FINAL

RADIOLOGICAL REMEDIAL INVESTIGATION REPORT
Former Naval Station Puget Sound
Seattle, Washington

Contract No. N62470-08-D-1007
Task Order FZN4
Shaw Project No. 137165

May 2011

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Acronyms and Abbreviations

ACM	asbestos-containing materials
ALARA	As Low As Reasonably Achievable
Argus	Argus Pacific, Inc.
BRAC	Base Realignment and Closure
CB	catch basin
City	City of Seattle
cm^2	square centimeter(s)
cpm	counts per minute
DoD	Department of Defense
dpm	disintegrations per minute
EBS	Environmental Baseline Survey
FCR	Field Change Request
FIS	Former Instrument Shop
GPS	Global Positioning System
GWS	gamma walkover survey
HEPA	high-efficiency particulate air
HVAC	heating, ventilating, and air conditioning
m^2	square meter(s)
MARSSIM	Multi-Agency Radiation Site Survey and Site Investigation Manual
MH	manhole
NaI	Sodium Iodide
NAS	Naval Air Station
NAVSTA PS	Naval Station Puget Sound
Navy	U.S. Department of the Navy
NOAA	National Oceanic and Atmospheric Administration
pCi/g	picocuries per gram
PPE	personal protective equipment
Ra-226	radium-226
RCA	radiologically controlled area
RCT	Radiological Control Technician
RMSA	Radioactive Material Storage Area
RPP	Radiation Protection Plan
RSS	Radiological Site Survey
Shaw E&I	Shaw Environmental & Infrastructure, Inc.
Sr-90	strontium-90
T&G	tongue and groove

1.0 Introduction

Shaw Environmental & Infrastructure, Inc. (Shaw E&I) performed radiological characterization surveys, sampling, limited contamination removal actions, and waste management activities as part of a Time Critical Removal Action project conducted in and around Buildings 27 and 2 at Former Naval Station Puget Sound (NAVSTA PS). The work was performed according to the *Final Work Plan for Time Critical Removal Action, Former Naval Station Puget Sound, Seattle, Washington* (Final Work Plan) (Shaw E&I, 2010a) and the *Final Accident Prevention Plan, Time Critical Removal Action, Former Naval Station Puget Sound, Seattle, Washington* (Final Accident Prevention Plan) (Shaw E&I, 2010b) prepared for the U.S. Department of the Navy (Navy) by Shaw E&I. Field activities were conducted from April 2010 through December 2010. Shaw E&I has secured portions of the two buildings that contain radiological contamination exceeding project cleanup criteria. Weekly inspections and radiological surveys are conducted to deter entry into radiologically controlled areas.

1.1 Site Location and History

Former NAVSTA PS is located approximately 6 miles northeast of downtown Seattle on the western shore of Lake Washington (Figure 1, “Site Location Map”). Former NAVSTA PS was initially named Naval Air Station (NAS) Seattle. Portions of the facility were built in 1925 on land donated by King County. Many of the major buildings were built in the late 1930s prior to World War II, including Building 27 (1937) and Building 2 (1929). Additions were constructed and remodeling took place in later years, including an addition to the southern portion of Building 27 in 1944 (“South Shed”) and the remodeling of an instrument shop in Building 2 in 1943 (“1943 Instrument Shop”).

During World War II, NAS Seattle supported air transport and ship outfitting personnel for the Alaskan and Western Pacific theaters of operation. Transport squadron personnel operated cargo flights to Alaska and the Aleutian Islands, supplying air stations such as Sitka, Kodiak, Dutch Harbor, Adak, and Attu. Outfitting personnel handled the preparation of escort carriers and seaplane tenders built in Tacoma and Vancouver, Washington prior to departure. In 1945, at the peak of its activity, the NAS Seattle supported more than 4,600 Navy/Marine Corps and civilian personnel. After the war, the NAS Seattle was designated a Naval Reserve Air Station. From 1945 to 1970, the station maintained Naval Reserve squadrons for supplementing active duty forces, both continental United States and abroad. Aviation activities officially ceased on June 30, 1970, and NAS Seattle was decommissioned.

On July 1, 1970, NAS Seattle was redesignated Naval Support Activity, Seattle. Three years after the Navy stopped its air activities, the facility was divided into three parts. National

Oceanic and Atmospheric Administration (NOAA) received 100 acres, including one third of the runways and 3,500 feet of waterfront. The City of Seattle (City) received the southeast portion, including approximately one mile of waterfront that later became Magnuson Park in 1977. The Navy retained the rest. From 1970 until April 1982, the Base provided logistic services such as supply, billeting, and administration to the 13th Naval District, Department of Defense (DoD), and other federal agencies. In April 1982, Naval Support Activity, Seattle was designated Naval Station, Seattle. In October 1986, Naval Station Seattle was designated NAVSTA PS as a result of the station's decreasing support role in the Pacific fleet activities.

In June 1991, the Base Realignment and Closure (BRAC) Commission of the DoD announced the closure of former NAVSTA PS. In accordance with recommendations of the 1991 BRAC Commission, the Navy closed former NAVSTA PS in September 1995. A disestablishment ceremony was held on September 28, 1995, to commemorate the closing of the Base.

Subsequent to closure, the Navy conducted environmental investigations and cleanup of portions of the facility. The condition of the property was described in the Environmental Baseline Survey (EBS) report (URS Consultants, Inc., 1996). The EBS described the significant operations and existing conditions at specific buildings and areas at former NAVSTA PS that were addressed in past environmental investigations. The EBS identified areas with potential environmental concern where storage or release of hazardous substances had occurred. No radiological contamination was identified in the EBS report. This EBS report was used by the Navy to generate the Finding of Suitability to Transfer for the property. After completion of these actions as well as the appropriate National Environmental Policy Act actions, the Navy initiated transfer of the former NAVSTA PS property to several government agencies in accordance with the BRAC closure plan.

The Navy transferred portions of the facility to the City for recreational development. Due to a long history of use of the facility by the Navy, and because of the potential that the environmental investigations conducted did not identify all environmental hazards that pose a threat to human health and the environment, the transfer deed between the Navy and the City included an environmental covenant that allowed the City to seek action by the Navy to address contamination that was not identified in the EBS (URS Consultants, Inc., 1996).

1.2 Radiological History

The EBS identified Buildings 27 and 2 as "Areas where only storage of hazardous substances or petroleum products has occurred (but no release, disposal, or migration from adjacent areas has occurred)" (URS Consultants, Inc., 1996). The transfer deed additionally included land use restrictions for Building 2 to address residual chemical contamination on the site. The EBS, however, did not describe the potential for radiological contamination.

During planning of recent proposed renovations of Building 27, the City reviewed historical drawings and identified rooms labeled “Instrument Shop” and “Radium Room” implying that radioactive materials may have been used or stored in these areas of the buildings. Buildings 27 and 2 are both former aircraft hangars. Airplane maintenance and storage activities of the era typically included the use of self-luminescent radium paint for the maintenance and repair of aircraft instruments and parts.

Screening level radiation surveys were performed in April and May 2009 by Argus Pacific, Inc. (Argus) under contract with Seattle Parks and Recreation (Argus, 2009a and 2009b). The surveys were conducted within Building 27, three pump houses (Pump House A, B, and 116) near Building 27, and within Building 2. The locations of Building 27, Building 2, and each of the three pump houses are shown on Figure 2, “Location of Bldg. 27 & Bldg. 2.”

The Argus survey (2009a) identified two locations of elevated radiation above background levels in Building 27. The two locations were associated with a former sink drainpipe located on the north wall of the S-1 Work Space located on the second floor of Building 27 (former Radium Room) (3,400 to 4,860 microRoentgen per hour) and where the pipe extended to the first floor (beneath the floor of the S-1 Work Space) (145 to 845 microRoentgen per hour). For radiological survey purposes rem can be assumed to be equivalent to roentgen (R). Measurements indicated that the radioactive materials appeared to be contained inside the drainpipe. The location of the S-1 Work Space and the pipe running to the Welding Shop (beneath) is shown on Figure 3, “Floor Plan of Bldg. 27.” The Argus survey (2009b) for Building 2 and the three pump houses identified no areas of radiation above background levels.

Based on the findings of the Argus screening surveys (2009a and 2009b), the Navy retained Shaw E&I to conduct radiological surveys in the former instrument shop (includes the former Radium Room) on the second floor and beneath the instrument shop on the first floor in Building 27. The Navy also requested that Shaw E&I conduct radiological surveys in two former instrument shops on the second floor of Building 2. The locations of the instrument shops within Building 2 are shown on Figure 4, “Floor Plan of Bldg. 2 (Second Floor).”

Due to the potential for radiological contamination in the sewer and storm lines, the Navy also requested that radiological surveys and sampling for radium-226 (Ra-226) be conducted along the gravity flow sewer line and pump houses 116 and 117, the storm drain systems adjacent to Building 27, and the inactive pressurized line and pump house 98 (Figure 5, “Pump Houses and Sewer / Storm Drain Lines”).

The Seattle Parks Department also contracted Northwest Radiation Services to perform radiological surveys on the hanger wall and at locations within the Building 27 South Shed. This work occurred before Shaw E&I arrived on the site in April 2010. Dose rates taken on the

Radium Room sink drain pipes were consistent with those levels later found by Shaw E&I. No direct-reading contamination or removable contamination was detected on the hanger side of the wall. One location of elevated gamma dose rate was identified that coincides with the Radium Room sink drainpipes that were in the wall at the time of the radiological survey.

1.3 Buildings and Structures

Radiological surveys were conducted within Buildings 27 and 2. Pipe location surveys and tracer surveys, and mapping were conducted at the three pump houses (116, 117, and 98) and the storm and sewer lines. Additionally, sludge samples from within the manholes and catch basins surrounding Building 27 were collected and analyzed. The following subsections describe these activities.

1.3.1 Building 27

Building 27 was originally constructed as a hangar for the Navy in 1937. The northern portion of Building 27 comprises the former hangar space and a north Shed Area. It has a concrete floor and steel framing. Structures ("towers") with stairs are present on each corner of Building 27. The towers are four stories high and provide access to the second floor and roof tops. At the south end of the building are two enclosed floors of storage rooms, offices, and restrooms (South Shed). The South Shed was added in 1944 (Drawing 54080 [1943]). A shared wall separates the hangar from the South Shed.

Building 27 was vacant at the start of the field activities in April 2010, except for use of the lower floor of the South Shed and portions of the hangar as storage. Shaw E&I secured access to the proposed work area on the second floor of the South Shed at the start of field activities in April 2010. In May 2010, a tenant of the City of Seattle Parks Department began renovation of the northern hangar area of Building 27 into an indoor sports facility.

The second floor of Building 27 South Shed is accessible by staircases in the towers on both the east and west sides. Stairs were present near the central portion of the South Shed (quarter deck) but have since been removed. One set of stairs led outside to the south and one set led to the hangar to the north. Site drawings dated November 1943 (Drawing 54080 [1943]) indicate that an instrument shop on the second floor, including a Radium Room, may have been used for handling low-level radioactive materials. Drawings dated 1975 (Drawing 54141 [1975]) and 1985 (Drawing 54151 [1985]) indicate that the building had been renovated during which the Radium Room was reconfigured and renamed the S-1 Work Space. Figure 3 presents both the 1943 and 1985 room configurations. The S-1 Work Space now contains a wall of mailboxes on the south wall. On the north wall, a sink has been removed, but the open drainpipe and capped water supply pipes are in place. A ventilation duct located in the ceiling has been abandoned, but the approximately 2-foot-by-2-foot penetration remains through the ceiling space above into the heating, ventilating, and air conditioning (HVAC) penthouse located on the roof. Prior to this investigation, the floor was covered with 9-inch square floor tiles that, along with the mastic, were composed of asbestos-containing materials (ACM).

1.3.2 Building 2

Building 2, located west of the NOAA facilities was constructed between 1929 and 1941, was an active air hangar until the NAS was decommissioned in 1970. Airplane maintenance and storage activities at Building 2 (also called Hangar 2) may have involved the use of self-luminescent radium paint for the maintenance and repair of aircraft instruments and parts.

The center part of Building 2 comprises two former hangar spaces. The first floor of the building has a concrete floor and steel framing and is currently used as a recreation facility. The northern portion of the building is utilized for storage, offices, and restrooms. There are unoccupied areas on the second floor of the building including two former Instrument Shops. The second floor is accessible by staircases. As shown on Figure 4, one instrument shop is shown on a 1939 drawing and one is shown on a 1941 drawing. There is also an area of interest located in the southeast corner of Building 2. This area is a small room that currently contains a two-basin sink and a floor drain located in the center of the tile floor.

1.3.3 Soils

During the period of time that Building 27 and Building 2 operations involved the use of Ra-226, there were unpaved areas nearby. There were exposed soil areas around Building 2 between entrances and also south and west of Building 27. Stairs under the Building 27 Quarterdeck led up to 1st Street with soil on both sides. Later, when the NOAA access road was built between Buildings 2 and 27, the elevation was raised, retaining walls constructed, and an overpass constructed. Soil areas on both sides of the NOAA road still exist but have been altered in places. A large area of soil west of Building 27 has since been paved with asphalt. The original concrete tarmac still exists and it is clear where the soil area once was under the asphalt. Sections of soil between Buildings 2, 12, and 27 have also been paved with asphalt.

1.3.4 Pump Houses and Sewer and Storm Lines

There are three pump houses (98, 116, and 117) near Building 27 (Figure 5). Pump house 116 is currently associated with the gravity feed sewer line that runs north from Building 12 (located south of Building 27) along the west side of Building 27. Pump houses 98 and 117 appeared to be associated with the inactive pressurized sewer line but it was later determined that pump house 98 was associated with the former fuel tanks (now removed). A valve pit, located immediately north of pump house 98, was determined during field activities to be the end of the former pressurized sewer line (Figure 6, “Pump House 98 Valve Pit”).

Pump House 98 is located 6 feet to the south of the valve pit located at the west end of the abandoned pressurized sewer line. This line was identified by the utility location subcontractor as one of the four lines coming into the pit from the east. Video inspection of this line supported this identification, although the video inspection was abandoned because of an obstruction and was not completed. The obstruction appeared to be lead that had flowed into the pipeline when pipe joints were sealed. Pump House 98 is a 15 foot by 8 foot single floor brick structure with a concrete floor with several dirt-floor sumps. A sign on the door indicates that this pump house is part of the fuel handling system and not associated with the abandoned pressurized sewer line. The pump house is divided down the middle with a brick wall separating the pump motor from the fuel pump and valves.

Pump House 116 is located on the shoreline nearest to Building 13 and the North Shore Recreation Area. It is a one-story building with a single sub-grade room that contains wastewater pumping systems and machinery. The machinery is accessible by a staircase from the ground-level landing. Pump House 116 currently handles wastewater from Buildings 11, 12, 13, and 20. A side sewer runs from the northern shed of Building 27 but it appears to be inactive (Figure 5). Pump House 116 pumps the wastewater to the city sewer system. Historically, Pump House 116 may have discharged into Lake Washington.

A side sewer line, present on the southeast corner of Building 27, connects to the active gravity feed sewer line that discharges to the NOAA sewer system (Figure 5). A side sewer line from Building 2 also connects to this line.

The inactive pressurized sewer line runs past Pump House 117 located east of Building 27 across the south end of Building 27 and then northwest to a valve pit near Pump House 98 (Figure 5). Based on historical drawings, it is not clear if Pump House 117 was ever connected to the pressurized line. It appears that the pressurized sewer line was connected to Building 1 Hangar, formerly located east of Building 27 (Drawing 54023 [1937]). Pump House 117 is located at the east end of the abandoned pressurized sewer line. It is a 13 foot by 13 foot single story structure built on a concrete pad. The structure houses two inactive pumps each mounted on a concrete pad. The interior of the structure is dry wall. Located immediately to the east of Pump House 117 is a water-filled concrete pit that was determined, by probing, to be approximately 12 feet deep. The top was covered by a metal grate and lights could be seen immediately below water level. It appears that this pit was previously dry and designed for access via a ladder. Video inspection of the east end of the abandoned pressurized sewer line indicated that the line turned to the north and went under Pump House 117. It could not be determined where this line terminated. It appears that the pit may have contained the original pumps for the pressurized line and that when these pumps were abandoned; Pump House 117 was constructed to house replacement pumps.

The existing storm water system runs along the west side of Building 27 and under Building 27 (Figure 5). The two lines connect at manhole-160 and discharges into Lake Washington. Catch basins that connect to the storm water lines are present along the west, south, and east sides of Building 27. The manholes and catch basins are shown on Figure 7, “Manhole, Catch Basin, Pipe, and Pump House Sampling Locations.”

2.0 Field Activities

The following subsections describe the radiological surveys conducted within Buildings 27 and 2; the pipe location and tracer surveys and mapping conducted at the three pump houses (116, 117, and 98) and the storm and sewer lines; and the sludge sampling of the manholes and catch basins surrounding Building 27.

2.1 Building 27

The original scope of work outlined in the Final Work Plan (Shaw E&I, 2010a) for Building 27 involved radiological surveys of the Former Instrument Shop. The Former Instrument Shop covers more than half of the western side of the second floor (Figure 3). Before the surveys could be performed, the previously identified radiologically contaminated pipe associated with the two sinks formerly located in the Radium Room and the Carbon Tissue Room (both on the second floor of Building 27) were removed. The pipe was identified as running through the floor to the welding shop below, across the ceiling, and through the concrete floor.

Inspection of the building construction indicated that during remodeling, additional flooring had been installed over the flooring that was exposed during instrument shop operations. The additional flooring included particle board underlayment and asbestos-containing 9 inch by 9 inch tiles. Once the contaminated piping was removed, the ACM flooring that covered the original wood floor was removed by a qualified asbestos abatement subcontractor using certified and licensed asbestos abatement personnel according to procedures outlined in the subcontractor-provided Asbestos Abatement Plan and Shaw E&I's Final Accident Prevention Plan (Shaw E&I, 2010b). Prior to removing the flooring, all the furniture, fire-fighting training structures, and debris were screened for radiological activity and removed from the survey area. The area was then cleaned with a high-efficiency particulate air (HEPA) filtration vacuum prior to initiation of radiological surveys. Radiological survey of the flooring prior to removal and monitoring of the ACM and non-ACM materials removed from the facility were used to assure unrestricted release of these materials (no contamination above free-release limits) was accomplished.

Class 1 radiological surveys (performed, according to the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (DoD et al, 2000), when a potential for radioactive contamination based on site operating history or known contamination based on previous radiation surveys above project cleanup criteria) were to be performed on the floor of the Radium Room and the floor beneath the pipe in the welding shop. Class 2 radiological surveys (performed, according to MARSSIM, when a potential for radioactive contamination or known contamination, but are not expected to exceed the project cleanup criteria) were proposed for the

Former Instrument Shop floors and the floor on the hangar side of the welding shop wall. Class 3 radiological surveys (performed, according to MARSSIM, when residual radioactivity is not expected, or are expected to contain levels of residual radioactivity at a small fraction of the project cleanup criteria, based on site operating history) were proposed for the walls of the Instrument Shop in Building 27. Scoping surveys that included dose rates and both total and removable contamination surveys were conducted for the roof and roof vents.

As the radiological surveys progressed, the magnitude and extent of contamination was found to be greater than originally anticipated. The surveys were upgraded to Class I and Class II and the progression of the expanded surveys and findings of the radiological surveys performed are described in detail in Section 4.2.1. Limited Time Critical Removal Actions identified in the original scope of work (i.e., Radium Room subflooring and wall removal) were scaled back and the project shifted from a Time Critical Removal Action to a radiological remedial investigation.

2.2 Building 2

The original scope of work planned for Building 2 involved the removal of ACM flooring that covered the original wood floor present at the time of the radium use in the building. The flooring removal was conducted by a qualified asbestos abatement subcontractor using certified and licensed asbestos abatement personnel according to procedures outlined in the subcontractor provided Asbestos Abatement Plan and Shaw E&I’s Final Accident Prevention Plan (2010b).

It was proposed that MARSSIM Class 2 radiological surveys would be conducted of the floor and MARSSIM Class 3 radiological surveys would be conducted on the walls of both the 1939 Former Instrument Shop and the 1941 Former Instrument Shop in Building 2 (DoD et al, 2000). As the scoping surveys progressed, the magnitude and extent of contamination was found to be greater than originally anticipated. The characterization surveys were upgraded to Class 1 (floors) and Class 2 (walls) and the progression of the expanded surveys and findings of the surveys performed are described in Section 4.2.2.

2.3 Piping and Pump Houses

The scope of work planned for the three pump houses (116, 117, and 98) and the storm and sewer lines included conducting pipe location surveys and tracer surveys, mapping the systems, and identifying what system the removed section of pipe from the Radium Room in Building 27 was connected to. The scope also included performing radiological surveys and collecting sludge samples at the three pump houses, at manholes, and at catch basins surrounding Building 27. Initially, it was believed that 15 manholes and catch basins would require sampling.

As part of the scope, the storm and sewer lines, manholes, and catch basins were identified, mapped, and sampled during this investigation. After conducting a series of smoke tests (described in Section 4.2.3.3) it was determined that the Radium Room pipe in Building 27 was connected to the storm lines that run to catch basin CB-3 near the southwest corner of Building 27. Catch basin CB-3 was then found to connect to manhole MH-141 to the west and ultimately flows through manholes MH-234 to MH-160 to Lake Washington. Ultimately, 42 manholes and catch basins were identified during the investigation. A description of the sampling and findings are discussed in Sections 4.3.2.

2.4 Field Work Variances

If a previously unknown hazard or additional work activity not addressed in the approved Final Work Plan (Shaw E&I, 2010a) or Final Accident Prevention Plan (Shaw E&I, 2010b) was identified during field activities, work was halted and redirected to other activities, pending review and acceptance by the Navy Technical Representative/Remediation Project Manager of a Field Charge Request (FCR) to the Final Work Plan. Three FCRs specific to the Final Work Plan were prepared and accepted. FCR-001 addressed an addendum to Section 14.2.1 of the Quality Assurance Project Plan/Sampling and Analysis Plan of the Final Work Plan providing greater detail of the sludge sampling and confined space entry procedures. FCR-002 addressed revising project cleanup criteria for equipment and building materials. FCR-003 addressed revising controlled area boundary dose rates to reflect the requirements of state regulations. The three FCRs are included in Appendix A, “Field Change Requests.”

3.0 Background Determination

Radiological surveys, sludge sampling, and soil sampling were conducted to provide background data. Three general types of background were necessary for this project:

- Surfaces of appropriate structural materials
- Sludge from the sanitary sewer system and storm drain system
- Surface soils

For the radiological surveys, reference areas were selected for each radiological measurement method and matrix type, based on features such as construction material and date of construction. The reference area is a geographical area from which representative reference measurements are performed for comparison with measurements performed in specific MARSSIM impacted areas. A MARSSIM impacted area is defined as an area with a reasonable possibility of containing residual radioactivity in excess of natural background. The reference areas were selected consistent with MARSSIM guidance (DoD et al, 2000). Background levels were determined for the following:

- Wooden floors (tongue and groove [T&G] flooring similar to that used in the instrument shops during radium operations)
- Wooden subflooring (1 inch by 6 inches used under the T&G floor)
- Plasterboard (drywall) walls
- Concrete floors
- Hangar concrete floor surface
- Roof vents
- Manhole and catch basin surfaces (Section 3.3)
- Sanitary Sewer and Storm Drain sludge (Section 3.3)
- Site soil (Section 3.4)

3.1 Background Plan

Prior to collecting background data, a Background Plan addressing sanitary sewer and storm drain sludge, and structural surfaces (Attachment 1, “Background Plan”) was prepared to identify the type, location, quantity, and sampling methodology for the various background samples. At that time, Pump House surfaces, Building 2 surfaces, and soils had not yet been investigated and were not addressed. The Background Plan was reviewed by the Navy and approved on June 22, 2010. Prior to background data collection, two manholes were discovered to be incorrectly identified in the plan. Therefore, the Background Plan was corrected and updated on August 25, 2010.

3.2 Structural Surface Reference Measurements

Background radiological surveys were conducted for the structural reference areas specified in Table 1, "Structural Reference Surveys."

A minimum of 18 measurements were collected at systematically selected locations. Measurements were taken with the following instrumentation:

- Ludlum Model 43-68 gas flow proportional detector coupled with a Ludlum Model 2360 dual channel scaler/ratemeter
- Ludlum Model 239-37 floor monitor with a large area gas flow proportional detector coupled with a Ludlum Model 2360 dual channel scaler/ratemeter
- Ludlum Model 44-10 Sodium Iodide (NaI) gamma detector coupled with a Ludlum Model 2221 single channel scaler/ratemeter
- Ludlum Model 3030 dual channel low background sample counter

The structural surface reference measurement results are shown in Table 2, "Structural Surface Reference Measurement Results."

3.3 Storm Drain and Sanitary Sewer Background Reference Measurements

Background reference surface measurements and sludge samples were collected within the storm drains and sanitary sewer lines. Samples and measurements were collected June 29, 2010, in accordance with the Background Plan (Attachment 1) from storm drain locations (manholes MH-140, MH-125, MH-126, and MH-1013) and sanitary sewer system locations (City of Seattle E6, manhole MH-215, manhole MH-212, and an un-numbered manhole 37 feet south of manhole MH-140) (Figure 7).

Smear samples were collected and surface contamination monitoring was performed on vault surfaces and interior pipe surfaces (if feasible). Surface contamination monitoring was performed using a Ludlum Model 2360 scaler/ratemeter coupled with a model 43-93 dual phosphor scintillation detector with an 88 square centimeters (cm^2) active surface area. Smear samples were counted on site with the Ludlum Model 3030 sample counter for gross alpha and gross beta contamination. Radiological survey measurements are documented in Radiological Site Survey (RSS)-169 and the results are shown in Table 3, "Reference Background Results for Sanitary Sewer and Storm Drain Surface Measurements."

Sludge samples were collected and sent to TestAmerica, St. Louis, Missouri, for radiochemical analysis for Ra-226 by gamma spectroscopy using EML Method GA-01-R, modified

(HASL-300) (U.S. Department of Homeland Security, 1997). Results are shown in Table 4, “Reference Background Results for Sanitary Sewer and Storm Drain Sludge.”

3.4 Soil Background Reference Measurements

A soil reference area was selected east of Building 27 (Attachment 2, “Soil Characterization Sampling Plan”). A gamma walkover survey (GWS) of the reference area was conducted (RSS-308) (Appendix B, “All Radiological Site Surveys (001 through 556)”). Data variations for this soil reference area were within the expected distribution (Figure 8, “Distribution of Soil Reference Area Gamma Walkover Survey Count Rates”). The soil appeared to be similar in composition, location, slope grade, and vegetation to the contaminated soils directly south of Building 27. A total of 6,612 data points were collected during the GWS, with a mean of 5,063 counts per minute (cpm) and a standard deviation of 526 cpm. The distribution of the data is presented in Figure 9, “Distribution of Soil Reference Area Static Count Rates.”

Ten randomly generated locations were staked in the soil reference area in a triangular grid pattern. One minute static counts were taken at a height of 15 centimeters at each location with the NaI 2 inch by 2 inch detector. The statistical mean and standard deviation was determined (Table 2). The mean and mean plus three standard deviations were determined to be 4,616 and 5,111 cpm, respectively. The data distribution for these 10 locations was determined to be 4,615.5 plus or minus 164.97 (statistical mean plus or minus one standard deviation). This minimal distribution suggests a log-normal distribution although nothing definitive can be concluded from this.

Four background soil boring locations (Figure 10, “Reference Area Boring Locations”) were drilled, using a hand auger, within the soil reference location area (Attachment 2). Selected depth intervals were collected for laboratory analysis of Ra-226 and strontium-90 (Sr-90), which was identified as a radionuclide of concern. Samples were sent to TestAmerica, St. Louis, Missouri, for radiochemical analysis. Sludge and soil samples were analyzed for Ra-226 by gamma spectroscopy using EML method GA-01-R, modified (HASL-300) (U.S. Department of Homeland Security, 1997), and for Sr-90 by gas flow proportional counter (EPA 905 Modified).

The Background Soil Concentration Determination paper (Attachment 3, “Background Soil Concentration Determination”) was written to summarize the soil reference area data and establish a mean soil background concentration for Ra-226 and Sr-90. The soil reference area data, the Ra-226 and Sr-90 mean soil concentrations are 0.467 picoCuries per gram (pCi/g) and 0.055 pCi/g, respectively (Table 5, “Analytical Results of Reference Area Samples”).

3.5 Background Data Analysis

Sludge and surface soil background reference measurements were statistically evaluated. Facility surface background reference measurements were evaluated using descriptive statistics.

3.5.1 Statistical Analysis

Multiple sludge background reference measurements were collected from four nonimpacted upgradient manholes in the storm drain system and four nonimpacted upgradient manholes in the sanitary sewer system. Statistical analysis was conducted on these results (Attachment 4, “Background Sludge Concentration Determination”). It was determined that there was no significant statistical difference between the storm drain sample results and the sanitary sewer system sample results. However, the analysis did find a statistical difference between manholes (locations). Therefore additional modeling of the random effects was conducted in accordance with MARSSIM guidance (DoD et al, 2000). The resulting sludge background decision value of 1.61 pCi/g for Ra-226 was derived. This decision criterion is consistent with the “statistical mean plus three standard deviations” criterion specified in the project Scope of Work (Navy, 2009), but has been superseded by the dose-based criterion derivation discussed in Section 3.5.2.

Background reference measurements for the collected facility surface samples are summarized in Table 2.

Soil background reference measurements were taken from four nonimpacted soil boring locations and analyzed for both Ra-226 and Sr-90. Statistical analysis was conducted on these results (Appendix B). The results indicate there is no significant statistical difference between the borehole locations. Therefore, there was no need for statistical modeling of the random effects for the data. The resulting (statistical mean plus three standard deviations) soil background values of 0.855 pCi/g for Ra-226 and 0.398 pCi/g for Sr-90 were determined (Table 5). These decision criteria are consistent with the “statistical mean plus three standard deviations” criterion specified in the project Scope of Work (Navy, 2009), but have been superseded by the dose-based criterion discussed in Section 3.5.2.

3.5.2 Dose-Based Criteria

MARSSIM guidance (DoD et al, 2000) specifies that Derived Contamination Guideline Levels are derived from activity/dose relationships through various exposure pathways or risk criteria. Following this guidance, a Dose-Based Sludge Concentration Derivation (Attachment 5, “Dose-Based Sludge Concentration Derivation”) was developed using RESRAD 6.5 (U.S. Department of Energy, 2001). This exposure pathway scenario analysis assumed contamination of sludge located in the storm drain system or sanitary sewer system and potential leakage into the surrounding soil. A resident farmer scenario was assumed as the most conservative potential receptor. The analysis identified a sludge concentration of 3.4 pCi/g for Ra-226 that would result in a 15 millirem per year exposure to the resident farmer. The mean background sludge concentration plus this value could be used for comparing downgradient (nonimpacted) sludge samples.

Additionally, Attachment 6, “Dose-Based Soil Concentration Derivation,” was developed for soil in a similar manner as was done for the sludge. The analysis resulted in a soil concentration of 0.93 pCi/g for Ra-226 and 3.7 pCi/g for Sr-90 that would each result in a 15 millirem per year exposure to the resident farmer. The mean soil background plus this concentration may be used as project cleanup criteria.

