- The CEDE in units of rem.

6.1.3 A summary of internal radiation exposure shall be maintained that provides the following information:

- Total CEDE from intakes of radioactive material by monitored individuals (including visitors) for the current calendar year in rem;
- Total lifetime CEDE in rem for employees and contractors who are trained Radiation Workers.

6.1.4 A chronological listing of previous in internal radiation exposure from occupational intakes of radioactive material shall be maintained on file. These records shall contain the following:

- The name of the organization where the exposure occurred;
- The address or location of the where the exposure occurred;
- The dates during which exposure occurred;
- The CEDE in rem.

6.2 Reports

Any intakes exceeding any established regulatory or administrative limit shall be reported to Tidewater management.

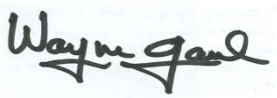
6.3 Retention of Records

The records associated with internal radiation exposure shall be retained, maintained and archived in accordance with the requirements of Procedure RSP-001, Radiation Safety Plan.

7.0 REVISION HISTORY

REVISION HISTORY		
Revision Number	**Issue Date**	**Reason for Change**

Air Monitoring

Approval:		Concurrence:	
 5-10-2019		 5-10-2019	
Radiation Safety Officer	**Date**	**Quality Assurance**	**Date**

1.0 SCOPE

1.1 Tidewater is committed to maintaining a documented, technically justifiable, and representative airborne radioactivity monitoring program that will measure ambient levels of airborne radioactivity in the work place and the environment, assess worker intakes, dictate posting requirements, and evaluate the adequacy of engineered and administrative process controls for maintaining exposures ALARA.

1.2 This procedure addresses the requirements and provides methods for performing airborne radioactivity monitoring of the workplace and the worker=s breathing zone. In addition, the procedure lists acceptable limits, and establishes actions to be taken when limits are exceeded.

2.0 REFERENCES

2.1 Radiation Safety Plan, RS-001.

2.2 USNRC Regulatory Guide 8.25, Air Sampling in the Workplace.

2.3 NUREG-1400, Air Sampling in the Workplace.

2.4 RS-012 "Respiratory Protection".

3.0 DEFINITIONS

Access Control: A location or locations at the perimeter of controlled areas through which all normal personnel entries and exits are made, and where action is taken to control the spread of radioactive contamination to adjacent uncontaminated areas and to control personnel exposure to radiation, radioactive materials, airborne radioactivity and contamination, as well as the act of controlling access to the work area.

Action Level (or Investigation Level): A level established for the quantities used in the course of implementing the safety and environmental programs, whether or not there are limits for these quantities. An action level is not a limit, but rather is used to determine a course of action when the value of a quantity exceeds or is predicted to exceed the selected value. The action initiated might range from simply recording the information, through investigating causes and consequences, to intervening measures.

Airborne Radioactivity: Any radioactive material dispersed in the air in the form of dust, fumes, particulates mist, vapor or gas.

Airborne Radioactivity Area: An area in which airborne radioactivity, composed wholly or partly of licensed material, exists in concentrations to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in any week, an intake exceeding 0.6% of the amounts specified in 10 CFR 20 Appendix B; or 12 DAC hours; or in excess of more restrictive criteria as established in the radiological safety program.

Air Sample: The collection of a representative portion of an atmosphere of interest to measure its radioactivity or to detect the presence of radioactive substances. Grab samples are of short duration (usually less than 15 minutes) and are obtained to determine real-time airborne concentrations. Continuous samples are longer period air samples (e.g., for the entire period of an activity) for determination of average or integrated airborne concentrations.

Annual Limit on Intake (ALI): The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in 10 CFR 20 Appendix B).

Bioassay: The identification and determination of concentration of radioactive material in the human body, whether by direct measurement (in vivo) or by analysis and evaluation of materials excreted or removed from the body (in vitro).

Derived Air Concentration (DAC): That concentration (µCi/ml) of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), would result in an intake of one ALI. DAC values are given in 10 CFR 20 Appendix B.