3.6 Project Cleanup Criteria

Based on the reference means and the dose-based guidelines discussed above, the project cleanup criteria for sludge (3.85 pCi/g for Ra-226) and soil (1.4 pCi/g for Ra-226 and 3.76 pCi/g for Sr-90) are shown in Table 6, “Project Cleanup Criteria Concentrations.”

Project cleanup criteria for equipment and building surfaces are presented in Table 7, “Project Cleanup Criteria for Equipment and Building Surfaces.”

4.0 Survey Activities and Status Determination

This section is presented essentially in the chronological order in which the site was investigated. The exception is that characterization surveys that provide the quantitative understanding of the areas surveyed were collected into one section.

4.1 Radiological Licensing

Shaw E&I performed radiological work at NAVSTA PS as authorized by our radioactive material licenses and in accordance with applicable regulations. Initially, work was performed under this reciprocal recognition of Shaw E&I's U.S. Nuclear Regulatory Commission license number 20-31340-01. Work under State of Washington reciprocal recognition is allowed for a maximum of 180 days in the authorized 12-month period. When it became clear that the work would not be completed within the 180-day-limit, Shaw E&I submitted a radioactive material license application to the State of Washington on September 29, 2010. State of Washington Radioactive Materials License number WN-L0237-1 was issued to Shaw E&I on December 2, 2010. The remainder of the site work was conducted under this license.

4.2 Field Operations

Field operations were initiated on April 20, 2010, with radiation worker training and survey instrument setup. Prior to the start of activities, access control was established to identify and control access to contaminated areas, prevent unauthorized access (to the extent practicable), and protect the public from exposure as a result of work activities. Specifically, Radiologically Controlled Areas (RCA) and Access Control Points were established and posted within the project controlled area. Access control was established based on known radiological conditions and planned work activities. Appropriate personnel protective equipment (PPE) and respiratory protection, medical monitoring, and air monitoring were implemented. Radiological Control Technician (RCT) coverage was provided, as appropriate, during the work activities.

Radiological support surveys were performed throughout the project in accordance with the Radiation Protection Plan (RPP) (Appendix C of the Final Work Plan [Shaw E&I, 2010a]). Support surveys are those surveys that are not intended to characterize the radiological condition of the facility, but to monitor the radiological activities to assure the contamination is adequately controlled and radiological exposure to the workers and the public are kept As Low As Reasonably Achievable (ALARA). Support surveys included job coverage, routine contamination control in the field trailer and at the RCA exits, monthly surveys in Radioactive Material Storage Areas (RMSA), shipping of sample coolers, and incoming and release surveys for equipment used on site. Not all of these surveys are described in detail in this report, but are included in Appendix B. It should be noted that the results of these support surveys indicate that all field activities were performed in such a manner that neither surface contamination nor airborne activity were released outside the radiologically controlled area. The originals of these surveys are maintained in the project files.

Characterization of floors was conducted using a floor monitor. The type used was a Ludlum Model 2360 scaler/ratemeter coupled with a model 43-37 gas-flow proportional detector with a 584 cm^2 active surface area. The system was cart-mounted placing the detector at a constant height of ¼-inch above the floor surface. Walls and other surfaces were surveyed with a smaller hand-held Ludlum 2360/43-68 gas-flow proportional 126 cm^2 detector. Other instruments included a Model 2121 scaler/ratemeter coupled with a Model 44-10 2 inch by 2 inch NaI detector and Model 19 microRoentgen meters for scanning soil, sludge, and piping. An Exploranium GR-130 portable gamma spectrometer was also used to identify isotopes in the field. A Model 2121 scaler/ratemeter coupled with a Model 44-2 1 inch by 1 inch NaI detector was used for down-hole gamma logging of soil borings. Smears and air samples were counted on a Ludlum Model 2929 scaler with a Ludlum 43-10-1 detector or a Ludlum Model 3030 with an internal detector. All instruments used were calibrated annually in accordance with the manufactures procedures and response checked at the beginning and end of each day they were used in accordance with the approved RPP (Shaw E&I, 2010a).

Four general categories of radiological survey were performed as follows:

- Scoping survey—a type of survey that is conducted to identify the following:
    - Radionuclide contaminants
    - Relative radionuclide ratios
    - General levels and extent of contamination.

- Characterization survey—a type of survey that includes facility or site sampling, monitoring, and analysis activities to determine the nature and extent of contamination, providing the basis for acquiring necessary technical information to select appropriate cleanup techniques.
- Remediation control survey—a type of survey that includes monitoring the progress of remedial action to determine whether or not efforts are effective and to guide further decontamination activities (performed to a minimal extent during this characterization activity).
- Radiological support surveys—surveys that are not intended to characterize the radiological condition of the facility, but to monitor the radiological activities to assure the contamination is adequately controlled and radiological exposure to the workers and the public are kept ALARA.

4.2.1 Building 27

Scoping surveys were performed at biased locations selected by the RCT in the field to identify the most likely location to find contamination. Scoping surveys included dose rates and both total and removable contamination surveys. Hand-held alpha/beta (scintillation or gas-flow proportional) instruments were used and smears were collected for counting on the alpha/beta sample counter.

Initial radiological scoping surveys were performed throughout the proposed survey area of the second floor of Building 27 (Figure 11, "Summary of Radiological Survey Results - Bldg. 27 (First & Second Floor)). These initial scoping surveys (RSS-001 through RSS-006) (Appendix B) were performed on the existing remodeled (asbestos) tile floors prior to asbestos abatement activities and do not represent the original floor surfaces present during instrument shop operations. The survey results indicated that no elevated levels or contamination in excess of project cleanup criteria were observed.

A scoping survey (RSS-007) (Appendix B) was also conducted on the accessible Radium Room sink plumbing. Elevated gamma levels were observed near the pipes and contamination was detected in the drain pipe opening. This location had been previously identified as contaminated and was labeled with radiation symbol caution tape. Following the radiological scoping survey, the wall opening was covered with plastic and tape.

4.2.1.1 Sink Drainpipe Removal

The Radium Room, located on the second floor of Building 27 (Figure 11), contained a sink, which had been previously removed. The existing sink drainpipe extended below the floor into the ceiling space of the Welding Shop, located below (Figure 11). A radiological scoping survey (RSS-008) (Appendix B) of the drainpipe was conducted on April 26, 2010, which indicated elevated gamma readings. It had been previously determined that the sink drainpipe must be removed and containerized to allow accurate radiological surveys both above and below the drainpipe area. In preparation for removing the drainpipe, radiological surveys (RSS-008 and RSS-009) were performed on the drainpipe. These results indicated elevated gamma levels outside the drainpipe and no removable contamination.

On April 26, 2010, the drainpipe was removed, sectioned, and placed in 55-gallon drums for disposal. The drainpipe sections were surveyed for radionuclide content estimating purposes and documented in RSS-013 and RSS-014 (Appendix B). The drainpipe sections were estimated to contain 0.122 millicuries of Ra-226. Scale sampling of the drainpipe contents and radiochemical analysis for Sr-90 resulted in an estimated 8.74 x 10^{-8} millicuries of Sr-90, as reported on the Navy waste disposal subcontractor's waste manifest. Sr-90 was not initially identified as a radionuclide of concern. However, after this radionuclide was detected in the drainpipe scale, Sr-90 was considered for evaluation during subsequent survey and sampling. Sr-90 analysis was performed on soil samples and building pipe scale samples.

Radiological control precautions (controlled area, access control, radiological control technician coverage, PPE, respiratory protection, and air sampling) were employed during this work. Post-removal surveys were performed (RSS-015, RSS-020, and RSS-029) (Appendix B) documenting the radiological conditions of the Welding Shop floor. No elevated contamination levels were identified during post-removal surveys.

Investigation of the Radium Room sink pipes indicated that there was a second sink located immediately to the west in the Carbon Tissue Room with connecting piping in the wall. Vent pipes were also identified, one that ran through the roof of the Carbon Tissue Room and exited on the roof, and one that ran through the wall, but the inside of the hanger, and exited onto the roof. All of this piping was removed using appropriate radiological control precautions. The piping was cut and placed in drums for waste disposal.

4.2.1.2 Asbestos Abatement

In order to survey the original flooring surfaces, the newer vinyl floor tile and associated mastic (contained ACM) needed to be removed to expose the floor surface that was present during the instrument shop operations. The existing exposed floor surface consisted of 9 inch by 9 inch tiles.

A Washington State-certified asbestos abatement firm (ECO Environmental) was used to remove and dispose of the ACM. Prior to initiating the asbestos abatement activities, it was necessary to relocate all the furniture (desks and chairs) in the west end of the second floor of Building 27 to the east end of that building. In addition, it was necessary to demolish a wooden maze that existed in the “Current Fire Fighter Training Area” (Figure 3) at the west end of the second floor of Building 27.

Site procedures for flooring removal were followed. The ACM was bagged and staged for disposal. The exterior of the bagged ACM was surveyed for removable contamination (RSS-016, RSS-019, RSS-021, RSS-023, and RSS-024) (Appendix B) and gamma dose rate prior to removal from the building. This process provided for detection of loose contamination that indicated contamination of the ACM. No contamination or elevated dose rates were detected.

Following asbestos abatement, it was determined that the Former Glass Shop (located at the east end of the second floor of the South Shed) was potentially contaminated as demonstrated by the contamination levels found in the Quarter Deck area (Figure 11) and associated hallways area. Contamination was found on the T&G floor surface that was exposed (or covered with sheet linoleum that has been removed) during radium work in the building. This indicates that contamination on the T&G floor surface may extend further to the east on the second floor. Discussions with the Navy determined that it was necessary to perform asbestos abatement of the remainder of the floor in the east end of the South Shed. Prior to initiating the abatement activities, it was necessary to remove and dispose of all the furniture (desks and chairs) that had been relocated to the Former Glass Shop. A radiological survey (RSS-065) (Appendix B) of this material was conducted and the results indicated no contamination or elevated dose rates. Therefore, the desks and chairs were loaded by ECO Environmental and transported to a local landfill. Asbestos abatement was performed on the east end of the second floor of the Building 27 South Shed. Non-ACM and ACM waste was bagged and surveyed (RSS-121, RSS-123, and RSS-149) prior to release for disposal. No contamination or elevated dose rates were detected.

4.2.1.3 Post-Asbestos Abatement Scoping

Following asbestos abatement in the Former Glass Shop, radiological scoping surveys of the floor (RSS-130, RSS-133, and RSS-148) were performed (Appendix B). The results indicated numerous locations of contamination were present in excess of the project cleanup criteria.

4.2.1.4 Additional Scoping Surveys

Additional scoping surveys were performed throughout Building 27 to provide an understanding of contamination conditions. Each location where scoping surveys were performed is discussed in the following sections and the data is summarized in Table 8, “Scoping Survey Results from Building 27.”

Heating, Ventilating, and Air Conditioning Penthouse – Roof

A small structure is located on the roof of the Building 27 South Shed that contains HVAC equipment. This equipment was abandoned (not operational) but did appear to provide air flow into and out of the Radium Room. This structure was investigated and a radiological scoping survey (RSS-025) (Appendix B) was performed for removable contamination and gamma dose rate. No detectable contamination or elevated dose rates were identified within the HVAC penthouse structure. On June 4, 2010, the interior of the air handling unit was accessed while wearing proper PPE and surveyed (RSS-099). The results indicated one location above the project cleanup criteria.

Former Instrument Shop Floor

When scoping surveys demonstrated that the Former Instrument Shop was contaminated to a much greater extent than was initially anticipated in the Final Work Plan (Shaw E&I, 2010a), discussions were held with the Navy on the necessity of continuing scoping surveys throughout the eastern portion of Building 27. It was determined that scoping surveys of the remainder of that area were appropriate to determine the extent of radiological contamination. Radiological surveys RSS-062 and RSS-066 document the floor scoping survey performed with the floor monitor (Appendix B). The floor monitor was moved over the floor while listening for elevated count rates. When an elevated count rate was detected (“hotspot”), the instrument was held in that area to identify the location and to obtain a static count. The average count rate, over the 1 square meter (m^2) area including the “hotspot,” was documented as well as a static count over the elevated location. Twenty “hotspot” locations were identified in this manner.

Quarter Deck Hotspots

The Quarter Deck area immediately to the east of the Former Instrument Shop (Figure 11) and hallways to the east and north of the Quarter Deck area were initially selected as reference areas for the floor, wall, and ceiling surfaces. These areas represent the project’s initial entry into the Former Glass Shop area to the east of the Former Instrument Shop. The non-asbestos tiles were removed from this area on May 11, 2010, and the next day a radiological scoping survey (RSS-031) was performed on the floor surface that was exposed during radium operations in the South Shed (Appendix B).

The exposed Quarter Deck floor was surveyed (RSS-036) with the floor monitor to identify elevated radiological locations (Appendix B). The elevated radiological locations were characterized with a hand-held gas flow proportional counter and smeared for removable contamination. A total of nine locations were identified in excess of project cleanup criteria.

When the Quarter Deck area of the Former Glass Shop was identified as contaminated, a removable contamination scoping survey (RSS-034) was performed throughout the Former Glass Shop area (Appendix B). No removable contamination above project cleanup criteria was identified.

Welding Shop

A scoping survey (RSS-073) of the Welding Shop concrete floor (first floor) was performed after completion of the drain line removal (Appendix B). Two hotspots were identified. One hotspot was identified directly below a floor penetration (at this ceiling location the floor joists are exposed and the underside of the second floor is visible) suggesting dripping may have occurred in the past, the other is located near where the drain line enters the floor. The potential drip location indicated removable contamination. Decontamination of the removable contamination was conducted at that time using duct tape and the location was then resurveyed as indicated on that scoping survey. Both hotspot locations were marked. More aggressive decontamination was performed the following day using Rad Wash and the location resurveyed (RSS-079). The removable contamination was brought below project cleanup criteria.

The remaining floor surface was covered with stored materials and unavailable for survey. A scoping survey was performed on the remaining floor area where access was possible (RSS-528) (Appendix B). No contamination in excess of project cleanup criteria was identified. This survey also identified two contaminated wall locations in close proximity to the contaminated floor penetration (Radium Room sink drain).

A biased survey of the penetrations in the first floor ceiling (which is also the underside of the second floor surface) was performed (RSS-090) (Appendix B). One location in excess of project cleanup criteria was identified. This location corresponds with a floor penetration hotspot identified on the second floor (RSS-041). No other contamination in excess of the project cleanup criteria was detected. The exhaust fan mounted on the south wall was surveyed (RSS-415). No contamination in excess of the project cleanup criteria was detected.

Southwest Tower

Initially only the second floor of the Southwest Tower was identified as an impacted area in the Final Work Plan (Shaw E&I, 2010a). Monitoring on the second floor identified elevated readings. A scoping survey was performed (RSS-107) indicating two locations that exceeded the project cleanup criteria and two locations with elevated gamma dose rates (Appendix B). A scoping survey of the stairway from the first to second floors (RSS-120) identified locations of fixed alpha contamination in excess of the project cleanup criteria. Additional removable contamination locations on the Southwest Tower stairs in excess of the project cleanup criteria were identified by survey RSS-128. A total of nine locations were identified on the second floor and stairs that exceeded the project cleanup criteria. No contamination in excess of project cleanup criteria was detected on other floors of the Southwest Tower.

In preparation for reinstalling the exterior siding by the general contractor, the outer surfaces of the horizontal beams of both the Southwest and Southeast Towers were surveyed (RSS-200) (Appendix B). This survey showed no contamination exceeding the project cleanup criteria was trapped when the siding was installed.

Southeast Tower

The Southeast Tower had asbestos flooring tiles on the second floor. A scoping survey (RSS-116) was performed prior to abatement (Appendix B). This survey identified two stairway locations with total alpha contamination in excess of the project cleanup criteria. No abatement occurred on the stairs because no ACM was present on the stairway surfaces. Access control has been maintained throughout the South Shed to prevent uncontrolled contact with these locations. Further scoping surveys of the Southeast Tower (RSS-132 and RSS-134) indicated additional locations of fixed contamination in excess of the project cleanup criteria. A scoping survey was performed in the first floor bathroom and electrical room areas (RSS-299). This survey identified three locations in the bathroom areas that exceed the total beta project cleanup criteria. Total alpha contamination was detected at several locations on the stairs (RSS-302) going from the first floor to the second floor. A total of 17 locations on the floors and stairs that exceed the project cleanup criteria were identified.

Six random ceiling locations on the first, third, and fourth floors of the tower were surveyed (RSS-175) (Appendix B). No elevated readings were identified.

East Shops

Radiological scoping surveys (RSS-181 and RSS-184) were performed on the floors in the shops located on the first floor, east end, of the Building 27 South Shed (Appendix B). These surveys identified no contamination readings in excess of the project cleanup criteria.

4.2.1.5 Characterization Surveys

Floors, walls, ceilings, and ventilation exhaust were surveyed for both alpha and beta/gamma surface contamination. Characterization surveys included preparing a systematic alpha-numeric reference grid (1 m^2 grid) over which a total scan was conducted on each cell location. A static count and a removable smear were taken at the maximum location identified during the total scan. The floor monitor was used for floor surfaces and a hand-held gas-flow proportional counter was used for wall and ceiling surfaces. Characterization surveys provided quantitative data on a predetermined portion of the surface (i.e., 100 percent, 50 percent, or 10 percent).

First Floor

A characterization survey (RSS-084) was conducted over the northern 3 meters of the Welding Shop floor (Appendix B). The survey results indicate seven survey measurements (out of 75) exceed the project cleanup criteria. The remaining floor was covered with stored materials and unavailable for survey. RSS-085 documents characterization of the accessible walls. Two locations were contaminated in excess of the project cleanup criteria. Both locations are adjacent to contaminated floor locations. Ten random locations on the Welding Shop ceiling were surveyed (RSS-089). No contamination in excess of the project cleanup criteria was identified at the 10 random survey locations. These results of the first floor characterization surveys are summarized in Table 9, “Characterization Survey Results from Building 27 – First Floor.”

Second Floor

The Safety Chief and Current Fire Fighter Training Area floor areas were characterized using the floor monitor (RSS-041) (Appendix B). Survey results indicate numerous locations in excess of the project cleanup criteria, some associated with floor penetrations, including pipe penetrations in which the pipes have been removed and the floor plugged and others where the pipe was cut off and left in place. Floor penetrations also include locations where existing or removed wall footings penetrate the flooring. Some elevated locations were associated with what appeared to be sheet linoleum backing paper that is still adhered to the floor. A radiological study survey was conducted before and after scraping this material from 10 contaminated locations (RSS-045). An average decontamination factor of 7.1 plus or minus 6.7 (mean plus or minus one standard deviation range 1.6 – 21) was achieved and in all but one location. The contamination was reduced to below the project cleanup criteria, indicating the contamination adhered to the backing paper. The S-1 Work Space floor (other than the Radium Room) was characterized (RSS-059) and fourteen cells (out of 51) exceeded the project cleanup criteria. The Radium Room floor was characterized and is discussed in Section 4.2.1.6. The walls were characterized (RSS-092), identifying two wall locations that exceeded the project cleanup criteria. One was the previous location of the Radium Room sink piping.

The Quarter Deck area and hallways floor were characterized using the floor monitor (RSS-040) (Appendix B). This survey detected 26, one meter grid squares in excess of the project cleanup criteria. The Quarter Deck area and hallways walls were characterized up to 2 meters above the floor (RSS-042). These surveys found no contamination in excess of the project cleanup criteria.

The remainder of the east end of the second floor was characterized (RSS-148) (Appendix B). Significant contamination in excess of the project cleanup criteria was detected.

Biased selection of wall locations (field determined) in the remainder of the Instrument Shop were characterized (RSS-156) (Appendix B). Walls around three floor vents were identified with fixed alpha in excess of project cleanup criteria. Biased selection of wall locations (field determined) in the Former Glass Shop were characterized (RSS-155). Two small seam radiators were identified with contamination in excess of the project cleanup criteria.

Eighteen second floor ceiling locations (grid squares) were identified for survey RSS-082 (Appendix B). Each 1 m^2 location was scanned using a hand-held gas-flow proportional detector and a 1 minute static count was performed at the location identified with the most elevated reading. No contamination in excess of the project cleanup criteria was detected.

The Radium Room ceiling was characterized (RSS-167) (Appendix B). No elevated contamination levels were identified. Eighteen randomly selected ceiling locations in the Former Glass Shop were characterized (RSS-173). Contamination in excess of the project cleanup criteria was not detected. The results are summarized in Table 10, “Characterization Survey Results from Building 27 – Second Floor.”

Roof

Roof sampling was performed at 11 biased sampling locations (RSS-033) (Appendix B). These locations were selected near potential exhaust points. The roof has been replaced since radium activities, so the roofing was removed down to the roof deck surface. The roofing does contain asbestos, so the removal was performed by a licensed asbestos subcontractor. Each location was a minimum of 12 inches by 12 inches. Both the decking and roofing materials were surveyed at each location. Gamma dose count rate surveys were also performed. No elevated readings were identified. Following surveying, each location was patched using sheet metal and roofing repair material.

Roof vents were identified as a potential exhaust point. These vents were surveyed to the extent possible from the outside. Access to the interior surfaces was not possible. RSS-075 documents this survey (Appendix B). No contamination was detected above the project cleanup criteria.

Hangar

The concrete hangar floor immediately adjacent to the Radium Room sink drain pipe and the wall immediately adjacent to this floor were identified as impacted locations in the Final Work Plan (Shaw E&I, 2010a). A characterization survey was performed of the floor (RSS-287) and the wall up to 2 meters (RSS-112) (Appendix B). No elevated readings were identified. The identification of additional contamination in the Building 27 South Shed extended the survey area of the hangar floor. The hangar floor survey was extended the entire width of the hangar from the west wall to the east wall of the hangar and 4 meters out from the shared wall. The hanger floor to the east of the Welding Shop was surveyed on a 50 percent basis, surveying alternate squares where possible (RSS-280, RSS-282, RSS-291, and RSS-292). A scoping survey was performed on wall penetrations from the hangar side of the wall (RSS-296). No contamination in excess of the project cleanup criteria was detected. The hangar wall was surveyed at 18 randomly selected locations (RSS-301 and RSS-303). Contamination in excess of the project cleanup criteria was not detected. The results are summarized in Table 11, "Characterization Survey Results from Building 27 – Hangar."

Southwest Tower

Characterization of the second floor of the Southwest Tower (RSS-119) indicated floor locations with fixed contamination in excess of the project cleanup criteria (Appendix B). No removable contamination in excess of the project cleanup criteria was identified.

Characterization survey (RSS-127) of the walls of the second floor of the Southwest Tower indicated three locations in excess of the alpha limits for project cleanup criteria (Appendix B). These locations coincided with the location of an abandoned steam radiator was identified by survey instruments as contaminated.

Six ceiling locations were characterized (RSS-177) but did not indicate any contamination in excess of project cleanup criteria (Appendix B).

The results for the surveys conducted on the floor, wall, and ceiling are summarized in Table 12, "Characterization Survey Results from Building 27 – Southwest Tower."

4.2.1.6 Focused Investigations – Building 27

A number of focused investigations were also performed at Building 27 as discussed in the following sections.

Drainpipe – Southwest Tower

During smoke testing (discussed in Section 4.2.3.3) an abandoned drainpipe penetration in the floor at the northwest corner of the first floor of the Southwest Tower was determined to be connected to the same under-slab pipe to which the Radium Room sink drain was attached. The penetration and surrounding concrete were surveyed (RSS-022) and indicated beta/gamma levels below the project cleanup criteria (Appendix B). It was expected that general contractor personnel that were not radiologically trained would be working in this area. To achieve ALARA, the Project Radiation Safety Officer elected to post this location as radiologically controlled. Hand chiseling of the concrete surface was performed to remove the contaminated concrete. Later, radiological coverage was provided when the concrete slab was cut and the soil around the pipe was removed for electrical conduit installation.

Radium Room Floor and Joist Space

Characterization survey (RSS-046) indicated the majority of the Radium Room floor surface was contaminated in excess of the project cleanup criteria (Appendix B). The flooring was removed exposing black roofing paper between the flooring and subflooring (Figure 12, “Cross-Section of Radium Room Flooring”). The black roofing paper was surveyed (RSS-048) and the results indicated no locations on the black paper surface exceeded the project cleanup criteria. Locations at the edge of the black paper did exceed project cleanup criteria. These edge locations corresponded with floor penetrations at the edge of a wall that had been previously removed (Figure 13, “Previously Removed Wall Penetrating Flooring”). The black roofing paper was removed to expose the subfloor underneath. This subfloor was surveyed (RSS-049) and indicated contamination in excess of the project cleanup criteria at locations corresponding to similar floor penetrations. The floor is constructed of 2 inch by 8 inch joists with subflooring nailed to the top and in some places the ceiling from the floor below nailed to the bottom. To determine the potential for contamination in the floor joist space under the subflooring, some of the subflooring was removed allowing access to that space (Figure 14, “Radium Room Floor – Joist Space”). RSS-050 documents the contamination detected within that space. One location within that space exceeded the project cleanup limit criteria. These results demonstrate the potential for contamination entering floor penetrations to contaminate the floor joist space.

Safety Chief Floor and Floor Joist Space

To further explore the potential for under-floor contamination, a location in the Safety Chief area was investigated. This area included two floor penetrations that were created by original walls. The black roofing paper was surveyed (RSS-053) after removal of the flooring. Three locations indicated contamination in excess of the project cleanup criteria (Appendix B). The radiological survey (RSS-056) of the subfloor performed after removal of the black roofing paper. Three contaminated locations identified in the previous survey were again found to be in excess of the project cleanup criteria, as well as one additional location. Two portions of the subfloor

(Figure 15, “Survey of Floor Joist Space (Insulation) – Safety Chief Office”) were removed and the interior of the joist space was surveyed. Both insulation and a cross brace member within that space were contaminated in excess of the project cleanup criteria (RSS-057). This verifies the potential for contamination of the spaces under the subfloor.

Floor Vents

Abandoned floor exhaust vents are located along the north and south perimeter walls of the Former Instrument Shop. These vents were surveyed (RSS-054 and RSS-061) by surveying the screen grates and surveying within the exhaust duct (Appendix B). Each of these floor vents was contaminated in excess of the project cleanup criteria. To investigate the extent of the exhaust duct contamination, the floor was cut at three locations, exposing the exhaust ducts (Figure 16, “West Floor Vent Exhaust” and Drawing 54124 [1952]). In all cases, it was determined that the ducts had been cut approximately 3 feet from the floor vent and the remainder of the exhaust ducting had been removed. The floor vent and attached exhaust duct were removed. RSS-069 documents the survey of the exposed joist space. Two of the three joist space locations indicated contamination in excess of the project cleanup criteria.

A single run of the exhaust duct from this abandoned system was attached to the ceiling in the first floor Tech and Library Parts area. A survey (RSS-196) was performed on the exhaust duct, including the accessible interior (Appendix B). Contamination in excess of the project cleanup criteria was detected.

Wall and Ceiling Vents

Several wall and ceiling vents throughout the Former Instrument Shop were surveyed (RSS-061, RSS-064, and RSS-071) (Appendix B). One ceiling vent over the Radium Room was identified in excess of project cleanup criteria. All vent penetrations into the Building 27 hangar area were covered with wood. A ceiling vent on the east end of the second floor indicated fixed alpha contamination in excess of the project cleanup criteria (RSS-181). This ceiling vent leads into the attic space above the Former Glass Shop. Entry into this attic space was unsafe; therefore, no additional surveys were performed. Five attic vents are installed in the wall separating the Building 27 hangar and the South Shed, which provided a potential path for attic contamination into the hangar. These vents were surveyed from the hanger side (RSS-195) and did not show any indication of contamination above cleanup criteria.

Abandoned Exhaust Duct

A 24 inch by 24 inch air duct from the ceiling of the Radium Room up into the HVAC penthouse on the roof of the South Shed was surveyed (RSS-025 and RSS-054) (Appendix B). This duct is from an abandoned exhaust system. A fan and exhaust stack appears to have been removed from the top of this duct and the roof of the HVAC penthouse has been repaired to close the stack opening. No contamination in excess of the project cleanup criteria was detected within the duct.

Radium Room Sink Wall Interior

A survey (RSS-097) was conducted on the wall interior at the location of the Radium Room sink (Appendix B). Results indicated contamination in excess of the project cleanup criteria near the pipe locations.

Janitor’s Sink – Former Glass Shop

The drain pipes remaining from an apparent janitor’s sink along the east wall of the women’s restroom was investigated (RSS-176) (Appendix B). Survey of the pipes, walls, and wall interiors found no contamination in excess of the project cleanup criteria. A smoke test was later performed on that line (Section 4.2.3.3) indicating that it connected to the sanitary sewer system.

Building 27 Hangar Loft

A loft over the southeast corner of the Building 27 hangar was accessible from the fourth floor of the Southeast Tower. Due to the fact that portions of that tower are contaminated, a scoping survey (RSS-295) was performed on the loft (Appendix B). No contamination in excess of the project cleanup criteria was detected.

The results for the focused investigations are summarized in Table 13, “Summary of Results for Focused Investigations – Building 27.”

4.2.2 Building 2

Scoping and characterization surveys were performed at Building 2 as discussed in the following sections.

4.2.2.1 Scoping Surveys

Radiological scoping surveys were conducted throughout the Former Instrument Shops in Building 2 (Figure 17, “Radiological Surveys of Bldg. 2 (Second Floor)”) in order to assess current radiological conditions. Scoping surveys included dose rates and both total and removable contamination surveys. Locations selected for investigation were biased according to historical data and professional experience.

The data collected during scoping surveys were used to evaluate the adequacy of the radiological characterization surveys proposed in the Final Work Plan. The scope of the Final Work Plan (Shaw E&I, 2010a) originally designated the floors of both Instrument Shops as MARSSIM Class 2 (DoD et al, 2000) (have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the project cleanup criteria) and the walls as Class 3 (not expected to contain residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the project cleanup criteria, based on site operating history). After reviewing scoping data (RSS-203) (Appendix B) and finding contamination on the floors in the 1941 Former Instrument Shop (FIS), the characterization survey effort was upgraded to Class 1 (have, or had prior to remediation, a potential for radioactive contamination based on site operating history or known contamination based on previous radiation surveys above project cleanup criteria) on the floors with 100 percent of the surface area surveyed and the walls changed to Class 2 with 50 percent survey coverage. This is consistent with MARSSIM guidance.

The initial scoping surveys (RSS-146) conducted in Building 2 consisted of both removable and total contamination measurements on the 1939 FIS and 1941 FIS floors prior to any flooring removal (Appendix B). Survey RSS-108 was a survey to support asbestos sampling of several different types of building media such as carpet, tile, baseboard, and ceiling tiles. All locations of building media surveyed were below project cleanup criteria. Scoping surveys were also performed after the top layer of flooring material was removed (RSS-171) and also on the final tongue and groove wood floor surface, which was the final flooring surface above the subfloor (RSS-203 and RSS-226). Top and intermediate floor layer locations surveyed were all below project cleanup criteria. A summary of the results are shown in Table 14, "Scoping Survey Results from 1939 and 1941 Former Instrument Shop Flooring."

Other scoping surveys were performed in areas potentially affected by operations in the FISs, such as stairwells, restrooms, sinks, floor penetrations, and piping. These investigations are discussed in more detail in following sections.

Throughout the performance of all scoping and characterization surveys in Building 2, there were no instances where the removable activity exceeded the cleanup criteria while total activity did exceed project cleanup criteria in multiple locations. Removable activity results can be found in the individual surveys in Appendix B.

4.2.2.2 Asbestos Abatement

Both the 1939 and 1941 FISs have had new flooring installed after radiological operations had ceased. In order to survey the original flooring surfaces, the newer flooring material needed to be removed.

An asbestos abatement subcontractor was used to remove the flooring and acoustical ceiling tiles (1939 FIS) and spray-on finish (1941 FIS), which contained asbestos material. Site procedures for flooring removal were followed and the bags of flooring debris were radiologically surveyed and properly disposed of off site. Surveys for the radiological release of the asbestos waste bags include RSS-149, RSS-153, RSS-185, RSS-188, RSS-190, RSS-193, RSS-202, RSS-206, RSS-212, RSS-214, RSS-420, RSS-425, RSS-427, RSS-428, RSS-438, RSS-448, and RSS-449 (Appendix B).

4.2.2.3 Characterization Surveys

Floors, walls, ceilings, and ventilation exhaust were surveyed for both alpha and beta/gamma surface contamination. Once the original flooring surface was exposed, the floors and walls were measured and labeled according to a 1 m^2 alpha-numeric reference grid. With the grid oriented toward north, the Y-axis was labeled numerically and the X-axis was labeled alphabetically. Starting in the southwestern corner of the second floor of Building 2 the first cell was numbered “A1” and the grid expanded from there to the north (numerals) and east (letters) (Figure 17).

Characterization surveys consisted of scanning 100 percent of each 1 m^2 of the selected grid while monitoring both the alpha and beta/gamma response of the instrument. After scanning, a 2-minute static count was taken in the area of the grid exhibiting the highest activity. A smear was also taken at this location and counted for 2 minutes. Total and loose (or removable) surface contamination levels were recorded for both alpha and beta/gamma and reported as disintegrations per minute (dpm) 100 cm^2. Surface activities were compared to the project cleanup criteria (Table 7).

1939 Instrument Shop

The 1939 FIS had limited contamination as compared with the 1941 FIS (Figure 17) and Building 27 South Shed (Figure 11). Survey results of floors, walls, ceilings, and ventilation exhausts are detailed in the following sections. Table 15, “Summary of Results from 1939 Former Instrument Shop,” summarizes the data.

Floors. Layers of carpet and tile were removed to expose a wooden T&G floor. The floors were scanned 100 percent (RSS-326) (Appendix B) and three cells (out of 101) exceeded the cleanup criteria of 100 dpm/100 cm^2 total with activity levels from 101 to 378 dpm/100 cm^2 total alpha.

Walls. Wallboard was removed to expose the original 1939 brick surface of the southern wall of the FIS. The wall had been painted at some point but the year is uncertain. The brick wall was surveyed 100 percent (RSS-309) (Appendix B). Two cells (out of 32) on the painted brick wall exhibited beta/gamma activity, which exceeded the cleanup criteria of 5,000 dpm/100 cm^2 total beta/gamma at 10,182 and 13,683 dpm/100 cm^2 with no detectable alpha activity.

An investigation was conducted with the Exploranium portable gamma spectrometer at this location of elevated activity. Both Ra-226 and Potassium-40 were positively identified in the spectrum. The spectrum data is presented in Attachment 7, “Exploranium Spectrum Results.”

The lower 2 meters of the remaining north, east, and inner walls dividing the three rooms (96 cells) were also surveyed 100 percent (RSS-318, RSS-320, and RSS-324) (Appendix B). Activity on these walls did not exceed the cleanup criteria.

Ceiling. Acoustic ceiling tiles were cemented to the plaster ceiling. Several tiles were removed and a survey was performed on both tiled and bare ceiling surfaces (RSS-259 and RSS-263) (Appendix B). No survey locations exhibited activity that exceeded the cleanup criteria.

Exhaust Vents. All of the vents in the 1939 FIS were surveyed. Surveys were performed on internal and external surfaces (RSS-259 and RSS-263) (Appendix B). None of the vents exhibited activity above the cleanup criteria.

1941 Instrument Shop

Drawings dated 1941 indicate that an addition was made to the southern wall of Building 2 more than doubling its size with workshops, offices, restrooms, and a second hangar. The northern wall of the 1941 FIS shared the south wall of the original hangar. The 1941 FIS (Figure 17) covered a floor area more than four times greater than the 1939 shop. Also, 22 percent of the surveyed floor cells were contaminated at levels greater than the cleanup criteria as opposed to only 3 percent of the cells in the 1939 FIS exceeding the cleanup criteria. Table 16, “Summary of Results from 1941 Former Instrument Shop,” presents a summary of all data from the 1941 FIS.

Floor. Layers of tile were removed to expose a wooden T&G floor. The majority of the floor contamination was in the eastern two-thirds of the FIS. The average alpha activity across the entire floor is 170 dpm/100 cm^2 with a maximum measurement of 7,161 dpm/100 cm^2; and beta average and maximum activity at 387 dpm/100 cm^2 and 16,580 dpm/100 cm^2, respectively (RSS-330, RSS-333, RSS-339, RSS-345, RSS-353, RSS-354, RSS-359, RSS-360, RSS-363, RSS-364, RSS-366, and RSS-414) (Appendix B).

Contamination was found in eight cells along the southern boundary of the 1941 FIS footprint. A decision was made to remove the top layers of flooring on the next two rows (9 and 10) of grids to the south and 30 meters in length from grids AK to BO (Figure 17). The rationale was to see if there was more contamination in the former passageway that separated the Instrument Shop from the former Parachute Shop.

The top layer of flooring was removed and the next layer of reddish brown 9 inch by 9 inch Masonite™ tiles was exposed. This tile layer was surveyed 100 percent (RSS-440) (Appendix B). There was only one location about an inch in length between two tiles in cell AX9 that was contaminated above the project cleanup criteria for total activity at 452 dpm/ 100 cm^2 alpha and 2,129 dpm/100 cm^2 beta.

The Masonite™ tiles were then removed and the T&G flooring was surveyed 100 percent (RSS-443, RSS-450, and RSS-453) (Appendix B). Only two more cells were found to have only alpha activity exceeding the project cleanup criteria. These were cells AQ9 and BL10 at 113 dpm/100 cm^2 and 286 dpm/100 cm^2, respectively. The entire floor data set as a whole indicates that the majority of the contamination found was limited to the area within the footprint of the 1941 FIS and was not widespread throughout the second floor.

Walls. Since the most recent remodeling of the second floor of Building 2, the 1941 FIS had 2-inch by 4-inch walls framed in and covered with wallboard to make several small offices. Fifty percent of the lower 2 meters of the wallboard surface was surveyed alternating grids in a checkerboard pattern (RSS-328, RSS-334, RSS-340, RSS-349, RSS-350, RSS-352, RSS-355, RSS-356, RSS-367, RSS-369, and RSS-377) (Appendix B). One cell (AV15-N1) on the wallboard surface was at the cleanup criteria at 100 dpm/100 cm^2 alpha (RSS-349). For clarification, the wall cells were labeled according to their orientation with the floor grid. Cell AV15-N1 is the lower 1 m^2 north wall grid adjacent to floor grid AV15. The 1 m^2 grid above this would be AV15-N2. South, east, and west walls are labeled S, E, and W, respectively.

Later, in an attempt to find a former sink, a section of the wallboard was removed and a painted brick wall was exposed. A survey of this wall indicated the presence of contamination and that this surface was most likely the original 1941 wall surface. It also appeared that objects were mounted on the wall and painted around (Figure 18, “1941 Former Instrument Shop Northern Brick Wall”). Wallboard was then removed from the entire length of the northern wall of the 1941 FIS.

The newly exposed brick northern wall and glass window surfaces were then surveyed on 100 percent of the lower 2 meters (RSS-396, RSS-398, RSS-400, RSS-405, RSS-406, and RSS-411) (Appendix B). Only one cell (AW18-N2) exceeded the cleanup criteria at 160 dpm/100 cm^2 alpha (RSS-396). This portion of the wall is where the former sink was likely installed and the presence of floor penetrations for the water supply and drain line.

Ceiling. The current ceiling in the 1941 FIS appears to be plaster covered with a spray-on acoustical finish, which is peeling and falling down in areas. A characterization survey (RSS-227) (Appendix B) consisting of 18 random locations was performed across the 1941 ceiling and none of the locations exhibited activity above the cleanup criteria.

Ventilation Exhaust System. The ventilation system in the 1941 FIS is unique in that the ventilation return or exhaust line is located inside the supply duct. There are seven supply/return ducts that penetrate the ceiling in the 1941 FIS. Figure 19, “1941 FIS Ventilation System,” for the supply/exhaust configuration of the ventilation system room vents. The section of ductwork lying on the wood is the exhaust duct after it was removed from within the supply duct as indicated by the blue arrow.

A scoping survey was performed on the ventilation exhaust system. The system was accessed from the attic space above the 1941 FIS. The return ducts were removed and the internal surfaces were surveyed (RSS-343) (Appendix B). Only one of the seven exhaust ducts exhibited contamination below the cleanup criteria. The other sic ventilation return lines have activity levels between 193 and 619 dpm/100 cm^2 alpha. Beta activity ranged from below background to 5,768 dpm/100 cm^2.

The ventilation is a recirculating closed-loop system that does not exhaust outside the building. Because of this, it is probable that more internal surfaces of the ventilation system have contamination exceeding the cleanup criteria.

Class 3 Floors

After finding contamination throughout the 1941 FIS and a limited amount in the 1939 FIS, the remaining areas of the second floor were characterized as a Class 3 area. Biased surveys had already been performed in the restrooms, sink room, stairwells, and locker room. No activity in these areas exceeded the cleanup criteria.

Eighteen 1 m^2 grids were selected randomly across the entire second floor, including the locker room and stairwells (Table 17, "Summary of Results from Building 2 Class 3 Floors"), excluding the two FISs. The top and subsequent layers of flooring were surveyed (RSS-417 and RSS-441) (Appendix B). The final layer was surveyed (RSS-457 and RSS-462) and none of the 18 locations exhibited activity exceeding the cleanup criteria for all layers. This survey process required the removal of the newer layers of flooring by the asbestos contractor. After each layer was removed, the newly exposed flooring surface was surveyed. Cell BZ17 was on the lower few steps of the northeast stairs. These lower steps are concrete with a resilient covering molded to the shape of the treads as opposed to the other floor grids having multiple covering layers. Results for the 18 base level (bottom layer) flooring were all less than the project cleanup criteria.

4.2.2.4 Focused Investigations – Building 2

A number of focused investigations were also performed outside the footprints of the 1939 and 1941 FISs. These surveys were intended to assess the radiological conditions of areas that existed in that era, such as restrooms, stairwells, drain lines, etc. Table 18, "Summary of Focused Investigations – Building 2," presents the results of the focused investigations.

Stairwells

There are four sets of stairs in the immediate vicinity of the FISs. They are named northwest, northeast, southwest, and southeast. The four stairwells can be seen on Figure 17.

The northeast stairwell is completely walled off with a temporary plywood barrier at the bottom to prevent public access. This set of stairs is the only means of access to the Locker Room (landing and doorway half way up) and currently access is only from the top of the stairs at the northeast corner of the 1941 FIS. The lower portion of the stairs is concrete while the upper portion is wood. This upper portion of stairs first appears in a renovation drawing dated 1952 (Drawing 54124). A scoping survey was performed of the stairwell and all measurements were below the cleanup criteria (RSS-269) (Appendix B).

From the south hangar, the southeast stairs lead up to the second floor passageway that divided the 1941 FIS from the Parachute Shop. These stairs also have a temporary plywood barrier installed halfway up to prevent public access to the second floor. Two scoping surveys (RSS-269 and RSS-395) (Appendix B) of the upper and lower portions of the stairwell were performed and none of the measurements exceeded the cleanup criteria.

The northwest stairs are between both FISs and lead down to the north hangar and are also blocked from public access. Two scoping surveys (RSS-390 and RSS-391) of the upper (Appendix B) and lower portions of the stairwell were performed and all measurements were below the cleanup criteria.

Finally, the southwest stairs exit to the outside of the building and at the top also provides access to the second floor between the two FISs and also the attic space, where the ventilation system is located. A scoping survey (RSS-223) (Appendix B) of the stairwell was performed and all measurements were below the cleanup criteria.

Floor Penetrations

Drawings of Building 2 indicate that water, pressurized air, and vacuum lines ran throughout the second floor. All or parts of these systems were removed during subsequent renovations. The penetrations left behind were revealed after flooring surfaces were removed. A scoping survey of 41 floor penetrations including a capped pipe protruding from a wall just outside the second floor restroom/shower room was performed (RSS-218 and RSS-225) (Appendix B). None of the locations surveyed exhibited activity above the cleanup criteria.

Public Spaces

At the time of this investigation, most of the first floor of Building 2 was being utilized for sports and recreation. The areas open to the public were surveyed at various times throughout the investigation to assess the radiological conditions. The first floor of Building 2 is presented as Figure 20, “Building 2 Plan Layout (First Floor).”

Some of the Public Space surveys included the following:

- Concrete, blue plastic tile, and green turf covered floors in an area under the 1941 FIS. This is the area around the batting cage and party room (RSS-179 and RSS-220) (Appendix B).

- The floor under the 1939 FIS, which is now used for storage of theater costumes and props (RSS-272) (Appendix B).
- Drain lines coming from the second floor restroom/shower rooms (RSS-471) (Appendix B).
- Another area immediately south of the lobby on the east side of the building was a former restroom. The floor and wall penetrations for the toilet, urinal, and sink drains were surveyed (RSS-474) (Appendix B).
- Drain lines from the red-tiled sink room above the southeast stairs (RSS-472) (Appendix B).
- A drain line starting at the top of the southeast stairs, which is suspected to come from a former water cooler (RSS-472) (Appendix B).
- Some piping was difficult to assess whether or not it was second floor drain lines; since the origin and purpose could not be determined, these lines were also surveyed (RSS-474) (Appendix B).

Out of 266 measurements for total alpha and beta activity, none exhibited activity above the project cleanup criteria. Gamma scans with a NaI 2 inches by 2 inches did not indicate activity outside the observed range of background for the building materials encountered. Dose rate measurements with a microRoentgen meter were consistent with background.

1941 Former Instrument Shop Sink Drain

Drawings of the 1941 FIS (Figure 21, "1941 Former Instrument Shop Sink Location") indicated that a sink existed approximately at the middle of the FIS along the northern brick wall. The drawing indicated that the drain line penetrated the northern brick wall and ran down one of the vertical steel I-beams to a drain system at the foot of the column.

Upon investigation the only piping that was found to remain was the last vertical section of pipe (approximately 15 feet in length rising out of the concrete hangar floor. The pipe was found capped at the top with an elbow at the bottom that entered the floor at approximately a 45 degrees angle towards the west. A gamma scan (RSS-408) of the pipe externally indicated background levels (Appendix B).

Following the initial survey, the cap was removed and the pipe found to be internally contaminated with total alpha and beta activity levels of 1,224 dpm/100 cm^2 and 4,396 dpm/100 cm^2, respectively (RSS-487) (Appendix B). The pipe was removed and cut flush with the hangar floor. A smoke test was performed and the pipe was found to be connected to a drain system that eventually discharged from a steel pipe into manhole MH-134 (storm drain) on the west side of Building 2 (RSS-518). The pipe at the floor was later filled with cement to prevent access (RSS-531).

Sludge samples (analyzed for Ra-226 and Sr-90) were taken from inside the sink drain line (SD-MH134-PIPE1) with results of 697 pCi/g for Ra-226 and Sr-90 specific activity of 0.65 pCi/g. Also sampled were manhole MH-134 (SD-MH134-SL-018), upstream manhole MH-162 (SD-MH162-SL-019 and SD-MH162-SL-020), and a sediment pit (SD-BLDG2-W.PIT-SL-021 and SD-BLDG2-W.PIT-SL-022) next to manhole MH-134, which appeared to be connected to the floor drain system. Also a small square hole in the north hangar floor between the sink drain line and manhole MH-134 was sampled (SD-BLDG2-W.FD-SL-023) since smoke was also seen coming from this area during the smoke test. All samples were analyzed for Ra-226 and Sr-90. During the sediment sampling, gamma scans were performed in biased locations inside the manholes, sediment pit, and the hole in the hangar floor (RSS-535 and RSS-536) (Appendix B). Sample results from the sediment pit near manhole MH-134 indicate the presence of cesium-137 for both samples at 3 pCi/g and 6.03 pCi/g. Cesium-137 is not a naturally occurring isotope but can be found in background in surface soils around the world as a result of fallout from nuclear weapons. At the time of the writing of this document, no conclusions had been drawn concerning the cesium-137 sample results from the sediment pit.

1939 /1941 Locker Room and Restroom

In Building 2 during the time the 1939 FIS was in use, drawings indicate that there was a first floor restroom off the southeast corner of the north hangar (Figure 22, “Building 2 Locker Room and Restroom Location”). There were also stairs that led to a locker room located directly above. Building 2 was later expanded to the south and the 1941 FIS was built. Walls were opened and steps installed to connect the new Instrument Shop to the existing Locker Room. In a 1952 renovation (Drawing 54124 [1952]), the stair configuration was changed to a continuous run from the second floor to the first with a landing midway, which provides the only means of access to the Locker Room.

Since the Locker Room and first floor restroom below were available during the times that both the 1939 and 1941 FISs were in operation, a scoping survey was performed in both rooms. A scoping survey (RSS-269) in the Locker Room included measurements of floors, a wall, vent, and a floor penetration (Appendix B). No activity was detected above cleanup criteria. The first floor restroom scoping survey (RSS-505) included measurements of floors, walls, piping, floor and sink drains, and the internals of a main drain line cleanout. None of the measurements exceeded the cleanup criteria.

Beta/gamma activity above background was detected inside one of the porcelain hand washing sinks at 1,580 dpm/100 cm^2 with no detectable alpha activity. Other hand sinks were then scanned on the tops, sides, and inside the basin and all surfaces exhibited activity above background. On one sink, the P-trap was removed and a scoping survey was conducted on the accessible internal surfaces of the drain piping (RSS-505) (Appendix B). No activity above background was detected. The sinks are most likely constructed of materials containing naturally occurring radioactivity.

Tiled Sink Area and Other Restrooms

A small sink room, containing a floor drain and red clay tile, is located above the southeast stairs. Scoping surveys (RSS-108 and RSS-146) were performed in this room on the tile, sink, and floor drain (Appendix B). The red clay tile floor exhibited beta/gamma activity above background but below the project cleanup criteria with the highest result at 1,909 dpm/100 cm^2 beta/gamma and 11 dpm/100 cm^2 alpha.

The second floor also contains restrooms and a shower stall. A scoping survey (RSS-416) was performed in these rooms on tile floors; floor, sink, and shower drains; and other surfaces (Appendix B). None of the measurements exceeded the cleanup criteria.

The red clay tile floor in both above mentioned areas did exhibit beta activity above background with the highest result still below the cleanup criteria at 4,853 dpm/100 cm^2. This is the same type of clay tile found in the southeast tower of Building 27 in which an investigation was conducted with the Exploranium portable gamma spectrometer. The naturally occurring radionuclide potassium-40 was positively identified in the spectrum for the red clay tile. The spectrum data is presented in Attachment 7.

4.2.3 Underground Pipe Investigation

Shaw E&I retained ULS Services Corporation to locate subsurface utilities in order to determine the layout and flow direction of the sewer and storm lines at NAVSTA PS. Shaw E&I retained Bravo Environmental to conduct smoke tests on pipes typically located within the buildings to determine whether they were connected to the sewer or storm lines. Figure 7 shows the current configuration of the sewer and storm lines.

4.2.3.1 Sanitary Sewers

Line locating showed that there were two gravity flow sewer lines currently servicing Building 27. One line is present on the west side of Building 27. It begins at Building 12 and flows to manhole MH-224 and through manholes MH-225, MH-234, MH-226, MH-227, and MH-228, to Pump House 116 that then connects to the city sewer on Sand Point Way. Building 27 connects to this line through a side sewer on the northwest side of the building. At the time of this investigation this side sewer was not in use.

The second sanitary sewer line is located on the southeast side of Building 27 and is connected through a side sewer at manhole MH-223. A former janitor’s sink located in the Regimen Staff Office and the sinks and toilets of the existing restroom located on the first floor are connected to the sanitary sewer at manhole MH-223.

A side sewer from Building 2 also connects to this sewer line at manhole MH-223. The sewer line flows west from manholes MH-223 through MH-NOAA1, MH-NOAA1.5 to the NOAA pumping station.

4.2.3.2 Pressurized Sewer Line

An abandoned pressurized sewer line is present under the southern portion of Building 27. The line apparently serviced Building 1 (formerly located east of Building 27) and Building 27 (and possibly others) and pumped sewage to a valve pit (located north of Pump House 98) associated with the former sewage plant that treated sewage prior to discharge to Lake Washington.

4.2.3.3 Storm Lines

Two storm water lines run under and around the west side of Building 27 and merge at manhole MH-160 located north of the building prior to discharging to Lake Washington. The storm line that runs west of Building 27 is 36 inches in diameter and carries storm water north from catch basins located south and west of Building 27 (catch basins CB-3, CB5, CB-6, and CB-7), further west near Building 11 (manhole MH-1011), and southwest (near manhole MH-1007) located under the NOAA Road overpass. A smaller line (4-inches in diameter) appears to wrap around the west and north sides of Building 27 from catch basins CB-4 to CB-14 to manhole MH-1005.

Smoke tests performed on the Radium Room pipe that was removed from Building 27 determined that the radium contaminated pipe was connected to the storm line. The removed pipe that penetrated the concrete floor in the first floor welding shop was found to traverse under the floor to a roof drain located just outside the door leading from the outside to the welding shop. The pipe then runs under the sidewalk west to catch basin CB-3 through manholes MH-141, MH-137, and MH-160 where it discharges to Lake Washington.

The storm line that traverses under Building 27 is 24-inches in diameter line and carries storm water north past the west side of Building 2 under Building 27 to manhole MH-136 located within the building to manhole MH-160 before it discharges to Lake Washington. Through smoke tests and historical documents it was determined that the radium contaminated pipe removed from Building 2 (connected to the former sink in the 1941 Instrument Shop), the roof drains located south of Building 27 (except the roof drain mentioned above), the catch basins located south of Building 27 (catch basins CB-1 and CB-2), and the catch basins that drain the parking area located east of Building 27 are connected to this storm line.

4.2.3.4 Video Inspection

Video camera inspections of the sewer and storm lines were performed by Bravo Environmental to assess the general construction and condition of the pipes and amount of sediment accumulation. In general, pipes that contained less than a few inches of water with a diameter of

8 inches or greater were surveyed. The pipe sections that were surveyed as part of this investigation are shown on Figure 23, “Sewer and Storm Line Video Inspection Locations.” The logs and video footage of the survey are provided in Appendix C, “Video Logging.”

4.2.3.5 Sludge Sampling

Once the locations and flow direction of the sewer and storm lines were established, Shaw E&I gained access to these lines through catch basins and manholes. In the case of the pressurized sewer line the only access available was the open end of the pipe at the valve pit located near Pump House 98. To gain access to the line at the other end, Shaw E&I excavated, exposed, and cut open the line near Pump House 117. Shaw E&I also excavated, exposed, and cut into the 6-inch storm drain line near catch basin CB-1 to obtain a sludge sample from the 24-inch diameter storm line at this location.

Sludge samples were collected from each of these manholes, catch basins, and pipes in accordance to sampling and confined space entry procedures outlined in the Final Work Plan (Shaw E&I, 2010a) and as amended in FCR-01 (Appendix A). Sludge samples were generally collected using a trowel or scoop or in the case of layered sediment using a hand auger. Storm water catch basins were generally less than 2 feet deep and were accessed from the surface. Manholes generally required confined space entry. Field data sheets were completed at each sampling location and are stored in the project files. The pipes, manholes, and catch basins sampling locations are shown on Figure 7. During sampling, an attempt was made to completely fill a 500 milliliter laboratory supplied sample container for each discreet sample. Multiple samples were collected at each location but in some cases, inadequate sample quantity was encountered and the container was filled with the available sludge present at the location. Select samples were then sealed and placed in laboratory supplied coolers for transport under chain of custody to Test America Laboratories located in St. Louis, Missouri. Results of the sludge sampling are presented in Table 19, “Laboratory Results of Radium-226 Analyses of Sludge Samples.”

4.2.3.6 Pipe Crawler Survey

A radiological survey was conducted within the 24-inch storm drain line under Building 27 from manholes MH-135 to MH-1005 to assess if sludge or sediments within the pipe exhibited elevated count rates that could indicate the presence of Ra-226. Sludge samples were previously collected in manholes manholes MH-135, MH-136, and MH-1005 and the 24-inch pipe near catch basin CB-1 and found to contain Ra-226 concentrations below project cleanup criteria for sludge. The primary objective of the radiological survey of the 24-inch line was to assess whether additional sludge sampling within the 24-inch line was necessary beyond the assessable manholes and catch basins.

The radiological survey within the 24-inch line involved using the TranSTAR Transporter (crawler) mobile video surveillance system coupled with a Ludlum 2221/44-10 NaI 2-inch by 2-inch gamma detector. The gamma survey meter was specifically calibrated with 260 feet of detector cable for this investigation. The crawler and gamma detector are shown on Figure 24, “Pipe Crawler Coupled with Sodium Iodide 2 inch by 2 inch Detector.”

The crawler was deployed inside the storm sewer piping while carrying the NaI 2 inch by 2 inch detector at a height of 6 inches from the pipe bottom to the centerline of the detector. A technician monitored the gamma count rate as the crawler advanced at a rate of less than 0.5 meters per second. The crawler was stopped if an increase in count rate was observed. One-minute static counts were taken at biased locations where there was a change in pipe conditions such as heavy sediment, intersections with other lines, and cracks. Static counts were also taken at 10-foot intervals. The data was plotted and reviewed along with video footage of the pipe internals to see if and where further investigation of the pipe for Ra-226 contamination was warranted. Figure 25, “Gamma Survey Results from Manholes MH-135 to MH-1005,” illustrates the gamma results plotted as gross cpm versus linear distance traveled in feet. Significant changes in conditions, such as pipe construction material and count rates are noted on Figure 25.

The crawler and detector assembly were first deployed into manhole MH-136 and traveled south toward manhole MH-135. The crawler traveled approximately 103 feet until it was obstructed by a large rock and prevented from moving any further.

The crawler was retrieved and then deployed from manhole MH-135 northwest toward manhole MH-1005. The crawler traveled approximately 170.5 feet until it reached manhole MH-1005. The crawler could not be used beyond manhole MH-1005 (toward manhole MH-160) due to the presence of water over 4 inches deep in the line that could damage the detector and/or affect the accuracy of the readings.

Next, the crawler was taken out of service and a similar vehicle referred to as a tractor was coupled to the gamma detector and used to finish the surveys (Figure 26, “Tractor Coupled with Sodium Iodine 2 inch by 2 inch Detector”). The tractor was selected because of its higher ground clearance. It was sent south from manhole MH-136 to the rock that obstructed the crawler. The tractor was able to survey the remaining section of piping to a total distance from manhole MH-136 of 245 feet where it was prevented from going further due to the obstruction of another pipe running perpendicular through the 24-inch line near catch basin CB-1 (Figure 27, “24 Inch Storm Sewer Line Obstruction near Catch Basin CB-1”).

For the final investigation, the crawler was deployed from manhole MH-135 north toward manhole MH-136. The crawler advanced approximately 55 feet until it reached the intersecting pipe (obstruction) near catch basin CB-1.

The survey results are documented in RSS-313 and RSS-314 (Appendix B). An increase in gamma count rates was observed when transitioning from a corrugated steel pipe to a concrete pipe. Increased count rates were also observed at the manholes where significantly more concrete and bricks are used as construction materials (Figure 28, “Concrete and Brick Construction Inside Manhole MH-135” and Figure 29, “Concrete Construction Inside Manhole MH-136”). Higher background gamma activity is expected due to naturally occurring radioactive material found in concrete and brick. After reviewing the data, no further sampling or investigations were deemed warranted.

4.2.3.7 Catch Basin CB-1 Connection/24 Inch Line

A 7.5-inch concrete pipe was identified exiting the east side of catch basin CB-1 going toward a 24-inch corrugated steel storm drain line that passes from south to north between manholes MH-134 and MH-136. Video inspection of the 24-inch line verified the connection of the 7.5-inch pipe into the storm drain. Radiological survey of this pipe at catch basin CB-1 (RSS-093) identified elevated fixed beta count inside the pipe (Appendix B). No removable contamination was detected. It was determined that a sludge sample taken in the 24-inch storm drain line at this location was necessary. To accomplish this, hand digging was performed to locate the 24-inch storm drain line. This work was performed using radiological controls including a Radiological Work Permit, PPE, access control, posting, and RCT coverage.

Hand digging demonstrated that a concrete reinforcement had been poured around the location of the pipe connection. Continued hand digging exposed the concrete pipe between the catch basin and the pipe connection reinforcement. Additional digging was performed to expose the pipe. A concrete saw was used to cut an access hole into the 7.5-inch concrete pipe at a location close to the connection. Access was gained through this access hole and a sample of the sludge lying in the bottom of the 24-inch storm drain line was obtained (SD-CB1PIPE-SL-018). This sample was analyzed for Ra-226. A result of 0.546 pCi/g Ra-226 was reported.

4.2.4 Soil

During an investigation to establish a background reference area for soil, an area west of Building 27 was selected and surveyed using a NaI 2-inch by 2-inch detector. Based on experience with this type of detector, background levels were expected to be in the range of 5,000 to 9,000 cpm but three areas were found with elevated gamma readings at the surface of the soil (RSS-262) (Appendix B). These areas of elevated activity or hotspots, were in the range of 11,000 to 130,000 cpm. The three areas were secured with radiological rope and postings and a Trimble Global Positioning System (GPS) unit with a data logger was mobilized to the project to perform a more detailed investigation of soils around the buildings.

The GPS assisted GWS were conducted on soil surfaces to the south and west of Building 27. This type of survey is performed by coupling a Ludlum Model 2221 scaler/ratemeter with a NaI 2-inch by 2-inch gamma scintillation detector to a Trimble GPS unit that also functions as a data logger. The surveyor walks slowly (less than 0.5 meters per second) holding the NaI detector approximately 4 inches above the ground and moves the detector in a serpentine motion while monitoring the audio response and digital count rate of the detector. If any increase in count rate is detected the technician pauses for a more thorough investigation of that area. At the same time, the Trimble unit is recording the gamma detector count rate along with GPS coordinates. Colored pin flags were used to mark the hotspots.

When the survey was complete, the data files were transferred from the Trimble unit to a computer and through GIS software the data was plotted on a map displaying the locations surveyed with the corresponding gamma count rate in gross cpm. To make interpretation of the maps easier a color coded scale was applied to different ranges of cpm values. Lower ranges such as blue and green are set to background levels while areas of elevated activity progressively change colors from yellow to red to black to illustrate hotspots.

An Exploranium GR-130 portable radionuclide identifier was used to survey the hotspots in an attempt to identify the radionuclides present. For some survey locations, the GR-130 did not positively identify the radionuclide(s) present but did report unidentified peaks in the gamma energy spectrum. Exploranium survey results are presented in Attachment 7. Field spectroscopy results were reviewed by the project Certified Health Physicist. No indication of other gamma emitting radionuclides was identified in these spectra.