Derived Air Concentration-Hour (DAC-hour): The product of the concentration of radioactive material in air [expressed as a fraction or multiple of the derived air concentration (DAC) for each radionuclide] and the time of exposure to that radionuclide in hours. 2,000 DAC-hours is equivalent to one ALI and is equivalent to a committed effective dose equivalent of 5 rem (0.05 Sv).

Incident: An off-normal occurrence with the potential for significant adverse safety effects to individuals or the general public, or which could result in violation of regulations or provisions of the license.

Monitoring: The measurement of radiation levels, airborne radioactivity concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses on a continuing basis.

Radiation Work Permit (RWP): A document which authorizes personnel to perform identified tasks based on radiological considerations in areas containing or suspected to contain radiation and/or radioactive material. The document describes work to be done, known or suspected area radiological conditions, and prescribes limits and precautions to be taken while work is in progress.

Radiologically Controlled Area (RCA): An area established with controlled access to provide for occupational radiation exposure and contamination control.

Respiratory Protective Device: An apparatus, such as a respirator, used to reduce an individuals intake of airborne radioactive materials.

4.0 RESPONSIBILITIES

4.1 The Radiation Safety Officer (RSO) is responsible for the preparation and update of this procedure. He/she is also responsible for the following:

- Ensuring that personnel are trained in and understand the requirements of the airborne radioactivity monitoring program.
- Administering the airborne radioactivity monitoring program in accordance with applicable regulatory requirements and license conditions.
- Maintaining the materials and equipment necessary to perform airborne radioactivity monitoring.
- Reviewing and maintaining current information with regard to the airborne radioactivity exposure received.

4.2 The Project Manager, having responsibility for work with at the facility is responsible for insuring that personnel under his/her control understand and follow the requirements of this procedure. He/she is also responsible to ensure that work is sufficiently planned and carried out in a manner that prevents unnecessary airborne radioactivity generation.

4.3 Radiological Safety Technicians (RSTs) are responsible for determining airborne radioactivity monitoring requirements in accordance with procedures, documenting requirements on RWPs, conducting sampling of radioactive material in air, analyzing the samples for radioactivity, and maintaining records of the analysis.

4.4 All site personnel performing work with radioactive materials, are responsible for limiting their individual exposure to airborne radioactivity. Personnel are also responsible for understanding airborne radioactivity monitoring requirements applicable to their specific task, following monitoring instruction, and properly maintaining monitoring equipment.

5.0 PROCEDURE

5.1 General Airborne Radioactivity Monitoring Requirements

5.1.1 Air sampling is required in occupied areas, where under typical conditions, an individual is likely to exceed in one year, an intake in excess of 10% of the applicable ALI. Examples of activities having a high potential for generating airborne radioactive material are:

- Miscellaneous radioactive waste handling, compaction, packaging, etc.
- Opening of a closed system containing radioactive materials;
- Radioactive material container sampling, filling, emptying, etc.

- Decontamination of contaminated surfaces;
- Maintenance on radioactive material handling components;
- HEPA filter or pre-filter change-outs;
- Burning or welding on contaminated surfaces.

5.1.2 When required, air samples representative of the workers breathing zone shall be collected and intakes tracked and controlled to ensure compliance with the occupational radiation exposure limits of Reference 2.3.

5.1.3 Portable air samplers or personnel breathing zone (lapel type) air samplers shall be used as necessary to monitor specific work activities where the potential exists to exceed the airborne radioactivity limits of 5.1.1 above.

5.1.4 Personnel air samplers (lapel type) shall be used whenever portable sampling cannot be positioned in such a manner to be representative of the breathing zone of the worker.

5.1.5 Routine bioassays will be performed to supplement air monitoring data for workers where normal operating conditions could result or have resulted in an intake of radioactive material in excess of 10% of the applicable ALI.

5.1.6 Individual exposures with estimated intakes greater than 0.02 ALI will be investigated as to cause and possible corrective actions. Individual intakes greater than 0.1 ALI will be investigated using follow-up bioassay measurements and available workplace monitoring. Respiratory protection credit may be taken in accordance with applicable protection factors given in Reference 2.1.

5.1.7 Any air sample which indicates an airborne radioactivity concentration in excess of 2% of the applicable DAC shall be investigated in accordance with Reference 2.3 to determine the cause of the airborne radioactivity and implement controls to maintain exposure ALARA.