4.2.4.1 Building 27 Soils

A GWS was performed over soil areas west, south, and southeast of Building 27 (RSS-308) (Appendix B) in order to better understand the extent of elevated activity in the soil. This survey revealed the presence of 18 hotspots west and south of Building 27. A survey was conducted with a Ludlum Model 19 microRoentgen meter to determine contact and general area dose rates at the hotspots (RSS-331). Figure 30, “Hotspot Locations Near Building 27,” presents the locations of hotspots 1, 3-18, and 22.

A gamma scan was also performed with an Exploranium and potassium-40, cesium-137, Ra-226 and thallium-232 were positively identified along with several other unidentified peaks. Results are presented in Attachment 7. Of the 27 gamma scans performed with the Exploranium, the spectrum number matches with hotspot numbers. There are no soil hotspots numbered 2 or 19 through 21. These gamma scans were taken at locations other than soil hotspots.

The area surveyed was then expanded to include areas around Building 27 that are soil covered or were previously unpaved during the 1940s when radiological operations were taking place in the Building 27 South Shed (RSS-344) (Appendix B). A 1944 figure obtained from a Sand Point historical preservation organization showed the unpaved areas adjacent to the tarmac on the west side of Building 27 and is provided as Figure 31, "Previous Soil Covered Areas Around Buildings 2, 12, and 27."

Five more hotspots (23, 24, 25, 26, and 27) were identified in the pavement west of Building 27, and adjacent to the NOAA entrance road overpass (RSS-347) (Appendix B) (Figure 32, "Hotspot Locations West of Building 27").

The 23 hotspots around Building 27 ranged in count rates from 7,291 to 310,203 gross cpm with the NaI 2-inch by 2-inch detector. Steel plates and concrete blocks were placed as shielding over hotspots that exceeded general area dose rates of 10 microRoentgen per hour. The shielding was effective at reducing the general area dose rates to background levels (less than 10 microRoentgen per hour).

4.2.4.2 Hotspot Excavation

After the GWS data was presented to the Navy, they requested that Shaw E&I investigate the hotspots to determine if they were discrete items, such as an aircraft instrument part, paintbrush, or similar object or if the radium was distributed through the soil. A soil excavation plan was prepared entitled, "The Building 27 Hillside Excavation Procedure" to provide direction for removal of the 18 hotspots around Building 27. The plan was approved by the Navy prior to implementation.

On September 22 and 23, 2010, hand excavation using shovels and trowels was attempted at three locations (Hotspots 1, 16, and 17). However, rather than removing a discrete radioactive item (i.e., "hotspot") the contamination was found to be distributed in the soil at each location (RSS-374 and RSS-379) (Appendix B). The effort was discontinued at these locations since the excavation task would require a much greater effort than just hand tools and 55-gallon drums to containerize the waste. Soil samples were taken following the limited excavation to characterize hotspots 1, 16, 17, and 6 (excavation not attempted here; only sampling). Table 20, "Analytical Results of Soil Hotspots 1, 6, 16, 17, and 23/24," presents the analytical results.

On September 28, 2010, excavation was attempted at two more hotspots (23 and 24) located outside the Controlled Area project security fence (RSS-397) (Appendix B). After excavation, the dose rate at a height of 30 centimeters from the soil surface at hotspot 24 was reduced from 11 microRoentgen per hour to 8 microRoentgen per hour. Soil samples were taken following excavation at the location of highest surface activity to characterize both hotspots.

Laboratory analysis was performed on two soil samples collected from hotspot locations 23 and 24 to determine if the activity present was due to Ra-226 contamination in the soil from Building 27 operations or if the activity was due to naturally occurring radioactive material in the sand and gravel present in the sample matrix. At the laboratory, gravel was separated from the soil in both samples and the soil and gravel were analyzed separately. The sample results after separation indicate that the Ra-226 is more abundant in the soil than gravel indicating that the soil was likely contaminated with Ra-226.

4.2.4.3 Building 2 and Building 12 Soils

The GWS expanded further to include current and former soil areas along roads and walkways around Buildings 2, 12, and 27 (RSS-422) (Appendix B). The rationale used for expanding the survey was that Building 2 was used for instrument repair operations similar to those in Building 27. Areas around Building 12 were surveyed because of their proximity to Buildings 2 and 27. Seven hotspots were detected north and northeast of Building 12 (Figure 33, “Hotspot Locations near Building 12”) and two on the south and southeast sides of Building 2 (Figure 34, Hotspots Locations Near Building 2”). Count rates for these hotspots ranged from 7,888 to 52,221 cpm with the NaI 2-inch by 2-inch detector. The hotspot survey results and locations can be found in survey RSS-422.

4.2.4.4 Soil Characterization

Following completion of the walkover surveys, the Navy requested that Shaw E&I assess the extent of soil contamination in the hotspot areas. As a result, Shaw E&I prepared a plan entitled “Soil Characterization Sampling Plan” (Attachment 2) to outline the procedures to characterize the extent of soil contamination around Buildings 2, 12, and 27. The primary objectives were to attempt to establish the depth and magnitude of Ra-226 contamination at individual hotspots or group of hotspots, attempt to characterize the lateral extent of the contamination, and to sample a reference area for determining background soil concentrations. All samples were analyzed for Ra-226 and Sr-90. For all soil samples analyzed, none exceeded the Sr-90 project cleanup criteria of 3.76 pCi/g.

The plan (Attachment 2) was approved by the Navy and originally proposed 66 boring locations. With Navy concurrence, the scope was reduced to 23 borings due to project time restraints, avoidance of underground utilities, and concerns over radiological waste generation. Attachment 1 presents the sample bowl field screening results, downhole gamma logging results, and laboratory analytical results. The procedures used during soil sampling and results of the soil characterization are provided in the following section and in Attachment 8, “Soil Boring Logs,” and boring locations are shown on Figure 35, “Soil Characterization Boring Locations.” The proposed boring locations can also be seen in the Soil Characterization Sampling Plan (Attachment 2). Some boring locations were changed slightly to avoid underground utilities.

Soil Sampling

The general approach to soil sampling was that a hotspot was first sampled by boring through the soil using a shovel or hand auger and placing each 0.5 foot soil interval into a stainless steel bowl. Once filled with 0.5 feet of soil, the bowls were screened with a NaI 2-inch by 2-inch detector.

The screening results for all intervals of each hotspot boring were reviewed and the depth of the contamination layer was determined. The borings were advanced at least 1 foot beyond the depth where soil screening indicated that background count rates were reached or groundwater was encountered. At hotspots, the intervals submitted for laboratory analysis were the 0.5 foot interval with the highest count rate and the interval of soil that was 1 foot deeper than the last interval with elevated activity.

Once the depth of the contamination layer was known for a given hotspot or group of hotspots, borings were drilled and sampled around the perimeter of the expected extent of contamination (boundary). For these boundary locations, the borings were advanced to at least the depth where the nearby hotspot contamination layer was determined to exist and then at least 1 foot deeper. The soil intervals were screened and the one exhibiting the highest count rate was submitted for laboratory analysis.

With both hotspots and boundary borings, every other 0.5 foot interval not submitted for immediate analysis was sent to the laboratory with the analysis placed on hold for possible future analysis, if necessary. Table 21, “Soil Screening Evaluation Example,” is an example of how the boring field screening data was evaluated to determine which samples were submitted to the laboratory for analysis, submitted and placed on hold, or discarded. Boring logs are presented as Attachment 8. Laboratory results for all boring samples analyzed are summarized in Attachment 9, “Soil Characterization Boring Data.”

Building 27. Soil characterization began south of Building 27 with hotspots around Catch Basin CB-1 and the Quarter Deck (Figure 29). Boring number 23 (B-23) was drilled adjacent to the sidewalk and was terminated at a depth of 2.2 feet due to finding what appeared to be underground utility marking tape. The 2 to 2.2 foot interval exceeded project cleanup criteria for Ra-226 therefore the vertical extent of contamination was not established at this location. Boring B-24 was drilled at the top of the steps leading towards the NOAA road. Soil collected from boring B-24 was found to exhibit elevated gamma field screenings to a depth of 3.5 feet and the laboratory analysis reported a Ra-226 concentration of 420 pCi/g for the surface sample and 3.2 pCi/g for the 4.5 to 5 foot sample where the boring was terminated when field screenings indicated background levels had been reached. There are a number of hotspots around and under the Quarter Deck. Boring B-25 was drilled in an attempt to bound the contamination to the south between the Quarter Deck and NOAA road. Four attempts were made at different locations but refusal was met each time. It was suspected that the refusal was a result of a buried sidewalk or street that was covered with fill when the NOAA road was built in the 1970s. Boring B-22 drilled near catch basin CB-2 did not contain readings above project cleanup criteria and appears to define the extent of soil contamination to the west of the hotspots around the Quarter Deck.

Figure 36, "Soil Concentration versus Depth," is a visual representation for the soil characterization sampling effort and also contains data from the previous hotspot sampling discussed in Section 4.2.4.1. Borings with soil concentrations greater than the project cleanup criteria are shaded in light red, clean samples are not shaded, and a rectangle indicates the deepest interval. Borings are grouped according to their proximity to each other with the hotspots in the center and boundary borings to the left and right.

There are also several hotspots around catch basin CB-1. While hand digging to expose the 24 inch storm sewer line, a layer of contamination was detected 6 inches to 8 inches below the soil surface near the sidewalk. There are hotspots on the surface in the area and in the bank of soil to the south. Hotspots 16 and 17 were sampled previously (Table 20) with contamination identified to a depth of 1.5 feet. During the soil characterization, boring B-29 was drilled in this area. This boring was bound vertically at a depth of 2.5 feet. Boring B-28 to the south and boring B-30 to the east bound the contamination laterally in this area. The building and sidewalk are to the north and to the west is the contaminated area under the Quarter Deck.

Boring B-17 was drilled next to the NOAA road concrete retaining wall and was found to contain contamination from the surface to a depth of approximately 2 feet. There are three hotspots in this area along the concrete wall and B-17 exhibited the highest gamma activity at the surface. This area is bound to the west, north, and east by borings B-16, B-18, and B-19, respectively.

West of Building 27 is a narrow unpaved areal between two original concrete sections of tarmac. Several hotspots are located in this area and around an electrical transformer nearby. An active gas line runs directly through this contaminated area and provides gas service to Building 27. From previously discussed excavation this radiological activity is distributed soil contamination. Hotspot numbers 1 and 6 were previously sampled (Table 20) in this area at a depth of 1 foot and had Ra-226 levels as high as 2,150 pCi/g. One-inch thick steel road plates (5 feet by 8 feet) along with smaller one-half inch plates were placed over these two hotspots as shielding to reduce general area dose rates to less than 10 microRoentgen per hour. Borings B-5, B-8, and B-12 bound the hotspots to the north, west, and south, respectively. Two smaller hotspots are located north of this group near catch basin CB-5. They are bound laterally to the north by boring B-1.

The three hotspots under the asphalt west of Building 27 may be limited to just a few feet in diameter and in depth. They do appear to be very discrete as measured from the surface and could possibly be similar in nature to the object found at boring B-60 (Figure 37, “Object Recovered from Boring Number 60”) and with some deterioration could also contribute to some limited distributed contamination in the surrounding soils.

Because of the decision to reduce the soil characterization sampling at this time, not all hotspots were sampled around Building 27. However, based on the sample data gathered and the shallow depth of groundwater, the contamination is most likely distributed in the soil (not discrete items) and appears to be limited to the top 3 to 5 feet of soil.

Building 12. Building 12 was a boiler house for the area. Surveys indicate elevated gamma activity northwest and northeast of this building. Borings B-49 and B-51 were taken on hotspots on the northwest side and sample results are below project cleanup criteria.

The three hotspots to the northwest of Building 12 are located under asphalt pavement and were not sampled. They appear to be similar in nature to those described under the asphalt west of Building 27 above. Transformers and underground electric utilities are in the vicinity.

Building 2. There is an area of elevated activity south of Building 2. A street lamp is located less than a meter from this hotspot. Only a surface sample (0 to 0.5 foot) was taken here with a hand trowel due to the close proximity of the street lamp electrical box and underground line below. This sample exceeded the cleanup criteria at 1.47 pCi/g Ra-226.

On the southwest corner of Building 2, a small isolated hotspot was located within inches of the building wall. Boring B-60 was drilled at this location. The top 6 inches of soil was the only interval with elevated activity. Upon closer investigation of the soil, a small article (possibly a piece of aircraft instrumentation [Figure 37]) was discovered and removed (RSS-509) (Appendix B). A dose rate at 30 centimeters from the object was 10 microRoentgen per hour above background. The object was labeled as radioactive material and stored in the locked Radioactive Material Storage Area located on the first floor of Building 27. The top 6 inch interval was analyzed and exceeded the project cleanup criteria at 64.6 pCi/g Ra-226. After sampling, a scan of the borehole indicated that the soil exhibited background gamma levels. A sample from the 1.5 to 2 foot interval had a Ra-226 concentration below the project cleanup criteria.

4.3 Current Radiological Condition Documentation

A matrix was assembled that categorizes all of the radiological surveys performed for scoping, characterization, and special studies. This matrix provides easy determination of which surveys provide data for which location. This matrix has been provided in Appendix B.

4.3.1 Gravity-Drain Sanitary Sewer

As catch basins and manholes were accessed for sludge sampling, surface contamination direct and removable contamination monitoring was also performed where possible on vault surfaces and exposed pipe surfaces (Figure 7). Wet surfaces prevented direct (static) measurements in some cases. Surface contamination monitoring was conducted at the following manhole locations (Appendix B):

- MH-224 – RSS-101
- MH-225 – RSS-101
- MH-223 – RSS-101
- NOAA-1 – RSS-101
- NOAA-1.5 – RSS-250
- MH-226 – RSS-105
- MH-227 – RSS-105
- MH-234 – RSS-105
- MH-222 – RSS-105
- MH-233 – RSS-109

No readings were detected on any manhole surfaces above cleanup criteria.

4.3.2 Pump House 116

Pump House 116 is currently active, providing lift from the gravity flow sewer to the City sewer main that runs along Sand Point Way. The wall surfaces were surveyed (RSS-204) up to 2 meters (Appendix B). No contamination in excess of the project cleanup criteria was detected. The floor was continually wet and could not be surveyed. Accessible ceiling locations were characterized (RSS-210). Much of the ceiling is approximately 20 feet above the pump house floor and is not accessible. No contamination in excess of the project cleanup criteria was detected.

4.3.3 Storm Drain

The following manholes and catch basins were monitored (Appendix B):

- CB-1 – RSS-093
- CB-3 – RSS-072
- CB-4 – RSS-072
- CB-5 – RSS-093

- CB-6 – RSS-076
- CB-7 – RSS-076
- CB-8 – RSS-076
- CB-9 – RSS-074
- CB-9 – RSS-076
- CB-10 – RSS-076
- CB-11 – RSS-076
- CB-12 – RSS-076
- MH-141 – RSS-109
- MH-136 – RSS-126
- MH-1005 – RSS-126

No elevated readings were detected with the exception of catch basin CB-1 (RSS-093) (Appendix B). Elevated beta/gamma readings were identified in the 3 to 4 inch clay pipe that connected the catch basin to the 24-inch storm drain line to the east (Figure 7).

4.3.4 Abandoned Pressurized Sewer Line

The abandoned pressurized sanitary sewer line was located and exposed at the east end near Pump House 117. The line was cut open and surveys (RSS-140 and RSS-144) were performed on the interior of the exposed pipe (Appendix B). No elevated readings were detected. Pump House 117 was characterized (RSS-151). No contamination in excess of the project cleanup criteria was identified.

Pump House 98 was identified as potentially associated with the abandoned pressurized sanitary sewer line. A scoping survey was performed (RSS-122) (Appendix B). No contamination or unusual gamma dose rate readings were identified. The brick structure showed a uniform elevation in the gamma dose rate, likely caused by naturally occurring material in the brick. A characterization survey (RSS-194) was performed on the interior of Pump House 98. No contamination in excess of the project cleanup criteria was noted.

A valve vault exists at the upper (northwest) end of the abandoned pressurized sanitary sewer line. Access to the upper end of that line was accomplished through this vault. A characterization survey (RSS-209) of the vault walls was performed (Appendix B). No contamination in excess of the project cleanup criteria was detected. The vault has a dirt floor and was not surveyed. These results are summarized in Table 22, “Summary of Results from Storm Drain and Sanitary Sewer Systems.”

5.0 Current Facility Status

Characterization field activities ended in December 2010. The following sections describe the status of Building 27 and Building 2.

5.1 Security

Characterization field activities ended in December 2010. A temporary fence is in place and surrounds the contaminated soils on the west and south sides of Building 27 (Figure 2). The fence gate is locked along with all the doors along the South Shed. Padlocked doors and plywood barriers have been installed to prevent access to all areas of the South Shed. The only exception is a small room in the Southeast Tower is open to Building 27 tenants for access to the Hangar water main shutoff valve. This area has been thoroughly surveyed and poses no radiological concerns for the public. Building 2 access doors and stairwells are secured by either plywood barriers or padlocks (Figure 2). Shaw E&I has secured the portions of the two buildings that were found to contain radiological contamination exceeding project cleanup criteria. Weekly inspections are being conducted to deter entry into these areas and to survey Controlled Area boundaries.

5.2 Posting

The Building 27 fencing and all access points to Building 2 and 27 are posted “Controlled Area” in accordance with the Radiological Protection Plan (Appendix C of the Final Work Plan [Shaw E&I, 2010a) and Security Plan (Attachment 10, “Building 27 and Building 2 Security Plan”). Shielding covering hotspots at Building 27 are posted with “Do Not Remove or Disturb” signs and below the shielding are appropriate radiological postings. Radiological postings are in place inside both buildings where necessary in accordance with the RPP. No radiological postings are visible to members of the public. This has been discussed with Washington Department of Health and they concur that this is the preferred method.

5.3 Building 27 Catch Basin Status

After reviewing the sediment results of sewers and catch basins, it was evident that catch basins CB-1, CB-3, and CB-5 had elevated levels of Ra-226 in the sediment. Attachment 11, “Stormwater Catch Basin Sediment Removal and Stabilization Plan,” was written and executed as a precaution to prevent contaminated sediment migration to larger downgradient storm drain pipes. The catch basin inlet and outlet pipes were plugged and the water pumped off the top of the sediment into storage drums. The sediment was scooped out and stored in three separate drums, one for each catch basin. After removing all sediment, quick-drying concrete was added to each basin and troweled over the bottoms and sides of the basin to cover any residual sediment and seal it in place. After the concrete was dry, the plugs were removed from the inlet and outlet pipes and the catch basins resumed their normal function. Radiological job coverage was provided during these activities in accordance with an approved Radiological Work Permit. Contamination levels were maintained within project cleanup criteria and dose rates ranged from 6 microRoentgen per hour to 50 microRoentgen per hour in the catch basins (RSS-432, RSS-433, RSS-434, RSS-435, RSS-445, RSS-446, and RSS-456) (Appendix B). The drums of water and sediment were sampled and stored in the Building 27 RMSA.

5.4 Radiological Waste

Currently stored in the Building 27 RMSA are 15 steel open-top 55-gallon drums containing soil, catch basin sediment (absorbent material added), and dry trash (used protective clothing, tape, smears, etc.) along with a 5-gallon bucket containing the radioactive item found at soil boring number 60. Stored in the Building 2 RMSA are three 55-gallon drums of dry trash, and two sections of contaminated pipe (from the 1941 FIS sink drain line). The two sections of pipe total approximately 10 to 15 feet in length and 3 inches in diameter and the ends are sealed with heavy plastic and tape. Approximately 9 microcuries is estimated to be the total activity for all waste currently stored on site.

5.5 Inspection Schedule

Attachment 10 addresses the measures in place for maintaining security of the site. Both buildings are inspected on a weekly basis to ensure that all points of access are in place and in working order and also to look for evidence of trespassing. Fencing, locks, plywood barriers, postings, and shielding are all inspected for integrity. A dose rate survey is performed at the perimeter of the Building 27 fence, at the doors to the South Shed and Southeast and Southwest Towers. Dose rates are also measured at Building 2 second floor entrances. This is done to ensure that radiological conditions have not changed at the boundaries of the Controlled Areas. Surveys are documented, reviewed, and placed in the project files. A security checklist is completed, signed, and forwarded to the Navy, Shaw E&I, and Seattle Parks Department personnel.

On a monthly basis, a smear survey is conducted at the boundaries of all RCAs to ensure that contamination has not migrated beyond the posted radiological areas. The surveys are filed with the project records.

6.0 Radioactive Waste

Radiological waste generated from characterization and time critical removal activities was properly surveyed, labeled, and stored in secure RMSAs in Building 27 and 2 and temporarily in a locked storage container within the site fence. The waste was sampled and characterized throughout the project for disposal purposes.

6.1 Generation (Activities)

Field activities in which waste was generated include the following:

- Building 27 Radium Room piping and flooring
- Sediment and water removal from catch basins CB-1, CB-3, and CB-5
- Soil excavated to locate sewer pipes
- Soil from soil boring advancement and sampling
- Water and sediment removed during manhole sampling
- Building 2 sink drain line from the 1941 FIS
- General trash and debris, such as used protective clothing and sampling waste

6.2 Disposal

The Navy contracted a waste broker to ship a boring B-25 box and seven 55-gallon drums of waste from the site to a radioactive waste disposal facility. These containers were used to store the Building 27 Radium Room piping and contaminated flooring. The waste shipment occurred on December 1, 2010, and was shipped on two separate manifests. One manifest was for containers that were only low-level radioactive waste and the second as low-level radioactive and hazardous waste due to the Radium Room piping also containing lead, mercury, and cadmium. The total activity for these two manifests was 0.174 millicuries. The radionuclides present were Sr-90, lead-210, lead-214, bismuth-212, bismuth-214, and Ra-226.

Three Baker tanks totaling approximately 50,000 gallons of water were generated during the site characterization (mostly during the manhole sludge sampling process), along with two large roll-off bins containing sediment and water, and three 55-gallon drums of catch basin water. All eight containers were sampled and found to be below State and Federal regulatory release limits for Ra-226 and the waste was disposed of as nonradiological, nonhazardous liquid waste. The Baker tanks and three 55-gallon drums were discharged to the local sanitary sewer system following the Navy's approved permit (Attachment 12, "King County Sanitary Sewer Discharge Permit"). The roll-off bins were transported to an in-state waste treatment facility for disposal of the contents as nonhazardous, nonradioactive solid waste (Appendix D, "Waste Manifests").

7.0 Data Quality Summary Report

A Shaw E&I Project Chemist manually performed a Level III and Level IV data review on the radiological analytical results and a Level II data review on nonradiological analytical results. Level III data review was conducted on all radiological analytical results with Level IV data validation performed on approximately 10 percent of the radiological analytical results.

The data review was performed in accordance with the guidelines and control criteria specified in the Final Work Plan (Shaw E&I, 2010a).

The following quality control elements were included in the Level III radiological data review:

- Laboratory method blanks
- Initial and continuing calibration blanks
- Sample extraction and analysis holding times
- Laboratory control sample/laboratory control sample duplicate recoveries
- Matrix spike/matrix spike duplicate recoveries
- Laboratory control sample/laboratory control sample duplicate, matrix spike/matrix spike duplicate, and relative percent differences
- Inductively coupled plasma serial dilutions (metals)
- Initial calibrations
- Continuing calibrations
- Field and equipment rinse blanks

Data were reviewed in terms of precision, accuracy, representativeness, comparability, and completeness. The precision, accuracy, representativeness, comparability, and completeness parameters were evaluated for the analytical data as follows:

- Accuracy is demonstrated by recovery of target analytes from fortified blank and sample matrices, laboratory control sample/laboratory control sample duplicate, and matrix spike/matrix spike duplicate, respectively. For organic methods, accuracy is also demonstrated through recovery of surrogates from each field and quality control sample. The recovery of target analytes from fortified samples is compared to acceptance criteria. When these criteria are not met, the data are flagged accordingly.
- Precision is expressed as the relative percent differences between the results of replicate sample analyses: sample duplicates, laboratory control sample duplicates, and matrix spike duplicates. When analyte relative percent differences exceed the acceptance criteria, the data are flagged accordingly.

- Representativeness of the samples submitted for analysis is ensured by adherence to standard sampling techniques and protocols.
- Comparability of sample results is ensured through the use of approved sampling and analysis methods.
- Completeness is expressed as a ratio of the number of usable data to all analytical data.

Appendix E, “Data Quality Summary Report,” presents a data quality summary report for each sample delivery group.

8.0 Conclusions

The following summary and conclusions are based on the results of the radiological surveys and sampling conducted by Shaw E&I for the US Navy at NAVSTA PS during a field investigation from April 2010 through December 2010:

- **Building 27**
    - Radiological contamination above project cleanup criteria within Building 27 is limited to the South Shed and the two adjoining towers (southwest and southeast towers) (Figure 11).
    - No radiological contamination above project cleanup criteria was found in the public areas surveyed within the hangar.
    - Radiological contamination above project cleanup criteria was found in the wood flooring that was exposed upon removal of the remodeled flooring in nearly all the rooms on the second floor of the South Shed.
    - The migration of radiological contamination into the wood subfloor below the T&G wood flooring appears to have been impeded by a layer of roofing-type tar paper found between the wood floor and subfloor, with the exception of floor penetrations (i.e., former steam piping) or areas where former walls had been removed and the roofing paper did not originally exist.
    - At penetrations and former wall locations (where the walls were removed), radiologiacal contamination appears to have migrated to the subfloor and in the three locations where the subfloor was removed (Radium Room and two locations in the Safety Chief Room), radiological contamination had migrated to the floor joists.
    - Radiological contamination above project cleanup criteria was found at limited locations on the walls (less than 2 meters) of the second floor, primarily near the location of former floor vents and steam radiators.
    - Radiological contamination above project cleanup criteria was found on one ceiling vent into the attic of the South Shed.
    - No radiological contamination above project cleanup criteria was found on the ceiling or roof of the South Shed.
    - Radiological contamination above project cleanup criteria on the first floor was limited to the concrete floor of the Welding Shop near the slab penetration location of the removed Radium Room drainpipe and one site consistent with dripping from a ceiling penetration into the second floor.
    - Radiological contamination above project cleanup criteria was found on the second floor and the metal stairs of the southwest tower and on the first floor and the metal stairs of the southeast tower.

  - The source of the radiological contamination probably originated from activities within the Instrument Shop and appears to have been spread throughout the building during cleanup activities (mopping).

- **Building 2**
  - Radiological contamination above project cleanup criteria within Building 2 was limited to the 1939 Instrument Shop, the 1941 Instrument Shop, the area immediately adjacent to (south and east) the 1941 Instrument Shop, and the 1941 Instrument Shop ventilation system (Figure 17).
  - Radiological contamination above project cleanup criteria was found in the wood flooring that was exposed upon removal of floor tile of the 1939 and 1941 Instrument Shops and on brick walls after removal of wallboard construction.
  - Assessment of the wood subfloor was not conducted due to public occupancy of the first floor. However, construction in this building did not include floor penetrations from second floor wall construction and floor joists are open to the first floor. It is unlikely that the subfloor or joist spaces are contaminated in areas where the wood floor is contaminated.
  - The area of radiological contamination above project cleanup criteria was limited to three one meter squares and a small area of the south wall in the 1939 Instrument Shop (Figure 17).
  - No other radiological contamination above project cleanup criteria was found on the walls, ceilings, or ventilation of the 1939 Instrument Shop.
  - The extent of radiological contamination above project cleanup criteria on the 1941 Instrument Shop floor was more substantial than the 1939 Instrument Shop and extends up to 6 meters laterally south and 5 meters to the east of the 1941 Instrument Shop footprint.
  - Only one measurement on the northern brick wall of the 1941 Instrument Shop exceeded project cleanup criteria. It appears that this was the location of the former sink.
  - With the exception of the 1941 Instrument Shop ventilation system, no radiological contamination above project cleanup criteria was found on the ceiling or ceiling vents (Figure 19) in areas surveyed. The ventilation system exhaust ducts (accessed from the attic) are contaminated with levels exceeding project cleanup criteria. With the 1941 Instrument Shop ventilation being a closed-loop system, there is a potential that contamination exceeding project cleanup criteria extends to other areas of the ventilation system.
  - No radiological contamination above project cleanup criteria was found on the first floor, except within the removed section of drain pipe associated with the 1941 sink.
  - The source of the radiological contamination probably originated from activities within the 1939 and 1941 Instrument Shops and in the case of the 1941 Instrument

Shop appears to have been spread to an area south during cleanup activities (mopping).

- **Storm and Sewer Piping and Pump Houses Surrounding Building 27**
  - The former Radium Room sink piping that penetrated the concrete floor of the Welding Shop on the first floor of Building 27 is connected to the storm drain line that runs south out of the building and west to catch basin CB-3 (Figure 7).
  - Catch basin CB-3 connects to manholes MH-141, to MH-137, to MH-160 and discharges to Lake Washington.
  - Of the sludge samples collected within this storm line, only samples collected from catch basin CB-3 were found to contain Ra-226 exceeding project cleanup criteria.
  - Drain pipes from former sinks located near the center of the South Shed (Building 27) are connected to the storm drain line that traverses south to catch basin CB-1.
  - Catch basin CB-1 connects to the adjacent 24-inch storm line that runs north to manholes MH-136, to MH-1005 to MH-160 and discharges to Lake Washington.
  - Of the sludge samples collected within this storm line, only samples collected from catch basin CB-1 were found to exceed project cleanup criteria.
  - A former janitor's sink located in the Regimen Staff Office (second floor) and the sinks and toilets of the existing restroom located on the first floor are connected to the sanitary sewer at manhole MH-223.
  - Manhole MH-223 connects to NOAA-1, to NOAA-1.5, and to the NOAA pump station.
  - None of the sludge samples collected within manholes along this sanitary sewer line (including manholes MH-233 and MH-22) was found to exceed project cleanup criteria.
  - None of the sludge samples collected from manholes of the gravity feed sewer line on the west side of Building 27 (manholes MH-224, MH-225, MH-234, MH-226, and MH-227) were found to contain Ra-226 exceeding project cleanup criteria.
  - None of the sludge samples collected within the inactive pressurized sewer line at the valve pit near Pump House 98 and at a sample point near Pump House 117 contained Ra-226 concentrations exceeding project cleanup criteria.
  - None of the pump houses (116, 117, and 98) were found to contain radiological readings exceeding project cleanup criteria.

- **Storm Piping along Building 2**
  - The removed piping of the former sink of 1941 Former Instrument Shop that was found to contain sludge exceeding project cleanup criteria is connected to the storm line that runs along the west side of Building 2 at manhole MH-134 (Figure 17).

  - None of the sludge samples collected within accessible locations in Building 2, in manholes east of Building 2 (manholes MH-162, MH-134, and MH-135) as well as manholes under and north of Building 27 discussed earlier (manholes MH-136, MH-1005, and MH-160) were found to exceed project cleanup criteria.

- **Soil**
  - Results of the GWS and soil samples collected indicate that soil containing Ra-226 concentrations exceeding project cleanup criteria is present in historically unpaved (nontarmac) areas south and west of Building 27 (Figure 30).
  - The vertical extent of this soil appears to be limited to a layer of soil typically 1 to 2 feet thick within the 3 to 5 feet of soil above ground water depending on elevation and whether the area received fill from past construction of the NOAA overpass.
  - Results of the GWS and soil samples collected indicate that soil containing Ra-226 concentrations exceeding project cleanup criteria is present in limited areas along the north side of Building 12 (Figure 33) and the south and east side of Building 2 (Figure 34).
  - The vertical extent of this soil appears to be limited to a thin layer of soil typically less than 2 feet below ground surface.
  - The source of the Ra-226 concentrations in soil appears to be a result of historical release of mop water containing Ra-226 from past cleaning activities.
  - However, a single discrete item (radioactive button) was found and removed from the soil along the east side of Building 2.

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Figures

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SCALE

0 1500 3000 FEET

SOURCE: 2009 GOOGLE-MAP DATA @ 2009 TELE ATLAS

SCALE: 1"=2 MILES

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FIGURE 1

SITE LOCATION MAP

FORMER NAVAL STATION - PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

XREF Files: IMAGE Files: sanpoint site.jpg
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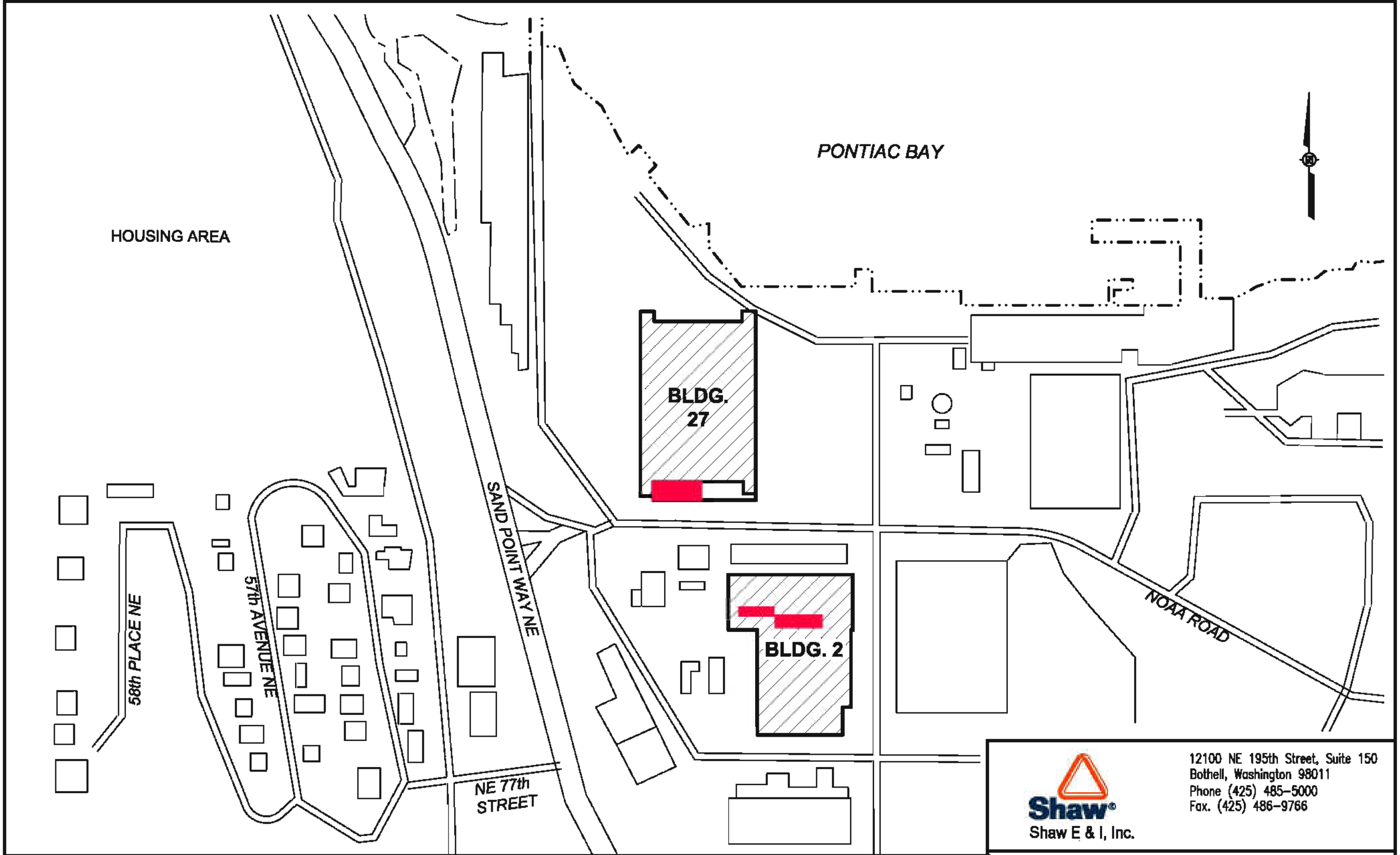

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SCALE

0 600 1200 FEET

SOURCE: 2009 GOOGLE-MAP DATA @ 2009 TELE ATLAS

LEGEND:

🟥 APPROXIMATE LOCATIONS OF INVESTIGATIONS

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FIGURE 2

LOCATION OF BLDG. 27 & BLDG. 2

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

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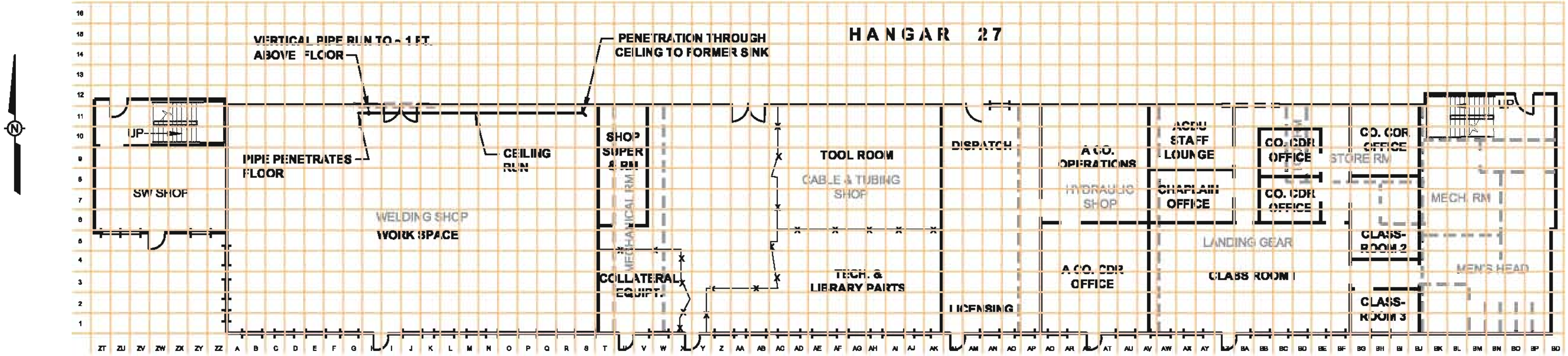
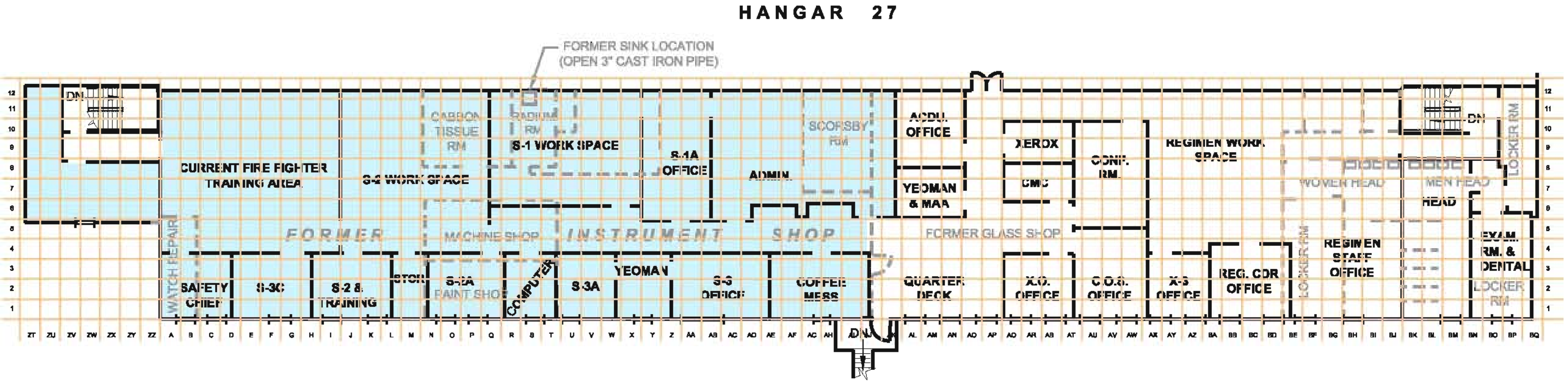


FIRST FLOOR PLAN



SECOND FLOOR PLAN

LEGEND:

- - - - -	OUTLINE OF BUILDING (1943)
———	OUTLINE OF BUILDING (1985)
▭	FORMER INSTRUMENT SHOP AREA

SCALE

0 20 40 FEET

SOURCE: US NAVAL STATION, SEATTLE WASHINGTON
BUILDING 27 PLAN - 1985 (DRAWING #54151)
1943 (DRAWING #54080)

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FIGURE 3
FLOOR PLAN OF BLDG. 27
FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

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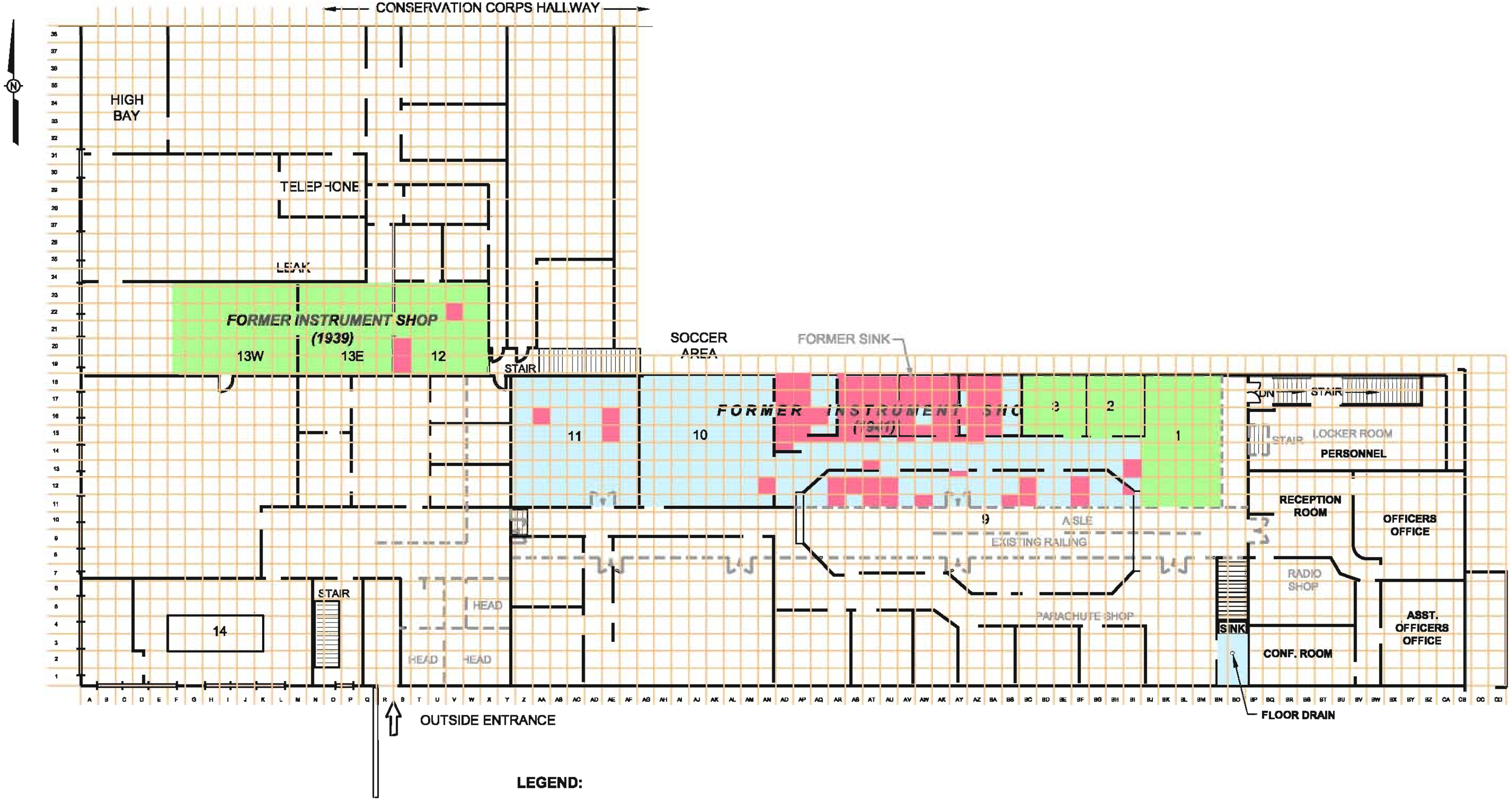

LEGEND:

- - - -	OUTLINE OF BUILDING (1941)	🟥	ABOVE PROJECT RELEASE CRITERIA
——	OUTLINE OF BUILDING (1986)	🟩	BELOW PROJECT RELEASE CRITERIA
🟦	FORMER INSTRUMENT SHOPS		

SCALE
0 20 40 FEET

SOURCE: US NAVAL STATION, SEATTLE WASHINGTON
BUILDING 2 PLAN - 1986 (DRAWING #50263)
1941 (DRAWING #50106)
1939 (DRAWING #50030)

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FIGURE 4
FLOOR PLAN OF BLDG. 2
(SECOND FLOOR)
FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

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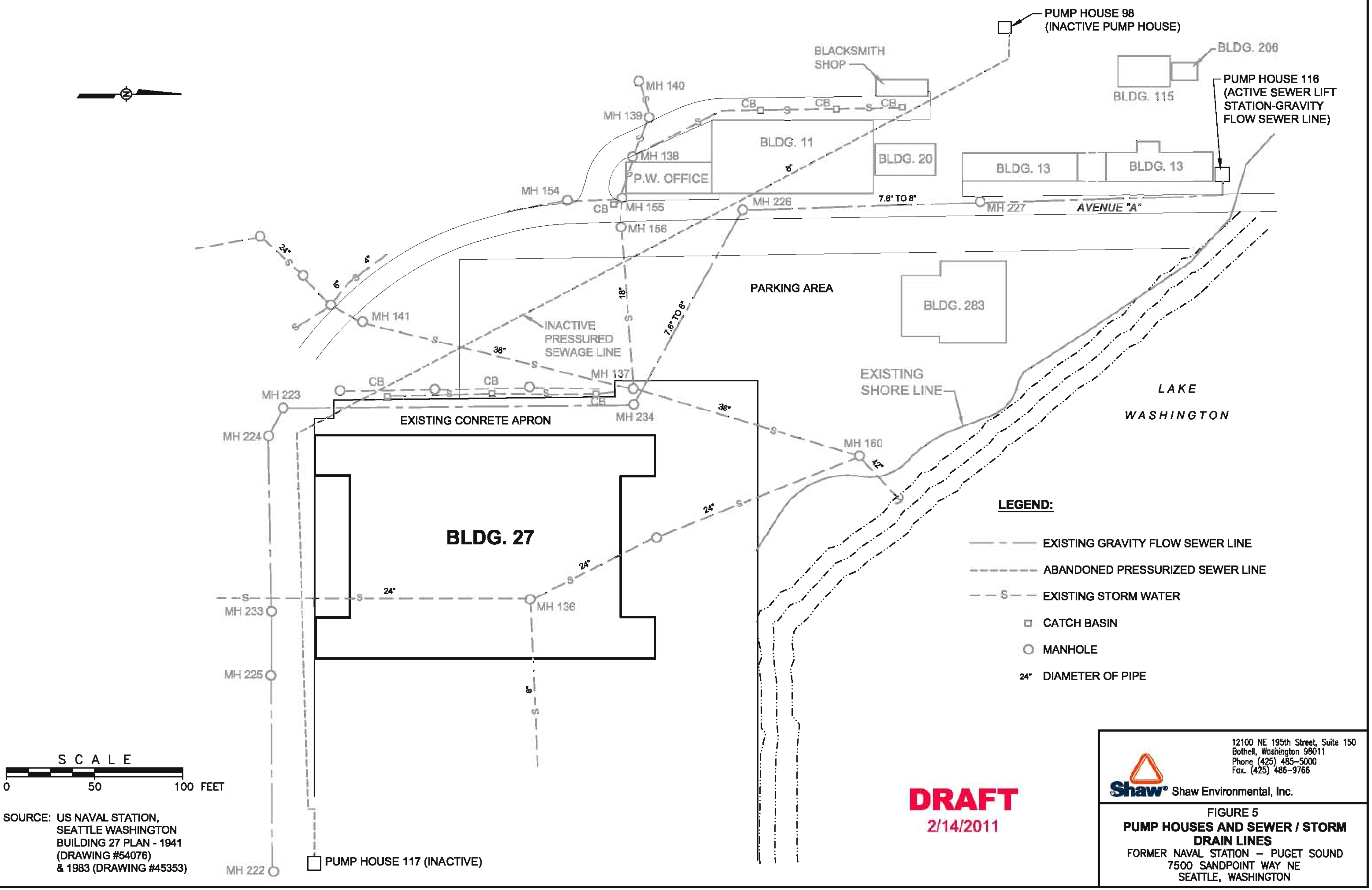

SOURCE: US NAVAL STATION,
SEATTLE WASHINGTON
BUILDING 27 PLAN - 1941
(DRAWING #54076)
& 1983 (DRAWING #45353)

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FIGURE 5

PUMP HOUSES AND SEWER / STORM DRAIN LINES

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

XREF Files: IMAGE Files:
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Figure 6
Pump House 98 Valve Pit

OFFICE	DRAWING NUMBER	
Bothell, WA		BT-137165-B2

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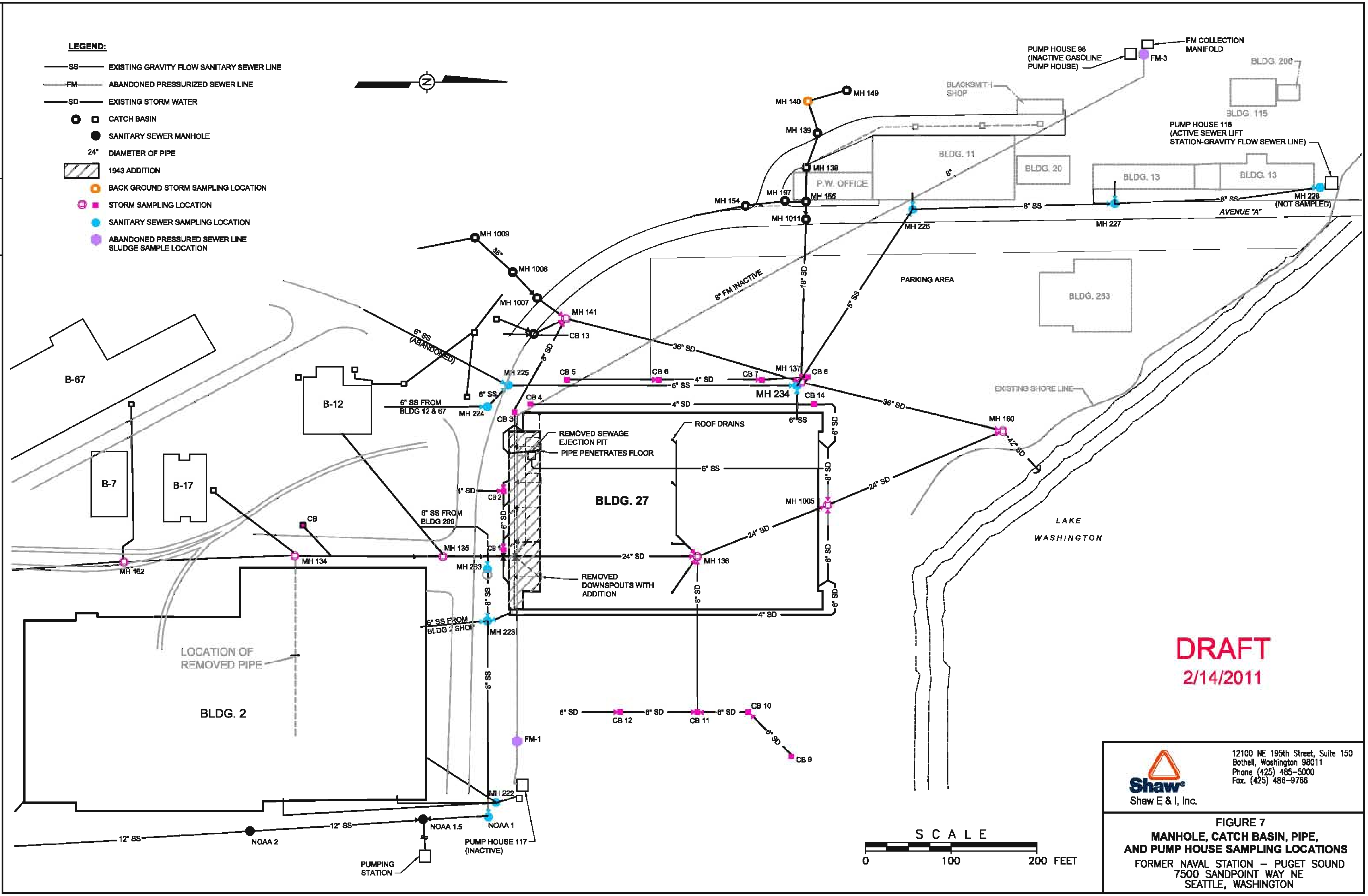

LEGEND:

- —SS— EXISTING GRAVITY FLOW SANITARY SEWER LINE
- —FM— ABANDONED PRESSURIZED SEWER LINE
- —SD— EXISTING STORM WATER
- ◙ ▫ CATCH BASIN
- ● SANITARY SEWER MANHOLE
- 24" DIAMETER OF PIPE
- ▨ 1943 ADDITION
- ◙ BACK GROUND STORM SAMPLING LOCATION
- ◙ ■ STORM SAMPLING LOCATION
- ● SANITARY SEWER SAMPLING LOCATION
- ⬢ ABANDONED PRESSURED SEWER LINE SLUDGE SAMPLE LOCATION

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FIGURE 7
MANHOLE, CATCH BASIN, PIPE, AND PUMP HOUSE SAMPLING LOCATIONS

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

Figure 8
Distribution of Soil Reference Area Gamma Walkover Survey Count Rates

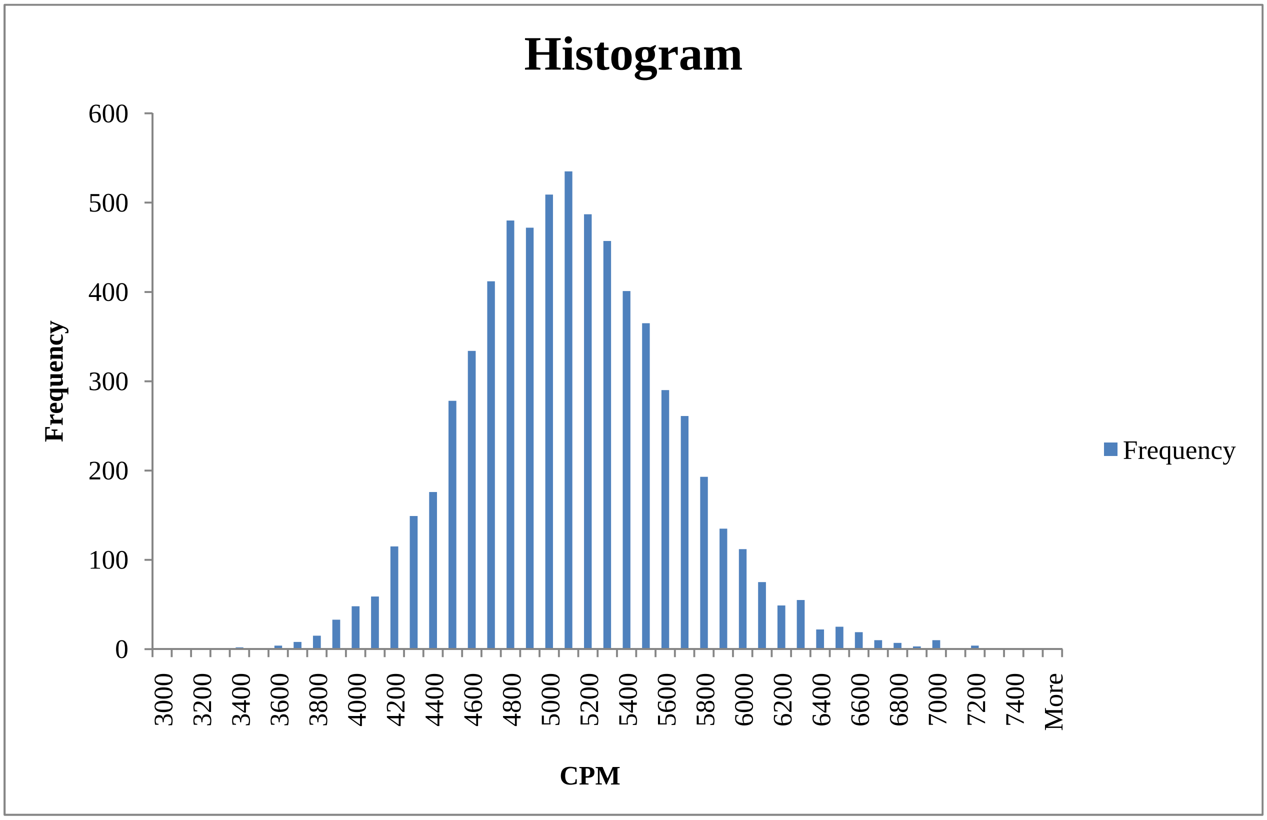
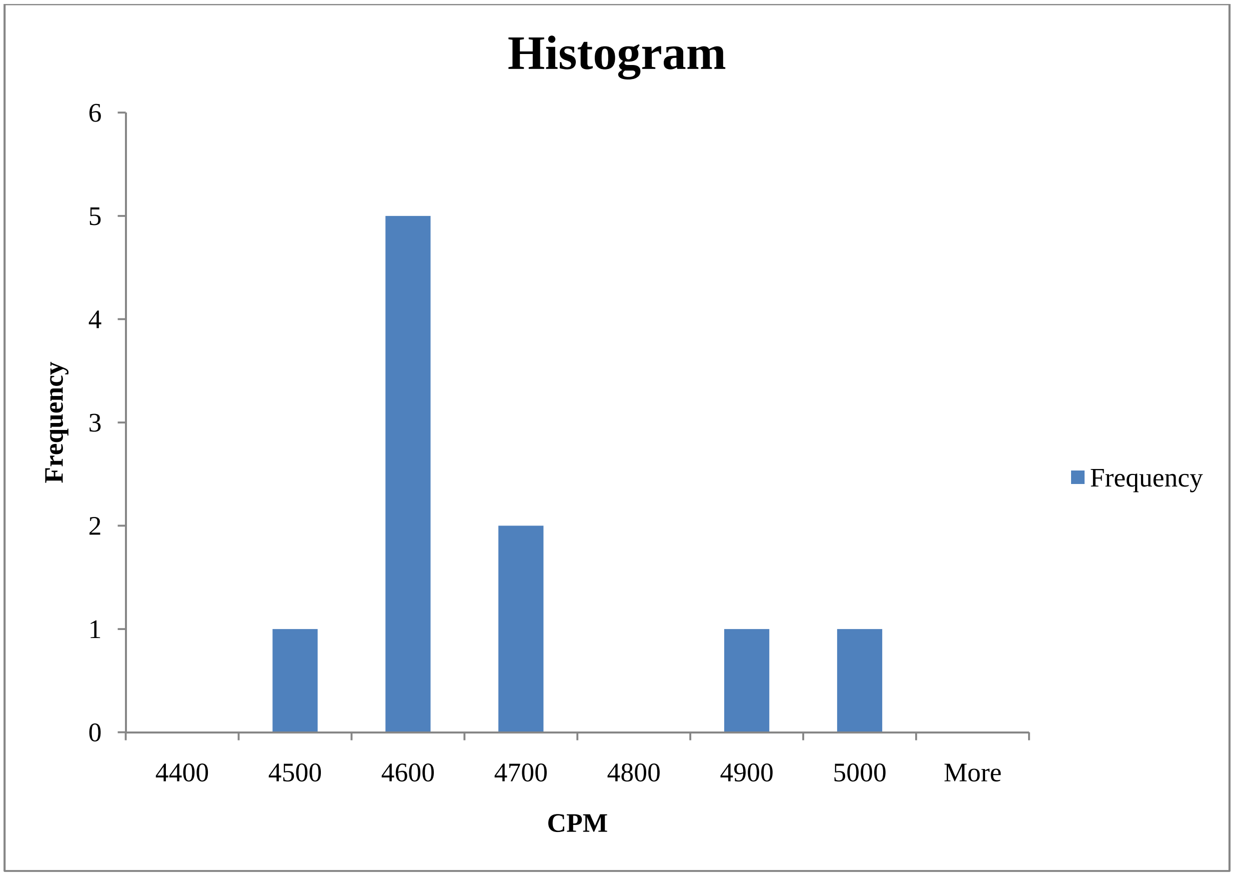