5.1.8 When airborne radioactivity concentrations are likely to exceed 25% of the applicable DAC, the need to wear respiratory protection shall be evaluated and documented prior to area entry.

5.1.9 Personnel shall not be exposed to airborne concentrations which exceed a daily intake of 8 DAC-hours without prior approval of the RSO.

5.1.10 Methods used to monitor airborne radioactivity shall have a Minimum Detectable Activity (MDA) equal to or less than 10% of the applicable DAC.

5.2 Job Specific Air Sampling Requirements

5.2.1 Portable air samplers may be used for job specific sampling in localized areas, general work areas, posted Airborne Radioactivity Areas, or boundaries of these areas. Sampling shall be conducted for activities having a high potential for generating airborne radioactive material such as:

- Miscellaneous radioactive waste handling, compaction, packaging
- Opening of a closed system containing radioactive materials
- Radioactive material container sampling, filling, emptying, etc.
- Decontamination of contaminated surfaces
- Maintenance on radioactive material handling components
- HEPA filter or pre-filter change-outs
- Burning or welding on contaminated surfaces.

5.2.2 Select a calibrated sampling pump, move it to the work location, and position the sample head facing the source of airborne radioactive materials, at the approximate worker breathing zone. Place the sampler between the occupied work location or area boundary and the potential source of airborne radioactive material.

5.3 Personnel Air Sampling Requirements

5.3.1 Conduct personnel air sampling with a lapel type air sampler for the conditions and activities as defined by job specific RWP and where a portable air sampler cannot be positioned to provide a representative air sample.

5.3.2 When a group of workers are working in a single confined area, use a single lapel sampler worn by the individual with the highest exposure potential to monitor for the entire group. Do not exceed a ratio of one sampler for four workers.

5.4 Air Sample Handling and Analysis Requirements

5.4.1 Store sample media in the original container or a glassine envelope prior to use. After use, and prior to analysis, it shall be stored in a glassine envelope to prevent damage or cross-contamination. Label the envelope with a unique number (i.e. 01-101), the time, date, RWP number, and worker, as applicable to prevent loss or misuse.

NOTE: Do not handle air samples and sample holders (i.e. filter cassettes, sample heads, etc.) with potentially contaminated gloves or hands, and do not allow them to contact potential contaminated surfaces

5.4.2 Used air sample filter media are exempted from radioactive material labeling requirements while in the care of a RST. These filters, however,

must be properly labeled and stored, when not being used. Used filters shall be retained for one year before disposal as radioactive waste.

5.4.3 Air samples should be counted and the data reported in an expeditious manner in order to evaluate appropriate radiological controls, changes in respiratory protection requirements, postings, and control worker intakes. This evaluation should take into account the reliability of the sample analysis based on factors such as sample volume, short lived radioactive progeny interference, and decay time to correct for that interference. Samples collected in the presence of radon should be held for a minimum of 48 hours prior to analysis to permit the radon to decay.

5.4.4 Air samples shall be counted on an appropriate laboratory counting instrument with an established geometry, counting efficiency, and background determination. Count time is variable depending on the desired sensitivity.

5.4.5 If the efficiency of the air sample filter is less than 95% for the material being collected, correct the analytical result to account for radioactive material not collected on the filter.

5.4.6 Use a documented correction factor if penetration of radioactive material into the filter media or self absorption of alpha radioactivity by the material deposited on the filter would reduce the count rate by more than 5%. Unless specific data is available, for beta counting use a default value of 1.0 and for alpha use a value of 0.8.

5.4.7 Using the known counting efficiency and background determination for the laboratory counting equipment used, convert gross count rate to net disintegration/minute (dpm) by subtracting the background and dividing by the appropriate counting efficiency factor. Correct for filter efficiency and self absorption per 5.4.5 and 5.4.6. The following formula can be used for calculating net dpm:

$$DR\ dpm = \frac{CR\ cpm - BR\ cpm}{E\ dpm / cpm}$$

Where:
DR = net disintegration per minute (dpm)
CR = gross count rate in units of cpm
BR = background count rate in units of cpm
E = the decimal equivalent of the % counting efficiency of the laboratory counting equipment used

5.4.8 The total run time of the sample and the average flow rate of the sampling system during the sampling period shall be used to calculate total sampled volume in milliliters (ml). The following formula can be used for calculating total sampled volume:

$$V = T \times R$$

Where: V = total sampled volume in units of milliliters (ml)
T = total sample elapsed time in units of minutes
R = sample flow rate in units of milliliters/minute (ml/m)

Note if the units are in cubic feet there are 28,317 ml/ft^3.

5.4.9 Convert d/m to microcuries (uCi) by dividing by 2.22 x 10+6. Calculate concentration by dividing µCi by the total volume sampled in ml. The result in µCi/ml can be compared to the appropriate DAC for the radioactive material in question. The following formulas can be used for converting dpm to µCi, and then calculating concentration in uCi/ml:

$$A\,\mu Ci = \frac{DR\ dpm}{2.22\ x\ 10^6\ dpm / \mu Ci} \quad and \quad C\ \mu Ci.ml = \frac{A\ \mu Ci}{V\ ml}$$

Where: A = radioactivity in units of microcuries (µCi)
DR = net disintegration rate in units of dpm
C = concentration of radioactive material in air in µCi/ml
V = total sampled volume in units of milliliters (ml)

5.4.10 To determine DAC-hours (a mathematical expression of worker intake), the concentration of radioactive materials in units of µCi/ml is divided by the appropriate DAC and multiplied by the number of hours of worker exposure. The following formula can be used for calculating DAC-hours:

$$DAC - hours = \frac{C\ \mu Ci / ml * T\ hrs}{DAC\ \mu Ci / ml}$$

Where C = concentration of radioactive material in air in µCi/ml
T = total worker exposure time in units of hours
DAC = derived air concentration value from Reference 2.3

5.4.11 Committed Effective Dose Equivalent (CEDE) in units of millirem (mrem) can be calculated by multiplying DAC-hours by 2.5 (5000 mrem is equivalent to 2000 DAC-hours). The following formula can be used for calculating CEDE:

CEDE mrem = DAC-hours x 2.5 mrem/DAC-hr

Where: CEDE = committed effective dose equivalent in units of mrem
DAC-hours = mathematical expression of worker intake

5.5 Airborne Radioactivity Limits and Administrative Control Levels

5.5.1 A record of concentration of radioactive material in air in units of uCi/ml and worker intake in units of DAC-hours shall be maintained to demonstrate compliance with the conditions of Reference 2.3. These records shall be specific to each area of a facility and each worker monitored.

5.5.2 The legal limit for occupational exposure to an individual worker is 5 rem Total Effective Dose Equivalent (TEDE) in a calendar year. The legal limit for exposure to airborne radioactivity is, therefore, 5 rem CEDE (2000 DAC-hours) in the calendar year.

5.5.3 Members of the public are limited to 2% of the occupational limits, or 0.1 rem (40 DAC-hours) in a calendar year. Visitors and contract workers not trained as Radiation Workers are considered members of the public.

5.5.4 Individuals under the age of 18 shall not exceed 10% of the occupational limits for adult radiation workers, or 0.5 rem (200 DAC-hours) in a calendar year.

5.5.5 A Declared Pregnant Female worker shall not exceed 0.5 rem (200 DAC-hours) during the entire period of the pregnancy. If, when the mother declares her pregnancy, the radiation exposure to the embryo/fetus is found to be 0.45 rem or greater, the additional dose received during the pregnancy cannot exceed 0.05 rem (20 DAC-hours).

5.5.6 Administrative Control Levels (ACLs) are established to prevent the exceeding of a legal limit and to maintain individual and collective radiation exposure of ALARA. The Tidewater ACL is 2,000 mrem TEDE for the calendar year. Special approval to exceed the ACL may be granted with written approval of the RSO and the Project Manager (PM).

5.5.7 Since TEDE includes the contribution of external exposure to the worker, the monthly airborne radioactivity ACLs is set at 100 mrem (40 DAC-hours).