Figure 9
Distribution of Soil Reference Area Static Count Rates



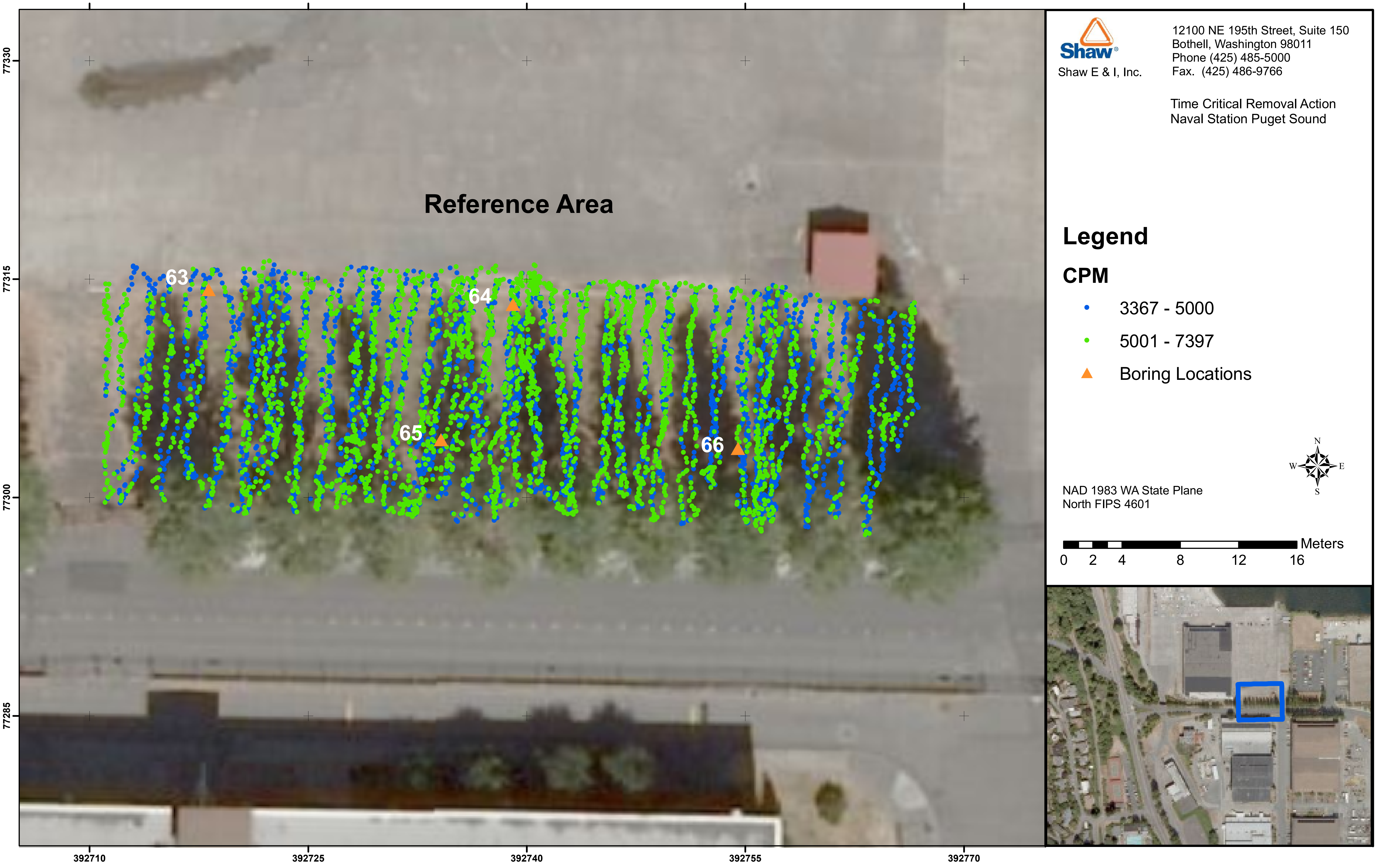
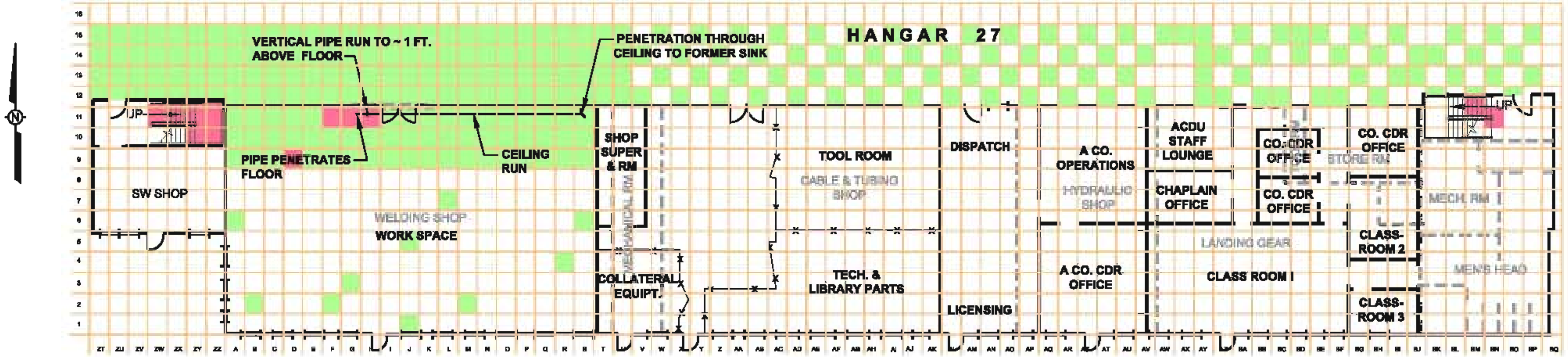
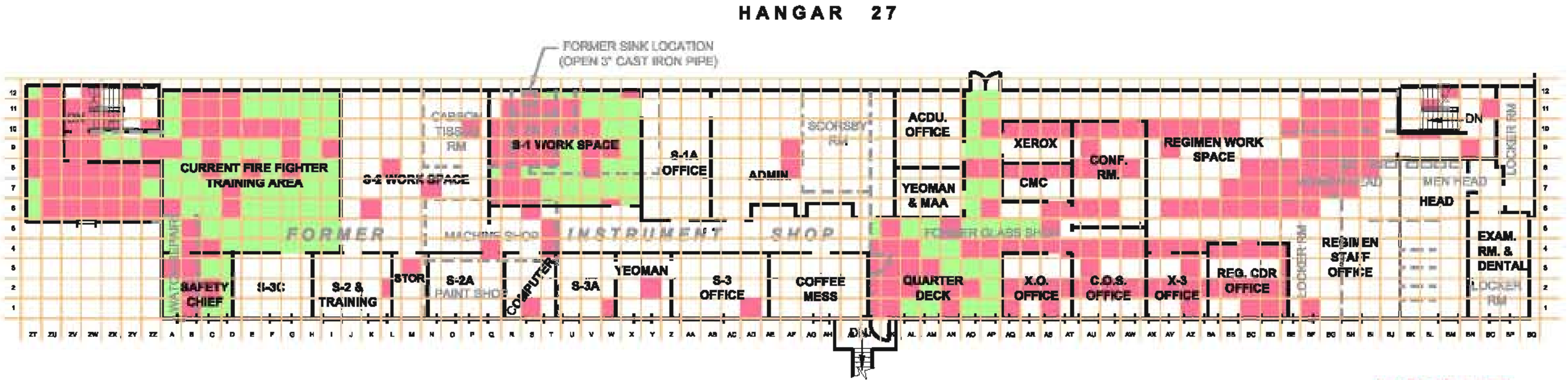


Figure 10 Reference Area Boring Locations



FIRST FLOOR PLAN

DATA SOURCE: RSS-084, RSS-120, RSS-132, RSS-328



SECOND FLOOR PLAN

LEGEND:

- - - - OUTLINE OF BUILDING (1943)
——— OUTLINE OF BUILDING (1985)
🟥 ABOVE PROJECT CLEAN-UP CRITERIA
🟩 BELOW PROJECT CLEAN-UP CRITERIA
☐ NOT SURVEYED

SCALE
0 20 40 FEET

SOURCE: US NAVAL STATION, SEATTLE WASHINGTON
BUILDING 27 PLAN - 1985 (DRAWING #54151)
1943 (DRAWING #54080)

DATA SOURCE: RSS-040, RSS-041, RSS-046, RSS-059, RSS-062, RSS-066, RSS-116, RSS-134, RSS-148

PROJECT CLEANUP CRITERIA

	Removable	Average
Ra-226	20 dpm α/100cm^2	100 dpm α/100cm^2
Beta-gamma	1,000 dpm β-γ/100cm^2	5,000 dpm β-γ/100cm^2

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FIGURE 11
SUMMARY OF RADIOLOGICAL SURVEY RESULTS - BLDG. 27 (FIRST & SECOND FLOOR)
FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

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Figure 12
Cross-Section of Radium Room Flooring

Figure 13
Previously Removed Wall Penetrating Flooring

Figure 14
Radium Room Floor – Joist Space

Figure 15
Survey of Floor Joist Space (Insulation) – Safety Chief Office

Figure 16
West Floor Exhaust Vent

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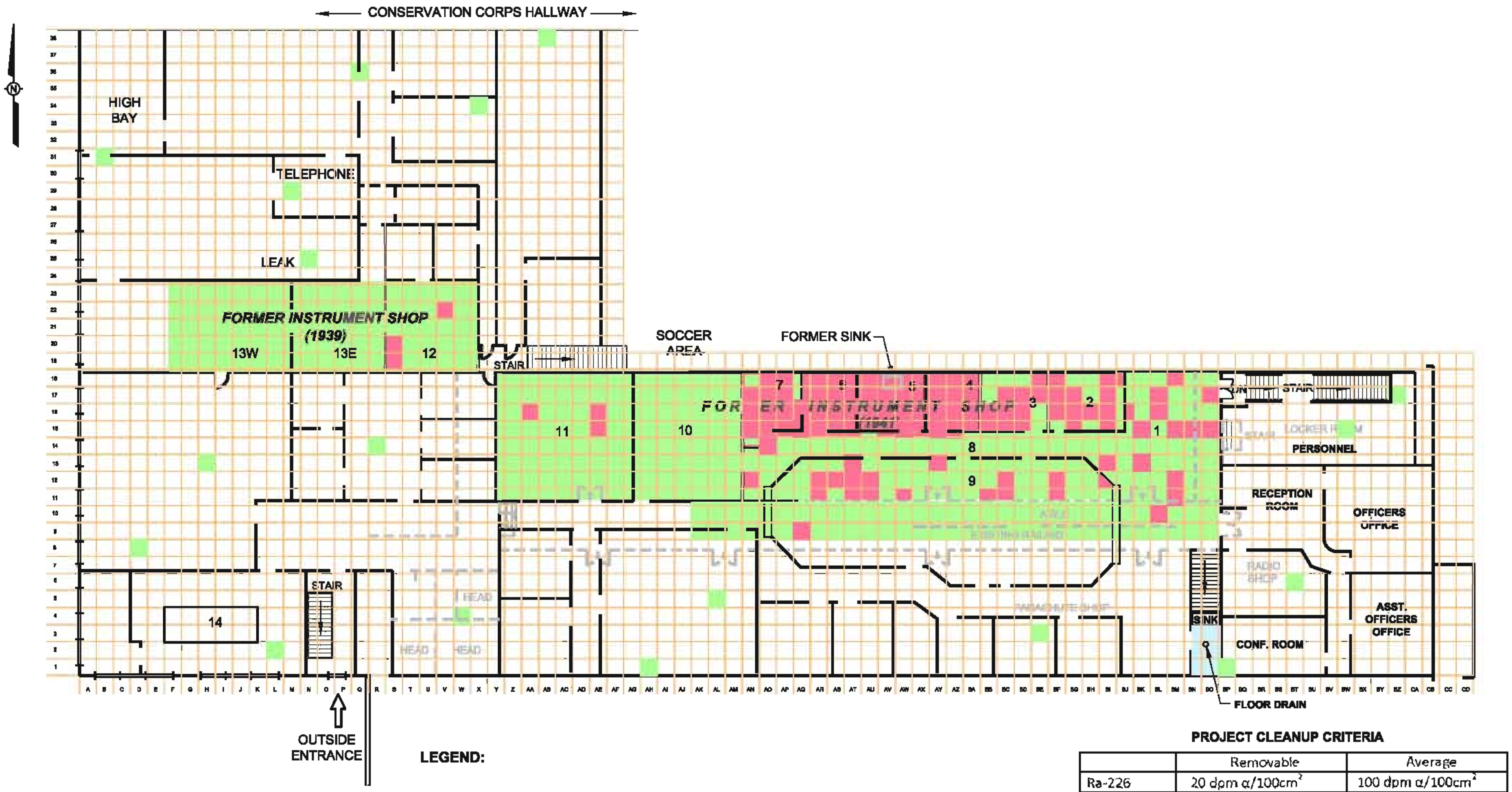

PROJECT CLEANUP CRITERIA

	Removable	Average
Ra-226	20 dpm α/100cm^2	100 dpm α/100cm^2
Beta-gamma	1,000 dpm β-γ/100cm^2	5,000 dpm β-γ/100cm^2

LEGEND:

- - - - OUTLINE OF BUILDING (1941)
—— OUTLINE OF BUILDING (1986)

🟥 ABOVE PROJECT CLEAN-UP CRITERIA
🟩 BELOW PROJECT CLEAN-UP CRITERIA
☐ NOT SURVEYED

DATA SOURCE: RSS-326, 330, 333, 339, 345, 353, 354, 359, 360, 363, 364,366,414,441,443,450,453,457,462

SCALE
0 20 40 FEET

SOURCE: US NAVAL STATION, SEATTLE WASHINGTON
BUILDING 2 PLAN - 1986 (DRAWING #50263)
1941 (DRAWING #50106)
1939 (DRAWING #50030)

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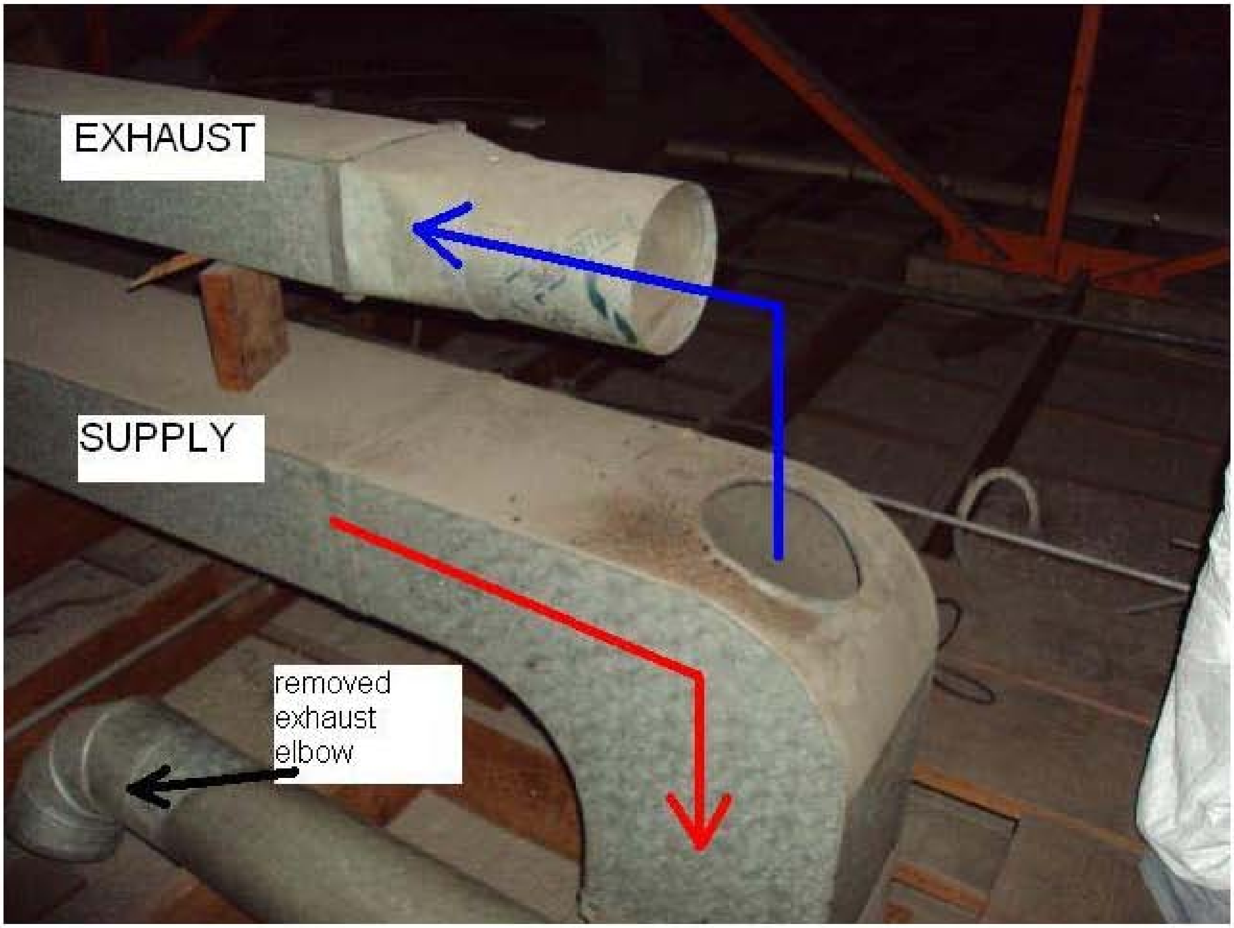
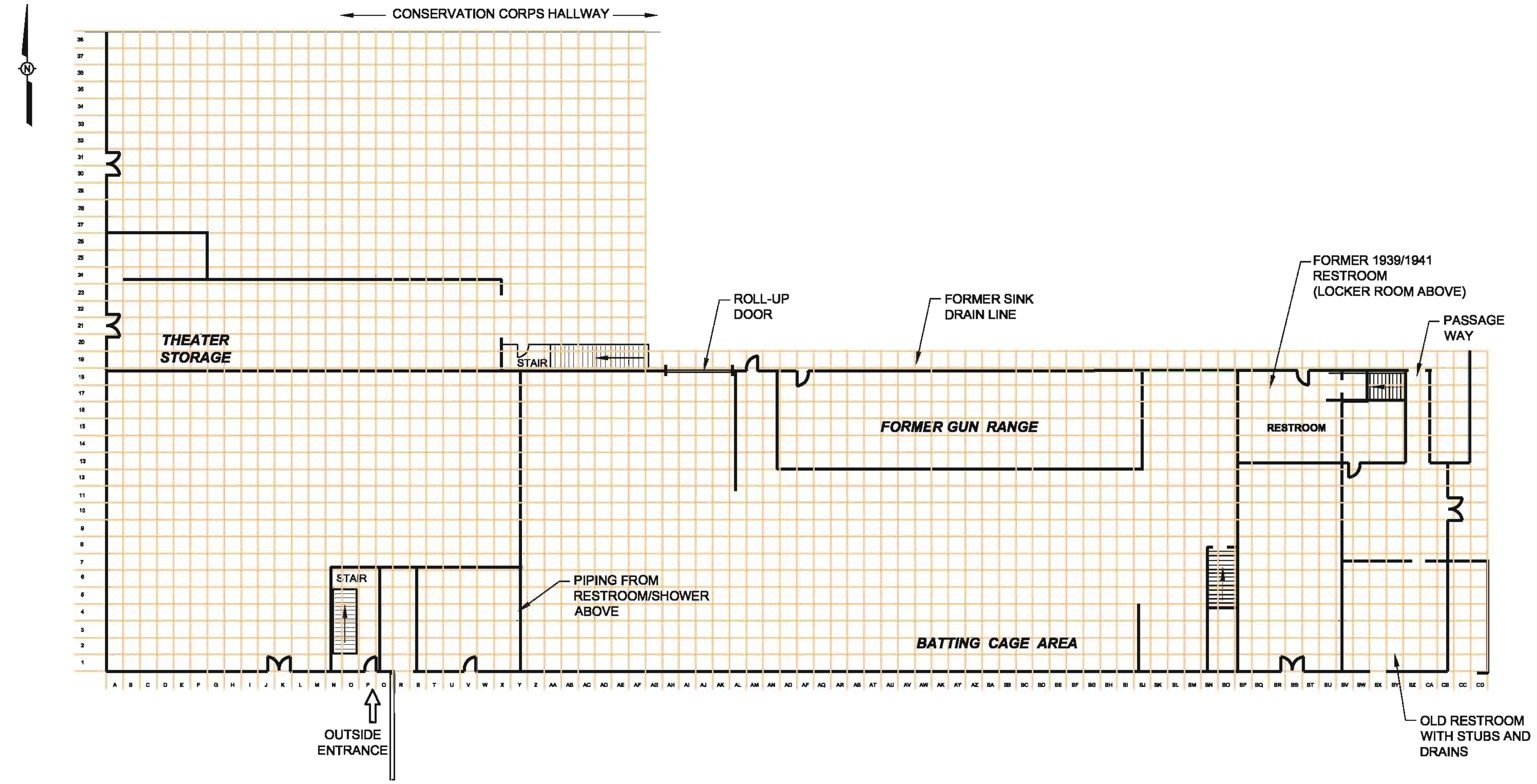
FIGURE 17
RADIOLOGICAL SURVEYS OF BLDG. 2 (SECOND FLOOR)
FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

Figure 18
1941 Former Instrument Shop Northern Brick Wall

Figure 19
1941 Former Instrument Shop Ventilation System





SCALE

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SOURCE: US NAVAL STATION, SEATTLE WASHINGTON
BUILDING 2 PLAN - 1986 (DRAWING #50263)
1941 (DRAWING #50106)
1939 (DRAWING #50030)

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FIGURE 20
BUILDING 2 PLAN LAYOUT
(FIRST FLOOR)
FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

Figure 21 1941 Former Instrument Shop Sink Location

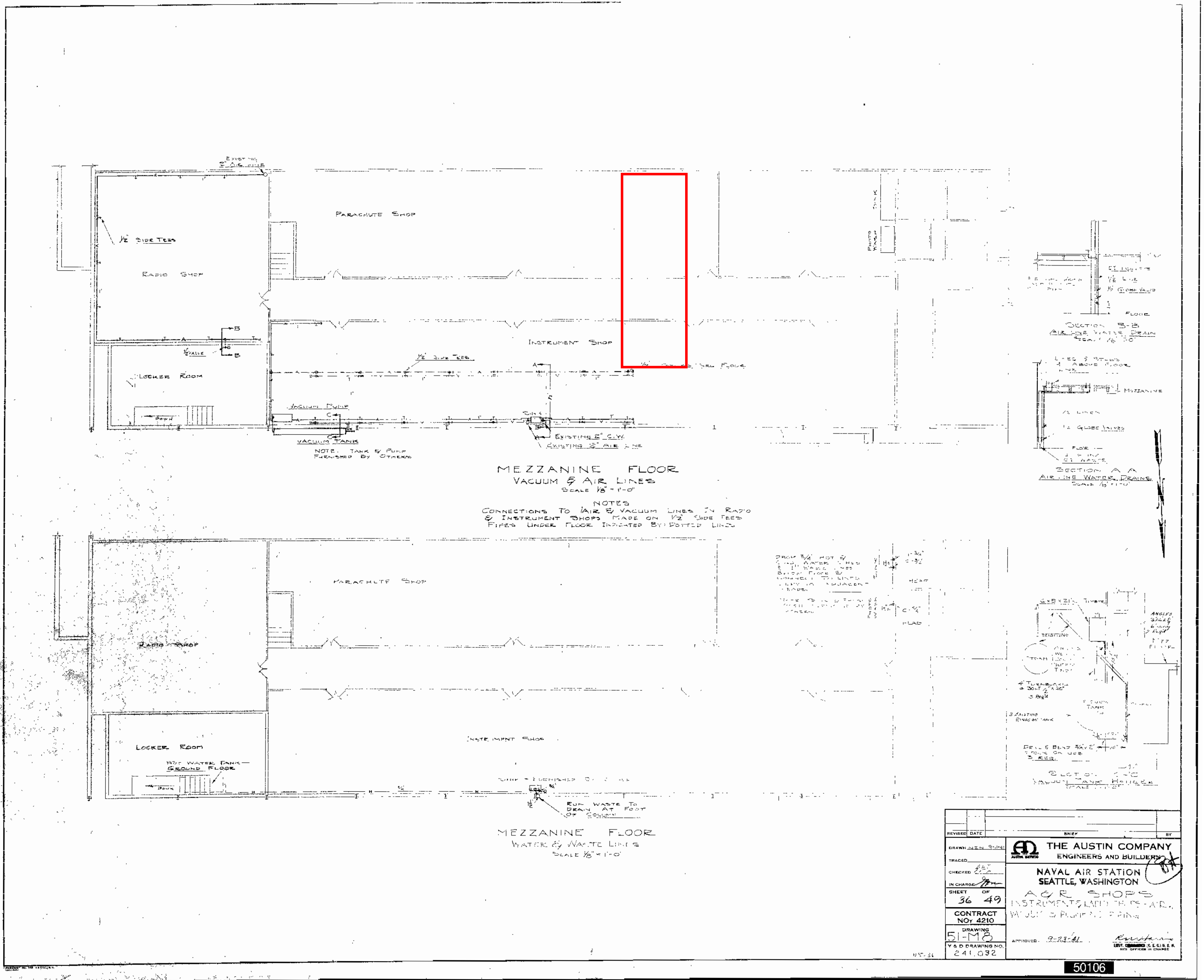
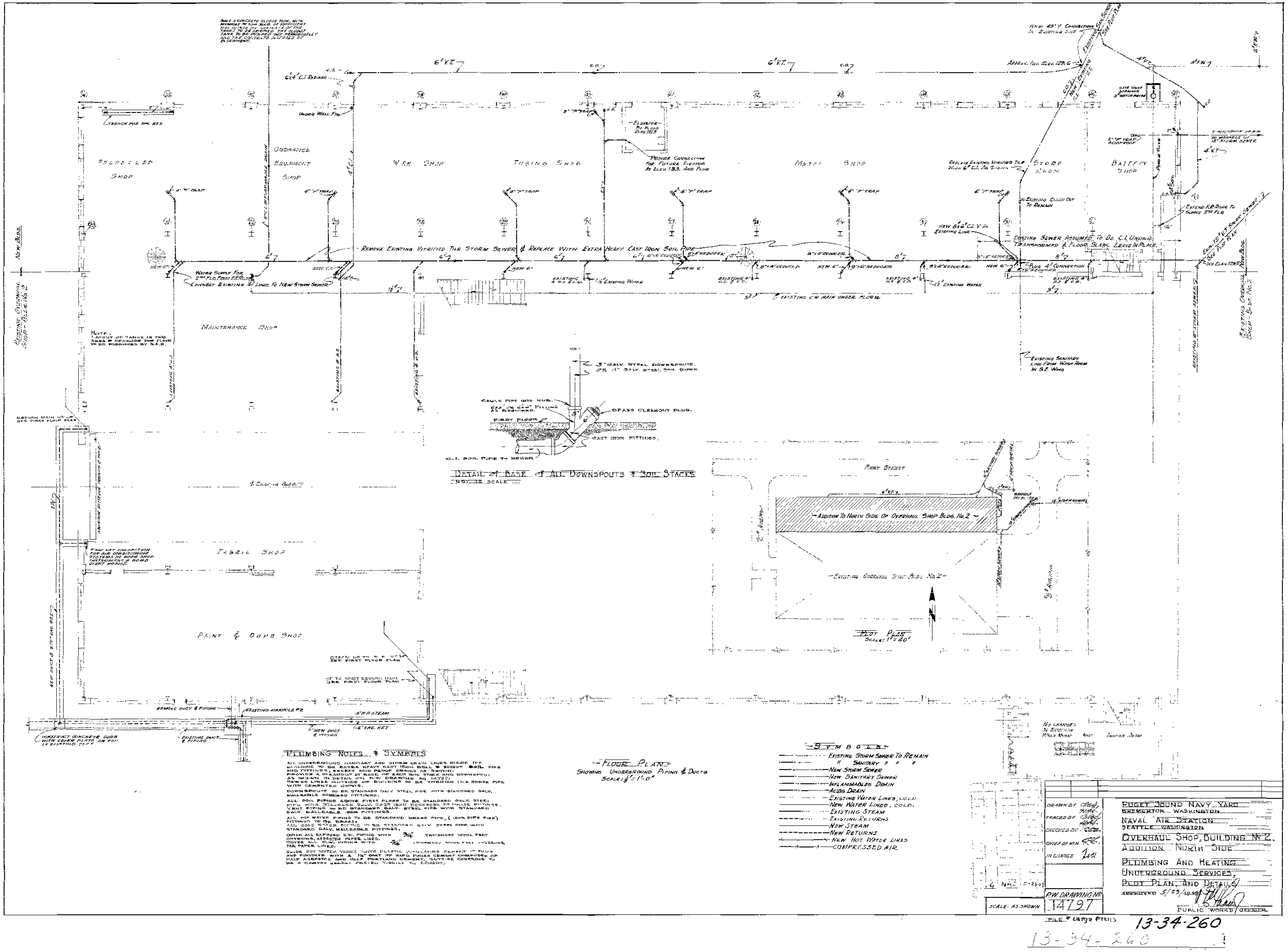


Figure 22 Building 2 Locker Room and Restroom Location



DRAWING NUMBER BT-137165-B6

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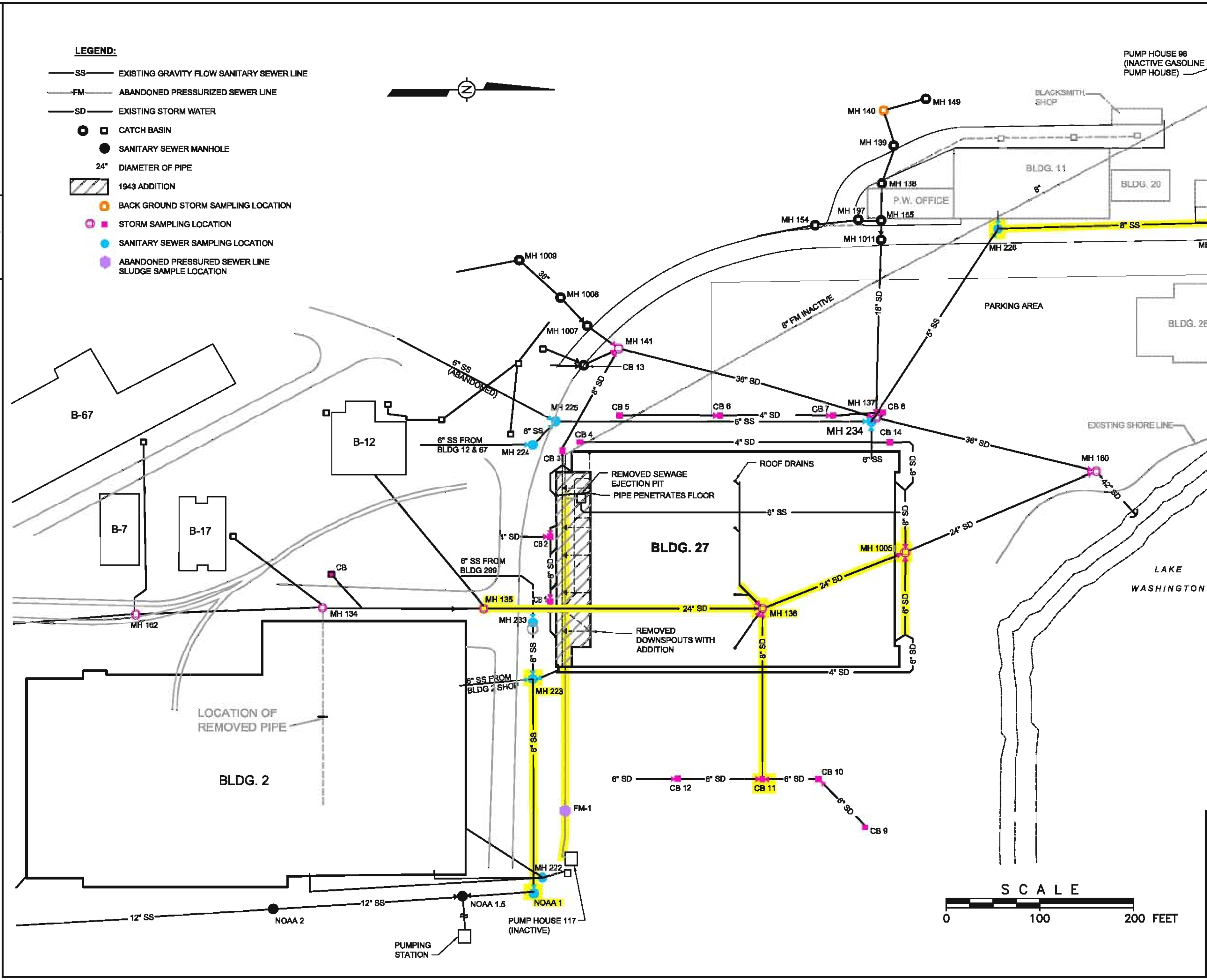