5.5.8 The ACLs for airborne radioactivity are as follows:

- Day 8 DAC-hours
- Week/Year 40 DAC-hours

5.5.9 Approval to exceed the ACLs may be granted by the RSO. Approval of both the RSO and the PM is required to exceed the 200 DAC-hour/year ACL. Exceeding 100 DAC-hours/year requires the approval of the RSO.

5.5.10 When accumulated DAC-hours for an individual in a month exceeds 40, entry to an airborne radioactivity area shall be restricted permitted pending an investigation and corrective action to prevent recurrence.

5.5.11 Other more restrictive ACLs may be established by specific plans, procedures, or work instructions for ALARA purposes as specified by the SRC.

5.7 Actions in Response to Elevated Airborne Radioactivity

5.7.1 An area in which the airborne radioactivity levels exceed the DACs listed in Reference 2.3, or an area in which an individual present without respiratory protection could exceed 0.6% of the ALIs listed in Reference 2.3, or 12 DAC-hours in a week shall be posted as an Airborne Radioactivity Area in accordance with Radiation Safety Procedure RS-002.

5.7.2 Engineering controls shall be used to the extent practical to prevent an individual from being exposed to airborne radioactivity levels in excess of the ACLs listed in Section 5.5.

5.7.3 Any measured airborne radioactivity concentration in excess of 2% of the applicable DAC shall be investigated by the RSO to determine the cause. Appropriate controls shall be implemented to maintain the airborne radioactivity concentrations ALARA.

5.7.4 Special diagnostic bioassays will be provided on a case-by-case basis in the event of unusual or unexpected airborne radioactivity monitoring results at the discretion of the RSO. Examples of situations that may require special follow-up bioassay include:

- The presence of unusually high levels of facial or nasal contamination
- Entry into a posted airborne radioactivity area without appropriate controls
- Loss of systems or container integrity
- CAM high level alarm in an occupied area
- An incident that results in a contaminated wound or skin absorption.

5.7.5 An exposure to airborne radioactivity with an estimated intake of greater than 40 DAC-hours shall be investigated as to cause and corrective actions. An incident resulting in a potential intake of greater than 40 DAC-hours shall result in a work restriction, an investigation, and follow-up diagnostic bioassay.

5.7.6 Respiratory protection shall be considered when airborne radioactivity levels are expected to exceed 25% of the applicable DAC after applying reasonable engineering controls. Worker efficiency with respiratory protection shall be taken into consideration for work in areas of elevated external radiation prior to area entry.

5.7.7 In the event of a CAM alarm in an occupied area which is confirmed not to be the result of an electrical transient, external radiation, or naturally

occurring radioactive materials, (a true high level alarm), the following actions shall be taken as appropriate:

- Operations identified to be the cause of the airborne radioactivity shall be suspended until adequate control is established
- Nonessential personnel shall be evacuated from the area
- Essential personnel shall don respiratory protection for re-entry in accordance with a recovery plan
- Unfiltered ventilation for the effected spaces shall be secured
- Investigative air sampling shall be performed to isolate the cause of the airborne radioactivity
- Evacuated personnel shall be monitored for contamination, and de-contaminated as necessary
- Potentially exposed personnel shall be evaluated for intake.

6.0 RECORDS AND REPORTS

6.1 Records of airborne radioactivity levels for activities at Tidewater and personnel air sampling records for all personnel having access to the Radiologically Controlled Area (RCA) shall be maintained in accordance with Section 17.0 of RS-001, Radiation Safety Plan. The official and permanent record of accumulated occupational exposure received by an individual shall be obtained from the interpretation of TLDs, bioassay results, and air sampling data as appropriate.

6.2 Record Forms

6.2.1 Records of airborne radioactivity monitoring shall be maintained in a form that provides all the required information. Such records shall contain the following as a minimum:

- The individual's full name, social security number, and birth date;
- A chronological listing of all intakes of radioactive material;
- The total intake in units of DAC-hours, and CEDE in rem.

6.2.2 A summary of occupational intakes of radioactive material shall be maintained that provides the following information:

- Total intake for the current calendar quarter in DAC-hours, and CEDE in rem;
- Total lifetime occupational exposure in rem.

7.0 REVISION HISTORY

REVISION HISTORY		
Revision Number	**Issue Date**	**Revision Description and Reason for Change**