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FIGURE 23

SEWER AND STORM LINE
VIDEO INSPECTION LOCATIONS

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

XREF Files: IMAGE Files:
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Figure 24
Pipe Crawler Coupled with Sodium Iodide 2 inch by 2 inch Detector

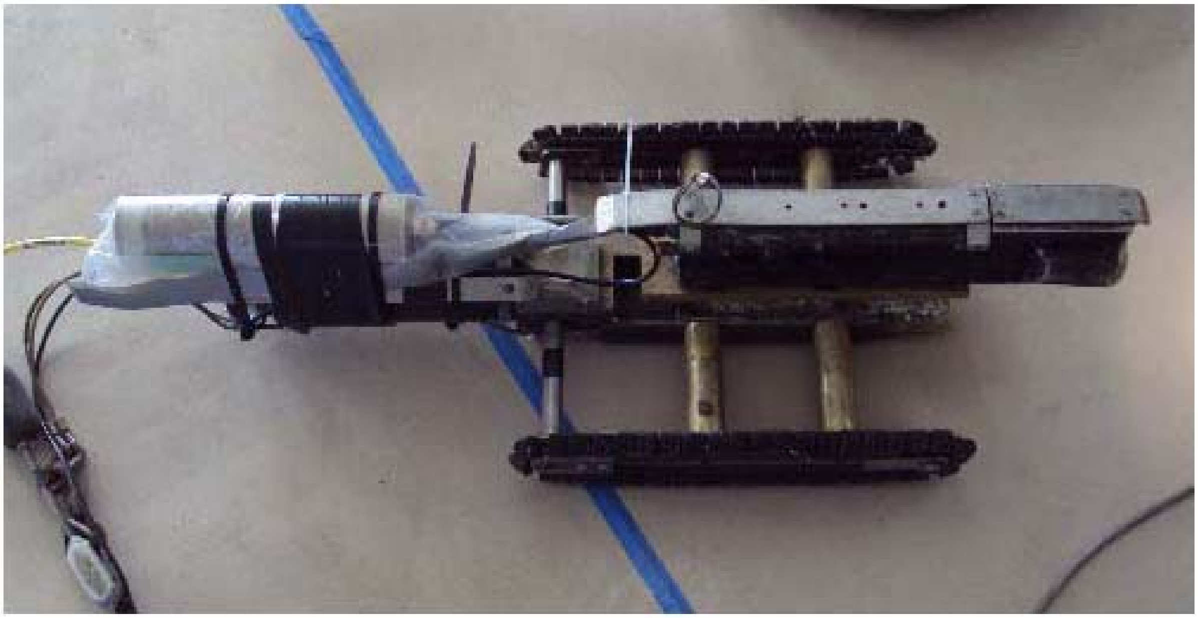


Figure 25
Gamma Survey Results from Manholes MH-135 to MH-1005

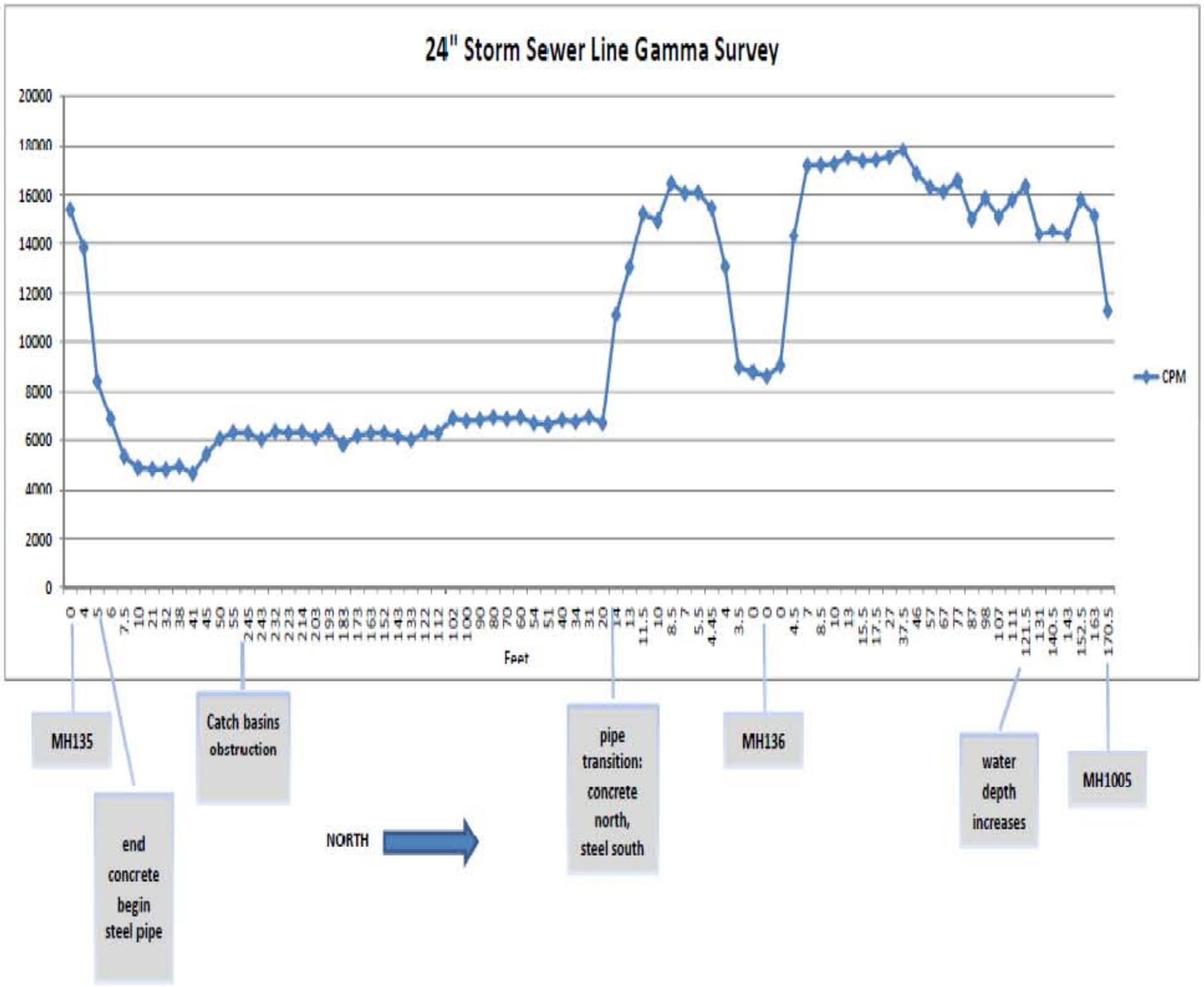


Figure 26
Tractor Coupled with Sodium Iodide 2 inch by 2 inch Detector

Figure 27
24 Inch Storm Sewer Line Obstruction near Catch Basin CB-1

Figure 28
Concrete and Brick Construction Inside Manhole MH-135

Figure 29
Concrete Construction Inside Manhole MH-136

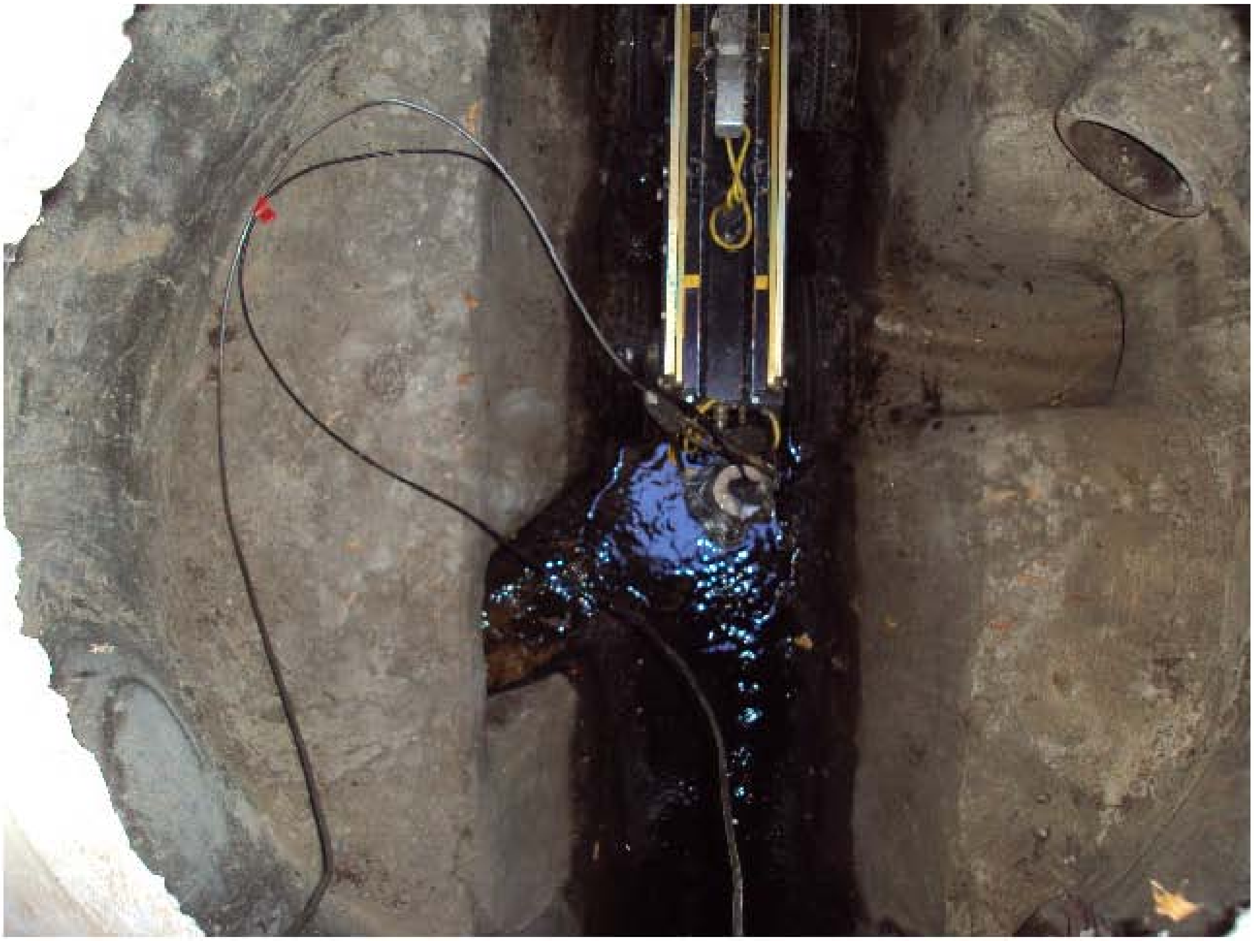
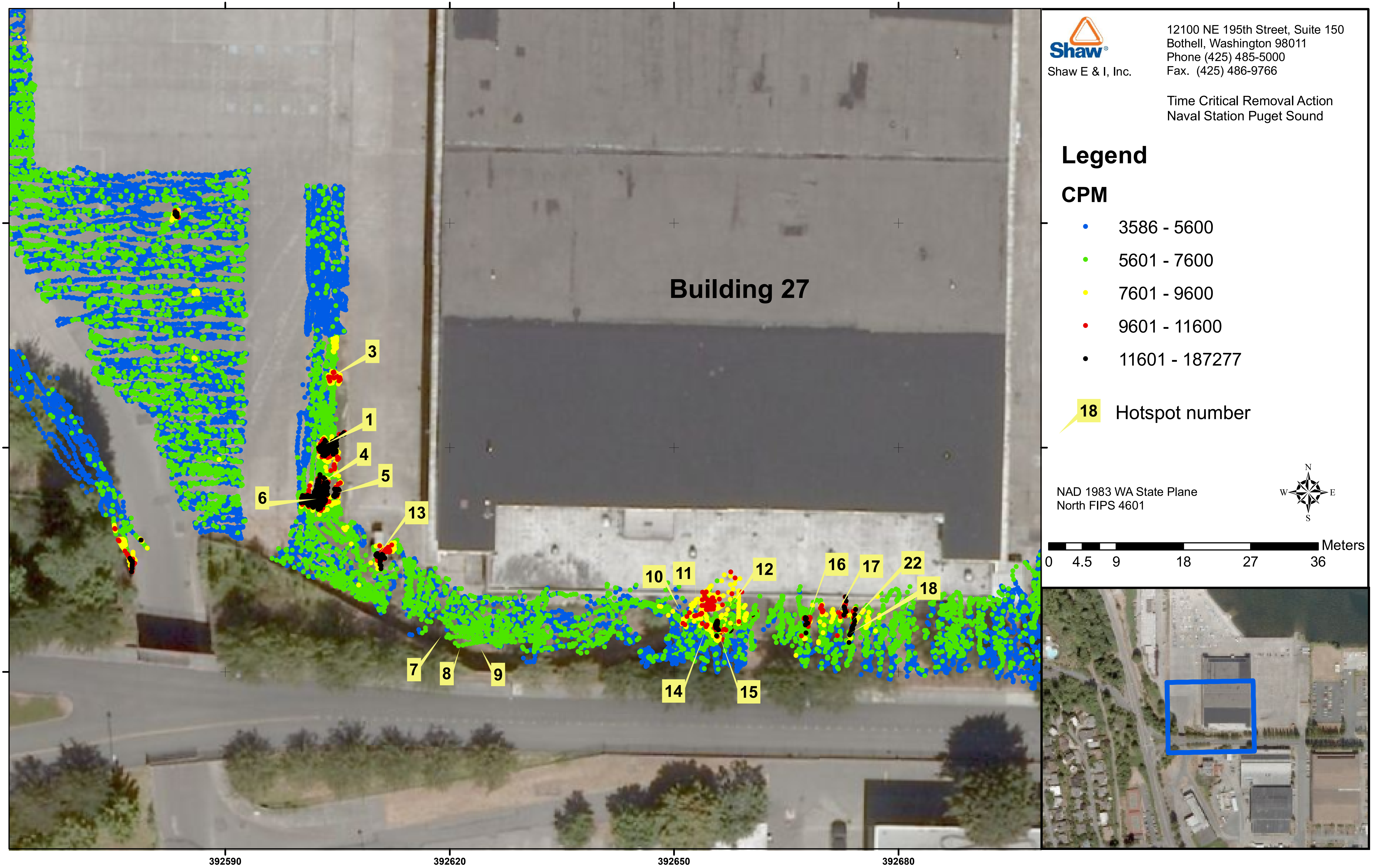


Figure 30 Hotspot Locations Near Building 27



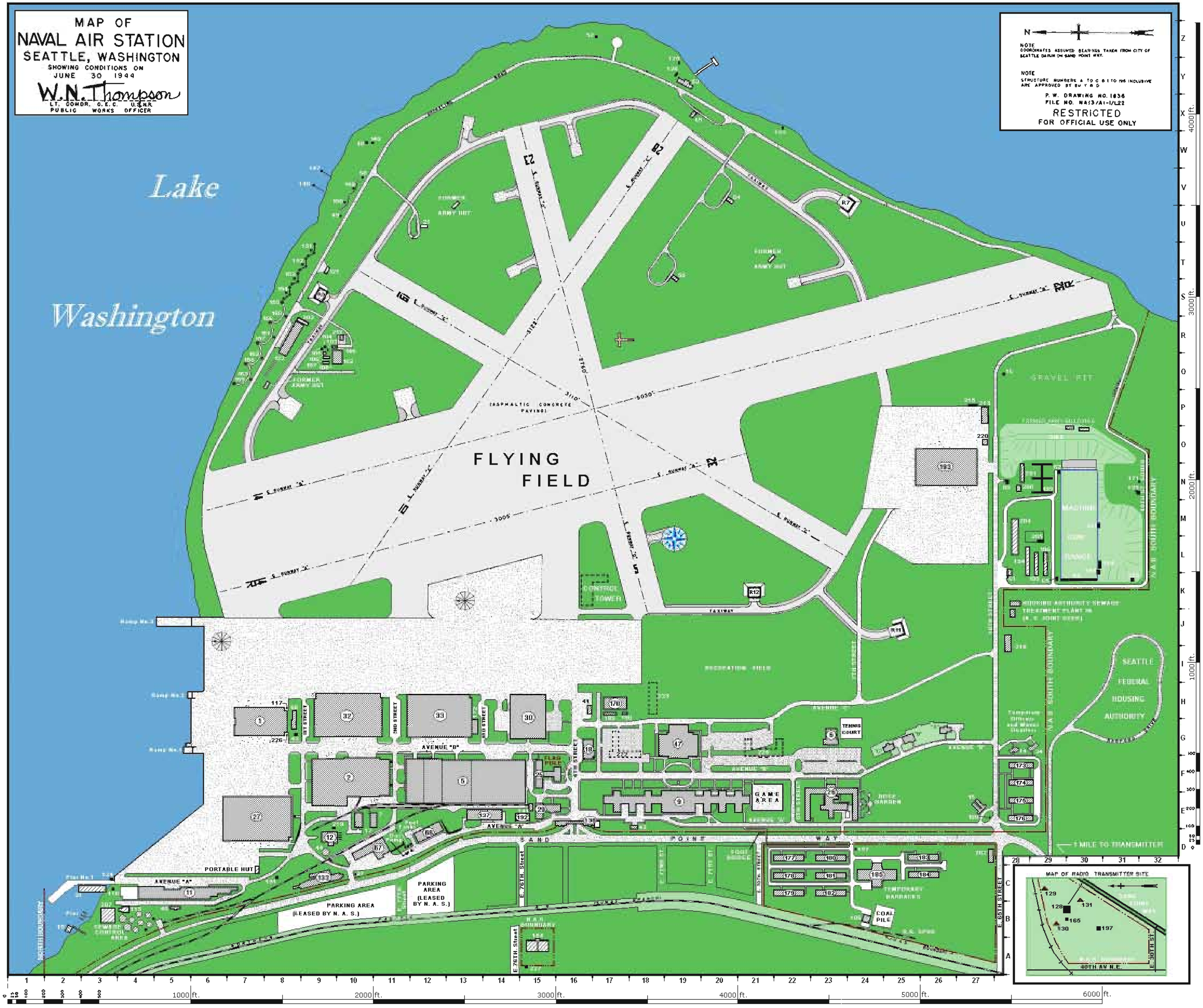


Figure 31 Previous Soil Covered Areas Around Buildings 2, 12, and 27

Figure 32 Hotspot Locations West of Building 27

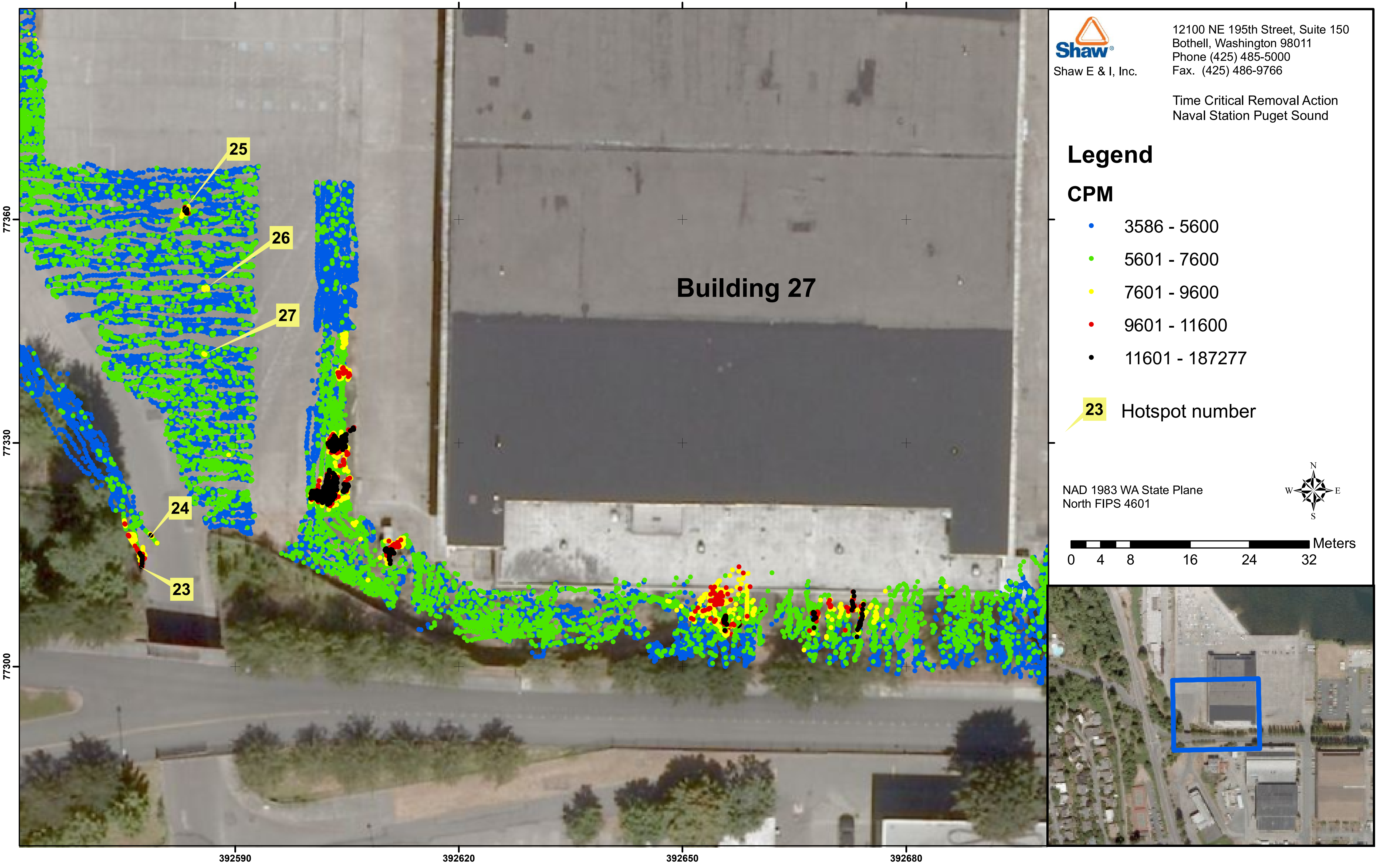


Figure 33 Hotspot Locations Near Building 12

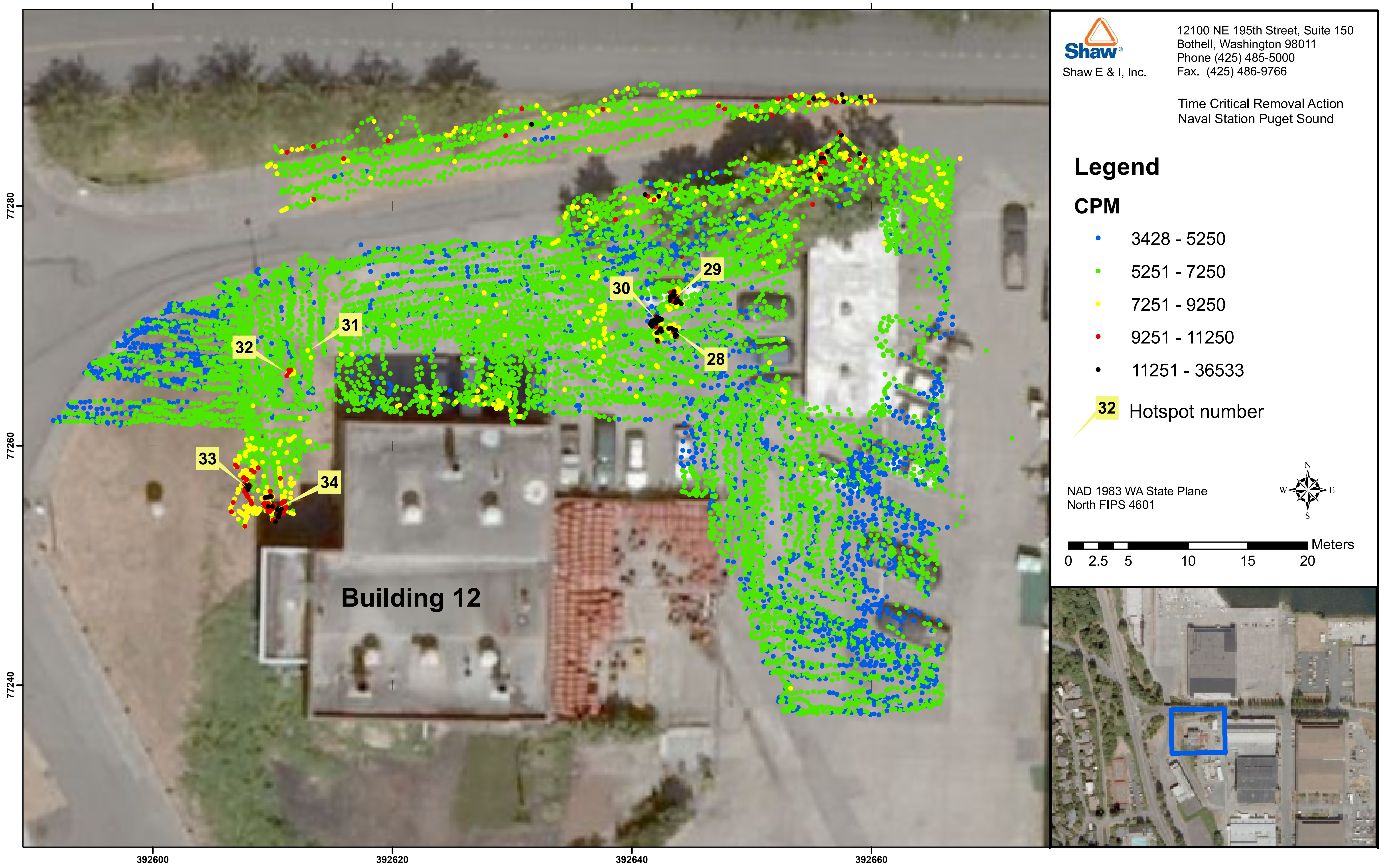
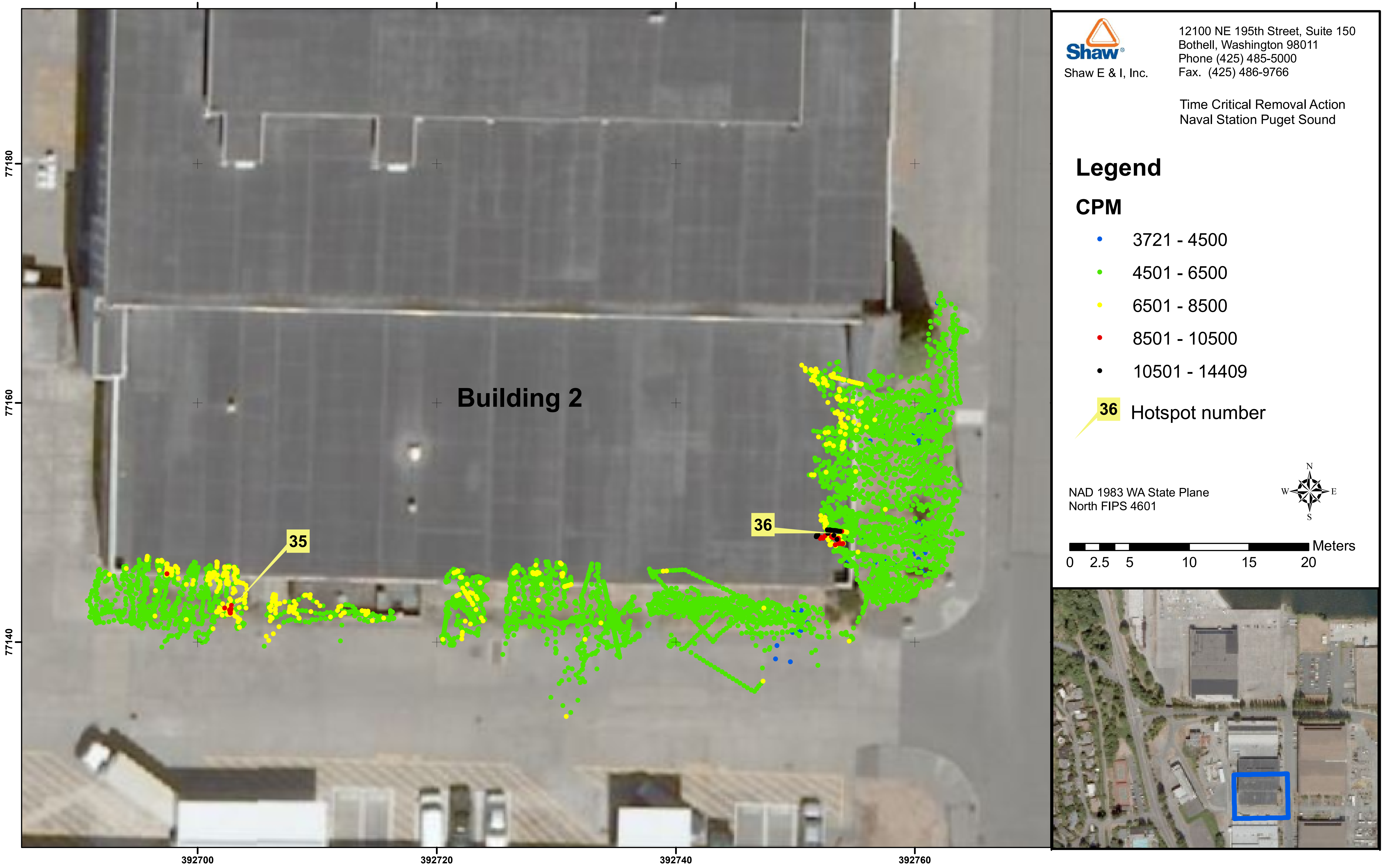
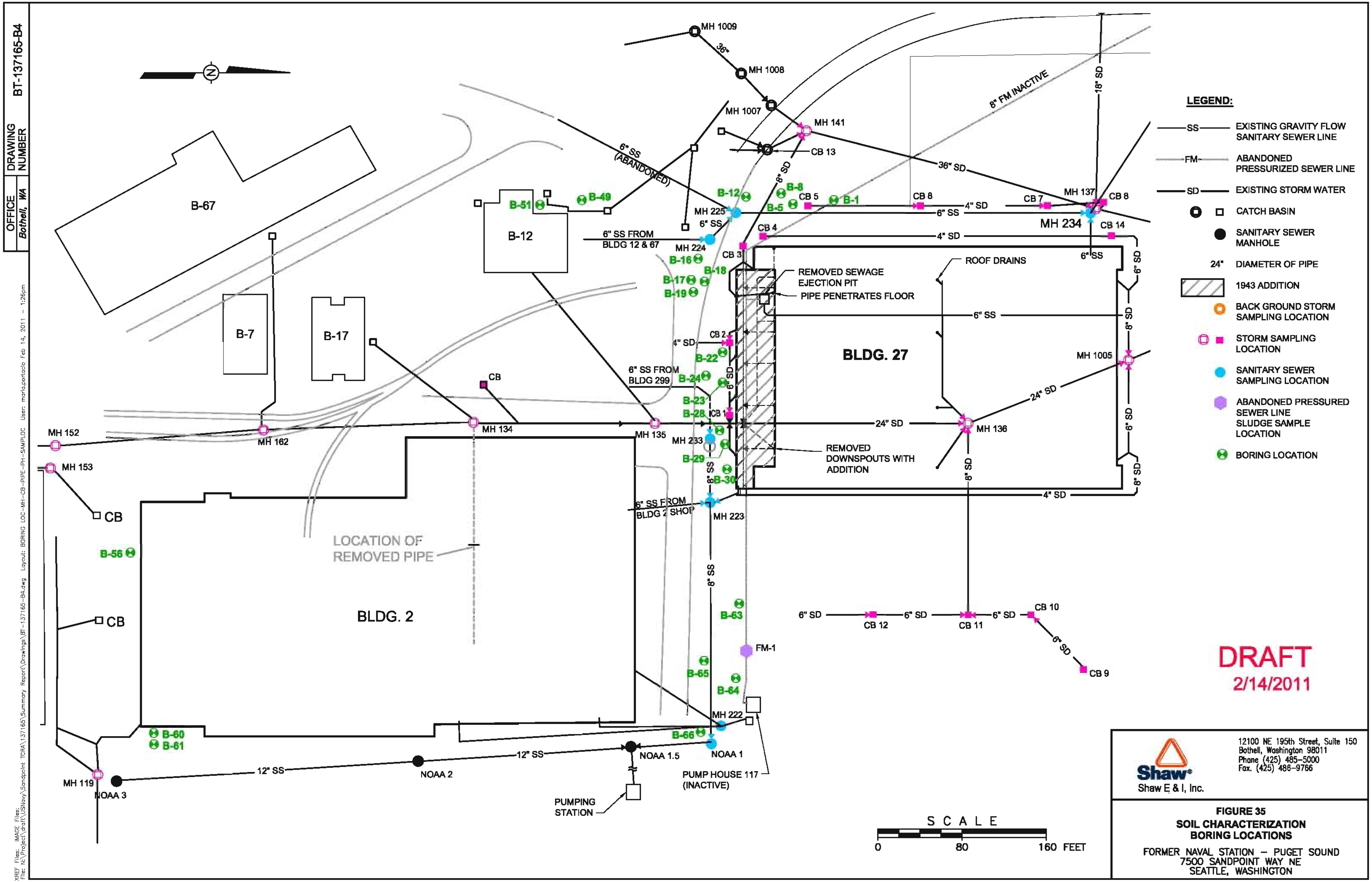


Figure 34 Hotspot Locations Near Building 2





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DRAWING NUMBER
BT-137165-B4

XREF Files: IMAGE Files:
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Shaw® Shaw E & I, Inc.

12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
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FIGURE 35
SOIL CHARACTERIZATION
BORING LOCATIONS

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

Figure 36 Soil Concentration versus Depth

Boring Number - Ra-226 (pCi/g)

depth	1	5	HS1	HS6	8	12
0.0'-0.5'						
0.5'-1.0'			2150	41.9	0.497	0.409
1.0'-1.5'		1.05				
1.5'-2.0'	0.461					
2.0'-2.5'						
2.5'-3.0'						
3.0'-3.5'						
3.5'-4.0'						
4.0'-4.5'						
4.5'-5.0'						
5.0'-5.5'						

Boring Number - Ra-226 (pCi/g)

depth	16	18	17	19
0.0'-0.5'		0.646	2.17	0.356
0.5'-1.0'	0.457			
1.0'-1.5'				
1.5'-2.0'			0.365	
2.0'-2.5'				
2.5'-3.0'				
3.0'-3.5'				
3.5'-4.0'				
4.0'-4.5'				
4.5'-5.0'				

Boring Number - Ra-226 (pCi/g)

depth	22	23	24
0.0'-0.5'		5.88	
0.5'-1.0'	0.89		
1.0'-1.5'			420
1.5'-2.0'			
2.0'-2.5'		1.54	
2.5'-3.0'			
3.0'-3.5'			
3.5'-4.0'			
4.0'-4.5'			
4.5'-5.0'			3.2

Boring Number - Ra-226 (pCi/g)

depth	28	29	HS16	HS17	30
0.0'-0.5'		16.6			
0.5'-1.0'				3.3	1.21
1.0'-1.5'			7.81		
1.5'-2.0'					
2.0'-2.5'		0.791			
2.5'-3.0'	0.563				
3.0'-3.5'					
3.5'-4.0'					
4.0'-4.5'					
4.5'-5.0'					

Boring Number - Ra-226 (pCi/g)

depth	HS23
0.0'-0.5'	1.89
0.5'-1.0'	0.66
1.0'-1.5'	
1.5'-2.0'	
2.0'-2.5'	
2.5'-3.0'	
3.0'-3.5'	
3.5'-4.0'	
4.0'-4.5'	
4.5'-5.0'	

Figure 36 Soil Concentration versus Depth

Boring Number - Ra-226 (pCi/g)

depth	49	51
0.0'-0.5'	0.759	0.816
0.5'-1.0'		
1.0'-1.5'		
1.5'-2.0'	0.605	0.618
2.0'-2.5'		☐
2.5'-3.0'		
3.0'-3.5'		
3.5'-4.0'		
4.0'-4.5'		
4.5'-5.0'		

Boring Number - Ra-226 (pCi/g)

depth	56
0.0'-0.5'	1.47
0.5'-1.0'	
1.0'-1.5'	
1.5'-2.0'	
2.0'-2.5'	
2.5'-3.0'	
3.0'-3.5'	
3.5'-4.0'	
4.0'-4.5'	
4.5'-5.0'	

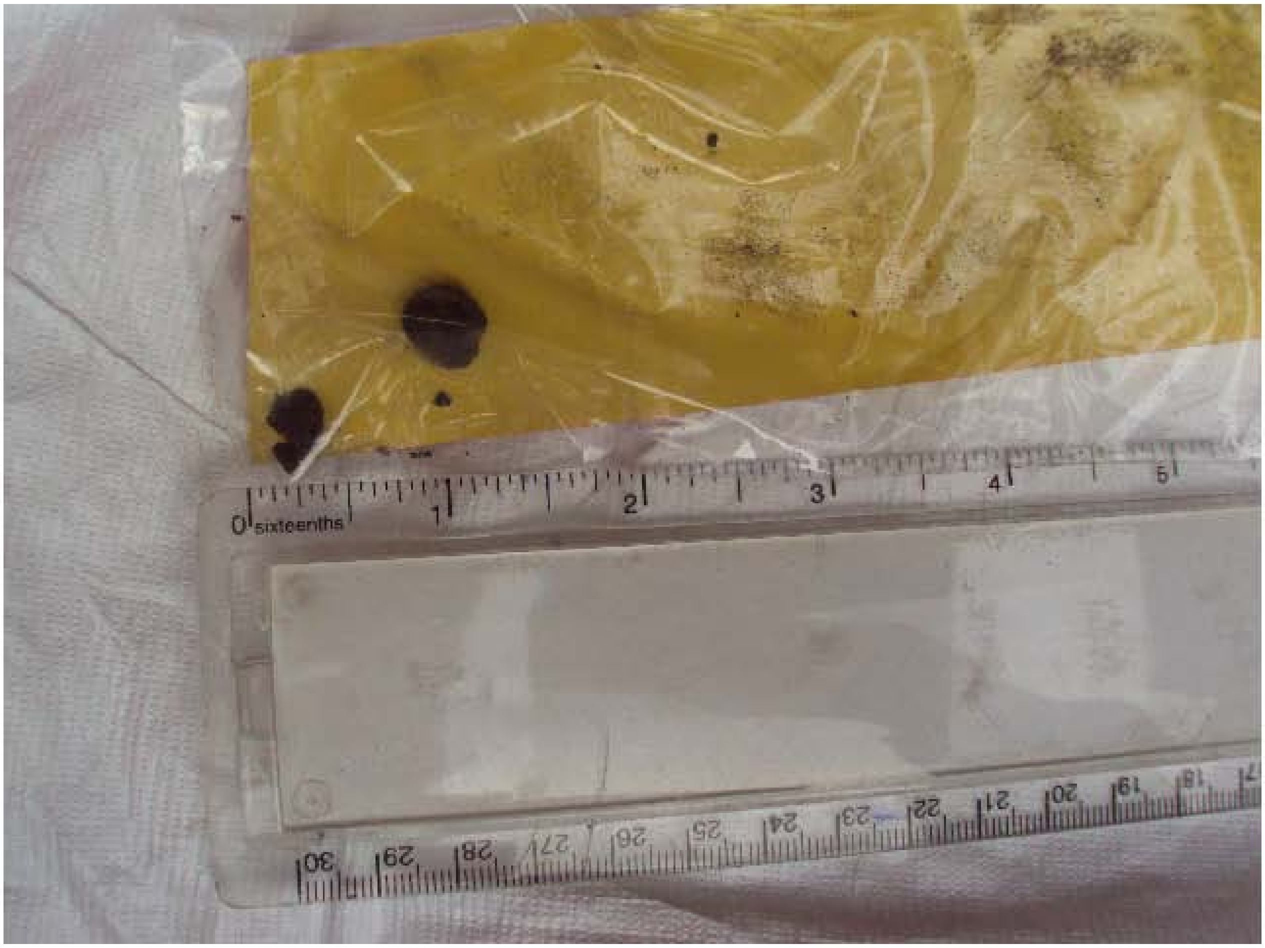
Boring Number - Ra-226 (pCi/g)

depth	60	61
0.0'-0.5'	64.6	
0.5'-1.0'	▨	0.617
1.0'-1.5'	▨	
1.5'-2.0'	0.562	
2.0'-2.5'	☐	☐
2.5'-3.0'		
3.0'-3.5'		
3.5'-4.0'		
4.0'-4.5'		
4.5'-5.0'		

▨ - indicates greater than background mean + DCGL (1.40 pCi/g)

☐ - indicates deepest interval (Total Depth)

Figure 37
Object Recovered from Boring Number 60



Tables

Table 1
Structural Reference Surveys

Reference Surface	Radiological Survey
Concrete Floors	RSS-198
Plasterboard Wall	RSS-199
Wooden Floor	RSS-180
Roof Vents	RSS-217
Wooden Subfloor	RSS-236
Hangar Floor	RSS-278

Note(s):

RSS denotes Radiological Site Survey.

All Radiological Site Surveys are located in Appendix B.

Table 2
Structural Surface Reference Measurement Results

Reference Matrix	Alpha Loose (dpm/100 cm^2)		Alpha Total (dpm/100 cm^2)		Beta-Gamma Loose (dpm/100 cm^2)		Beta-Gamma Total (dpm/100 cm^2)		2x2 NaI (cpm)	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Concrete Floor	0.50	1.15	1.56	11.63	126.39	29.60	78.22	138.47	--	--
Plasterboard Wall	0.50	1.15	3.39	12.37	119.44	50.67	68.83	47.84	--	--
Wooden Floor	0.00	0.00	17.94	13.64	6.67	27.22	338.83	379.88	--	--
Roof Vents	0.75	1.36	7.50	4.52	-4.58	22.91	62.75	53.53	--	--
Wooden Subfloor	0.44	1.26	2.48	10.15	20.36	67.68	74.20	64.84	--	--
Hanger Floor	0.17	0.59	-6.45	18.45	4.48	17.58	469.76	177.64	--	--
Hanger Floor Reference	0.67	1.28	-10.78	7.86	-17.00	18.04	190.00	137.11	--	--

Note(s):

cm^2 denotes square centimeters.

cpm denotes counts per minute.

dpm denotes disintegrations per minute.

NaI denotes Sodium Iodide.

Std Dev. denotes standard deviation.

Table 3
Reference Background Results for Sanitary Sewer and Storm Drain Surface Measurements

System	Manhole and Sample ID	Loose α dpm/100 cm²	Total α dpm/100 cm²	Loose β dpm/100 cm²	Total β dpm/100 cm²
Storm Drain	MH-140				
	mean	0.43	3.00	17.8	325.0
	standard deviation	1.1	4.24	18.6	187.0
	MH-125				
	mean	0.0	20.2	3.42	1222
	standard deviation	0.0	11.7	6.89	545.9
	MH-126				
	mean	0.50	17.5	8.17	1002
	standard deviation	1.2	13.6	12.1	222.5
	MH-1013				
	mean	0.50	25.7	11.0	394.8
	standard deviation	1.2	12.1	16.1	165.2
Gravity Flow Sewer System	COS-E6				
	mean	1.2	2.20	12.5	392.2
	standard deviation	1.6	4.92	12.8	194.0
	MH-215				
	mean	0.0	6.33	11.0	373.2
	standard deviation	0.0	5.43	22.9	67.42
	MH-212				
	mean	0.0	5.33	5.92	359.0
	standard deviation	0.0	4.93	12.3	158.8
	37' S of MH-140				
	mean	0.0	1.67	10.1	340.3
	standard deviation	0.0	2.58	9.65	64.61
	grand mean	0.31	10.3	10.1	549.6
	grand standard deviation	0.93	11.8	14.3	402.8

Note(s):

From RSS-169 (Appendix B).

cm² denotes square centimeters. *COS denotes City of Seattle.*

dpm denotes disintegrations per minute. *MH denotes manhole.*

Table 4
Reference Background Results for Sanitary Sewer and Storm Drain Sludge

System	Manhole and Sample ID	Radium-226 (pCi/g)
Storm Drain	MH-140	
	SD-MH140-SL-001	0.665
	SD-MH140-SL-002	0.541
	SD-MH140-SL-003	0.554
	SD-MH140-SL-004	0.634
	SD-MH140-SL-005	0.654
	SD-MH140-SL-006	0.583
	MH-125	
	SD-MH125-SL-007	0.452
	SD-MH125-SL-008	0.612
	MH-126	
	SD-MH126-SL-014	0.389
	SD-MH126-SL-015	0.263
	MH-1013	
	SD-MH1013-SL-009	0.2
	SD-MH1013-SL-010	0.207
	SD-MH1013-SL-011	0.219
	SD-MH1013-SL-012	0.269
	SD-MH1013-SL-013	0.174
Gravity Flow Sewer System	COS-E6	
	GS-COSE6-SL-001	0.171
	GS-COSE6-SL-002	0.0495
	GS-COSE6-SL-003	-0.176
	GS-COSE6-SL-004	0.127
	GS-COSE6-SL-005	0.0244
	GS-COSE6-SL-006	0.145
	MH-215	
	GS-MH215-SL-014	0.621
	GS-MH215-SL-015	0.333
	GS-MH215-SL-016	0.538
	GS-MH215-SL-017	0.578

Table 4 (continued)
Reference Background Results for Sanitary Sewer and Storm Drain Sludge

System	Manhole and Sample ID	Radium-226 (pCi/g)
Gravity Flow Sewer System (continued)	GS-MH215-SL-018	0.491
	MH-212	
	GS-MH212-SL-008	0.612
	GS-MH212-SL-009	0.527
	GS-MH212-SL-010	0.366
	GS-MH212-SL-011	0.386
	GS-MH212-SL-012	0.555
	GS-MH212-SL-013	0.335
	37' S of MH-140	
	GS-MH140-SL-007	0.483

Note(s):

COS denotes City of Seattle.

MH denotes manhole.

pCi/g denotes picocuries per gram.

Table 5
Analytical Results of Reference Area Samples

Boring Number	Depth (feet)	Sample ID	Radium-226 (pCi/g)	Lab Flag	Strontium-90 (pCi/g)	Lab Flag
63	0-0.5	63-SC-R-0-0.5'	0.407		0.171	
	1.0-1.5	63-SC-R-1.0-1.5'	0.572		-0.109	U
	2.0-2.5	63-SC-R-2.0-2.5'	0.414		0.0622	U
	3.0-3.5	63-SC-R-3.0-3.5'	0.305		-0.0233	U
64	0-0.5	64-SC-R-0-0.5'	0.391		-0.0317	U
	0.5-1.0	64-SC-R-0.5-1.0'	0.375		0.13	U
	1.0-1.5	64-SC-R-1.0-1.5'	0.573		0.176	
	2.0-2.5	64-SC-R-2.0-2.5'	0.274		-0.066	U
65	0-0.5	65-SC-R-0-0.5'	0.562		0.089	U
	1.0-1.5	65-SC-R-1.0-1.5'	0.658		0.215	
	2.0-2.5	65-SC-R-2.0-2.5'	0.418		0.00542	U
	3.0-3.5	65-SC-R-3.0-3.5'	0.596		0.0645	U
66	0-0.5	66-SC-R-0-0.5'	0.341		0.192	
	1.0-1.5	66-SC-R-1.0-1.5'	0.711		-0.122	U
	2.0-2.5	66-SC-R-2.0-2.5'	0.399		0.179	U
	3.0-3.5	66-SC-R-3.0-3.5'	0.478		-0.0571	U
Mean			0.467		0.055	
Standard Deviation			0.129		0.114	

Note(s):

Lab Flag “U” indicates that the result is less than the sample detection limit.

pCi/g denotes picocuries per gram.

Table 6
Project Cleanup Criteria Concentrations

Media	Radionuclides of Concern	Mean Background	Dose-Based Guideline	Cleanup Criteria
Sludge	Radium-226	0.453 pCi/g	3.4 pCi/g	3.85 pCi/g
Soil	Radium-226	0.467 pCi/g	0.93 pCi/g	1.40 pCi/g
Soil	Strontium-90	0.055 pCi/g	3.7 pCi/g	3.76 pCi/g

Note(s):

pCi/g denotes picocuries per gram.

Table 7
Project Cleanup Criteria for Equipment and Building Surfaces

Nuclide	Total	Removable
Radium-226	100 dpm/100 cm^2	20 dpm/100 cm^2
Beta-gamma emitters	5000 dpm β-γ/100 cm^2	1,000 dpm β-γ/100 cm^2

Note(s):

cm^2 denotes square centimeters.

dpm denotes disintegrations per minute.

Table 8
Scoping Survey Results from Building 27

Surface	Number of Measurements[1]	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm²)	
			Alpha Max	Beta/Gamma Max
Top Flooring[2]	125	0	--	--
HVAC Penthouse	20	1	179	--
T&G Floor[3]	152	44	8,042	162,000
Hotspot T&G Floor[3]	17	17	5,331	34,027
Quarter Deck T&G Floor[3]	17	17	7,256	32,500
Welding Shop Floor	27	3	2,853	60,948
Welding Shop Ceiling	9	1	--	9,163
Southeast Tower Floor	102	9	705	18,026
East Shops Floor	26	1	563	--

Note(s):

[1] *The Floor area scanned for each measurement was less than 1 square meters.*

[2] *Top-most layer of flooring prior to any removal.*

[3] *Lower layer of flooring consisting of tongue and groove (T&G) wood nailed to the sub-floor.*

dpm/100 cm² denotes disintegrations per 100 square centimeters.

Table 9
Characterization Survey Results from Building 27 – First Floor

Surface	Number of Measurements[1]	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm²)	
			Alpha Max	Beta/Gamma Max
Floors[2]	60	3	200	17,067
Walls	52	2	112	6,033
Ceilings	10	0	--	--

Note(s):

[1] *The Floor area scanned for each measurement was less than 1 square meters.*

[2] *Concrete floor.*

dpm/100 cm² denotes disintegrations per 100 square centimeters.

Table 10
Characterization Survey Results from Building 27 – Second Floor

Surface	Number of Measurements	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm^2)	
			Alpha Max	Beta/Gamma Max
Floors[1]	317	167	21,000	97,000
Walls	154	1	300	--
Ceilings	74	0	--	--

Note(s):

[1] Lower layer of flooring consisting of tongue and groove wood nailed to the sub-floor.

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Table 11
Characterization Survey Results from Building 27 – Hangar

Surface	Number of Measurements	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm^2)	
			Alpha Max	Beta/Gamma Max
Floors[1]	206	0	--	--
South Wall	79	0	--	--

Note(s):

[1] Concrete floor.

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Table 12
Characterization Survey Results from Building 27 – Southwest Tower

Surface	Number of Measurements	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm²)	
			Alpha Max	Beta/Gamma Max
Floors[1]	50	35	21,844	634,000
Walls	80	3	425	--
Ceilings	6	0	--	--

Note(s):

[1] Concrete floor.

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Table 13
Summary of Results from Focused Investigations – Building 27

Surface	Number of Measurements	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm²)	
			Alpha Max	Beta/Gamma Max
Floor Joist Spaces[1]	26	6	568	16,810
Floor Vents	21	17	1,550	43,380
Wall and Ceiling Vents	33	1	563	--
Pipe and Wall Spaces[2]	24	5	543	--

Note(s):

[1] Under sub-floor.

[2] At previous sink locations.

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Table 14
Scoping Survey Results from 1939 and 1941 Former Instrument Shop Flooring

Surface	Number of Measurements[1]	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm^2)	
			Alpha Max	Beta/Gamma Max
Top Flooring[2]	47	0	--	--
Mid-Flooring[3]	32	0	--	--
T&G Floor	113	12	2,863	17,000

Note(s):

[1] The Floor area scanned for each measurement was less than 1 square meter.

[2] Top-most layer of flooring prior to any removal.

[3] Middle layer of flooring after upper layer of tile and asbestos removed.

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

T&G denotes tongue and groove.

Table 15
Summary of Results from 1939 Former Instrument Shop

Surface	Number of Measurements[1]	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm^2)	
			Alpha Max	Beta/Gamma Max
Floors	101	3	378	--
Walls[2]	128	2	--	13,683
Ceiling	38	0	--	--
Ventilation	15	0	--	--

Note(s):

[1] For the Floors and Walls the area scanned was 1 square meter. Ceilings and Ventilation locations scanned were less than 1 square meter.

[2] Only the lower two meters of walls (both brick and wallboard) were scanned.

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Table 16
Summary of Results from 1941 Former Instrument Shop

Surface	Number of Measurements[1]	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm^2)	
			Alpha Max	Beta/Gamma Max
Floors	470	105	7,161	16,580
Walls [2,3]	259	1	100	--
North Brick Wall [3,4]	70	1	160	--
Ceilings	18	0	--	--
Ventilation	14	9	619	5,768

Note(s):

[1] *For the Floors and Walls the area scanned was 1 m2. Ceilings and Ventilation locations scanned were less than 1 square meter.*

[2] *Wallboard surface surveyed prior to removal.*

[3] *Only the lower two meters of walls were scanned.*

[4] *Northern brick wall surveyed after removal of wallboard.*

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Table 17
Summary of Results from Building 2 Class 3 Floors

Surface	Number of Measurements[1]	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm^2)	
			Alpha Max	Beta/Gamma Max
Floors	18	0	--	--

Note(s):

[1] *The floor area scanned for each measurement was 1 square meter.*

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Table 18
Summary of Results from Focused Investigations – Building 2

Surface	Number of Measurements[1]	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm^2)	
			Alpha Max	Beta/Gamma Max
Stairwells	71	0	--	--
Floor Penetrations	41	0	--	--
Public Spaces [2]	86	0	--	--
Locker Rooms [3]	31	0	--	--
Restrooms [4]	19	0	--	--

Gamma Results (cpm)

Surface	Number of Measurements	Average	Max
Public Spaces [2]	43	4,993	7,723
Locker Rooms [3]	4	6,078	8,170
Restrooms [4]	15	6,832	7,745

Note(s):

[1] *The areas scanned for each measurement was less than 1 square meter.*

[2] *Includes Theater Storage, party room and batting cage areas, and the former restrooms on the first floor southeast corner.*

[3] *Locker Room and the restroom located directly underneath it on first floor.*

[4] *Includes tiled sink room above the southeast stairs and the restroom and shower room on the second floor.*

cpm denotes counts per minute.

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Table 19
Laboratory Results of Radium-226 Analyses of Sludge Samples

Catch Basins and Manholes (Storm)	Sample ID	Results (pCi/g)	Comments (inches)
CB-1	SD-CB1-SL-018	17.9	Sample taken from bottom of sludge (18 – 12)
	SD-CB1-SL-019	7.50	Sample taken from middle of sludge (12 – 6)
	SD-CB1-SL-020	0.594	Sample taken from top of sludge (6 – 0)
	SD-CB1-SL-021	6.32	Sample taken from middle of sludge (12 – 6)
	SD-CB1-SL-022	6.70	Sample taken from bottom of sludge (18 – 12)
CB-1 at 24 Inch Line	SD-CB1PIPE-SL-018	0.546	Sample taken from sediment in pipe
CB-2	SD-CB2-SL-016	0.666	
CB-3	SD-CB3-SL-014	4.88	Sample taken from bottom of sludge (18 – 14)
	SD-CB3-SL-014 dup		
	SD-CB3-SL-015	3.28	Sample taken from middle of sludge(14 – 10)
CB-4	SD-CB4-SL-001	0.748	
	SD-CB4-SL-001 dup	0.874	
	SD-CB4-SL-201	0.864	
CB-5	SD-CB5-SL-017	1.62	Sample taken from bottom of sludge (32 – 28)
CB-6	SD-CB6-SL-010	0.697	Sample taken from bottom of sludge (4 – 0)
CB-7	SD-CB7-SL-011	0.546	Sample taken from bottom of sludge (6 – 0)
CB-8	SD-CB8-SL-012	0.450	Dry bottom, sample taken from trace material on bottom.
CB-9	SD-CB9-SL-013	0.629	Sample taken from bottom of sludge
CB-10	SD-CB10-SL-006	0.409	Sample taken from bottom of sludge
CB-11	SD-CB11-SL-007	0.615	Sample taken from bottom of sludge (9 – 3)
	SD-CB11-SL-008	0.419	Sample taken from bottom of sludge (9 – 0)
CB-12	SD-CB12-SL-009	0.405	Sample taken from middle of sludge
CB-14	SD-CB14-SL-023	0.505	Sample taken from 6 inches of sludge
	SD-CB14-SL-223	0.497	Sample taken from 6 inches of sludge
	SD-CB14-SL-223 dup	0.454	Sample taken from 6 inches of sludge
Manholes (Storm)			
MH-134	SD-MH134-SL-018	0.478	Composite sample of sand, silt and clay
	SD-MH134-SL-018 dup	0.576	

Table 19 (continued)
Laboratory Results of Radium 226 Analyses of Sludge Samples

Catch Basins and Manholes (Storm)	Sample ID	Results (pCi/g)	Comments
MH-135	SD-MH135-SL-011	0.670	Composite from bottom
MH-136	SD-MH-136-SL-005	0.510	Sampled from sludge at bottom
MH-137	SD-MH137-SL-006	0.404	Sample taken from bottom of sludge (23 – 12)
	SD-MH137-SL-007	0.995	Sample taken from top of sludge (12 – 0)
	SD-MH137-SL-008	0.522	Sample taken from bottom of sludge (23 – 12)
	SD-MH137-SL-208	0.589	Sample taken from bottom of sludge (23 – 12)
	SD-MH137-SL-009	0.637	Sample taken from top of sludge (12 – 0)
	SD-MH137-SL-010	0.644	Sample taken from bottom of sludge (23 – 12)
MH-141	SD-MH141-SL-001	1.23	Sample from bottom of sludge
	SD-MH141-SL-002	0.933	Sample from bottom of sludge
	SD-MH141-SL-003	2.03	Sample from top of sludge
MH-160	SD-MH160-SL-012	0.864	Sample taken from bottom of sludge (24 – 12)
	SD-MH160-SL-013	0.718	Sample taken from top of sludge (6 – 0)
	SD-MH160-SL-014	2.64	Sample taken from middle of sludge(12 – 6)
	SD-MH160-SL-015	1.21	Sample taken from bottom of sludge (24 – 12)
	SD-MH160-SL-215 dup	1.47	Sample taken from bottom of sludge (24 – 12)
	SD-MH160-SL-016	0.757	Sample taken from top of sludge (6 – 0)
	SD-MH160-SL-017	1.39	Sample taken from middle of sludge(12 – 6)
MH-162	SD-MH162-SL-019	0.471	Composite of bottom
	SD-MH162-SL-020	0.646	Sample taken from 6 inches of clay
MH-1005	SD-MH1005-SL-004	0.503	Composite sample
	SD-MH1005-SL-004 dup	0.442	Composite sample
Gravity Flow Sewer Manholes			
MH-222	GS-MH222-SL-014	0.410	Composite sample from channel
MH-223	GS-MH223-SL-007	1.37	Composite from benches above channel

Table 19 (continued)
Laboratory Results of Radium 226 Analyses of Sludge Samples

Catch Basins and Manholes (Storm)	Sample ID	Results (pCi/g)	Comments
MH-224	GS-MH224-SL-001		
	GS-MH224-SL-002	0.501	Sample from bottom of sludge (4 feet thick)
	GS-MH224-SL-002 dup	0.601	Sample from bottom of sludge (4 inches thick)
MH-225	GS-MH225-SL-004	0.486	Taken from bottom of sludge (3 feet thick)
	GS-MH225-SL-005	0.398	Taken from bottom of sludge (3 feet thick)
MH-226	GS-MH226-SL-008	0.273	Taken at base of north wall, minimal sludge
	GS-MH226-SL-009	0.298	Taken at base of north wall, minimal sludge
MH-227	GS-MH227-SL-010	0.458	Composite sample of sludge in channel
	GS-MH227-SL-011	0.425	Taken from bench in southeast corner
MH-233	GS-MH233-SL-015	0.671	Taken from inside pipe
	GS-MH233-SL-016	1.09	Taken from bottom of basin; composite
MH-234	GS-MH234-SL-012	1.19	Composite sample, minimal sludge
MH-NOAA 1.5	GS-NOAA1.5-SL-011	-0.107	
	GS-NOAA1.5-SL-011 dup	-0.100	
	GS-NOAA1.5-SL-012	0.120	
Pump House 116	PH116-SL-001	0.447	Minimal sludge
	PH116-SL-002	0.288	Minimal sludge
Pressurized Sewer	PS-117-SL-002	0.250	
	PS-117-SL-003	0.575	Collect sample from pipe scrapings
	PS-117-SL-003 dup	0.588	Collect sample from pipe scrapings
Former 1939 Sink Pipe Building 2	SD-MH134-PIPE 1	697	Pipe has been removed
	SD-MH134-PIPE 1 dup	685	
Outside Pit Near MH-134 Building 2	SD-BLDG2-W.PIT-SL-021	0.313	
	SD-BLDG2-W.PIT-SL-022	0.957	
	SD-BLDG2-W.PIT-SL-222	0.678	

Table 19 (continued)
Laboratory Results of Radium 226 Analyses of Sludge Samples

Catch Basins and Manholes (Storm)	Sample ID	Results (pCi/g)	Comments
Floor Drain inside Building 2	SD-BLDG2-W.FD-SL-023	1.11	Located between former sink pipe and MH-134; composite sample of native soil

Note(s):

Draft Sludge Cleanup Criteria = 3.85 pCi/g.

pCi/g denotes picocuries per gram.

Table 20
Analytical Results of Soil Hotspots 1, 6, 16, 17, and 23/24

Sample ID	Depth (feet)	Radium-226 (pCi/g)
HS23-SO-001 [1]	0.0 – 0.5	1.89
HS23-SO-002	0.5 – 0.7	0.66
HS1-SO-003	0.5 – 1.0	2150
HS6-SO-004	0.5 – 1.0	41.9
HS16-SO-005	0.8 – 1.3	7.81
HS17-SO-006	0.5 – 1.0	3.3
HS23-SO-001-SOIL ONLY	0.0 – 0.5	2.07 [2]
HS23-SO-001-ROCKS ONLY	0.0 – 0.5	0.427 [2]
HS23-SO-002-SOILS ONLY	0.5 – 0.7	0.666 [2]
HS23-SO-002-ROCKS ONLY	0.5 – 0.7	0.293 [2]

Note(s):

[1] *The sample ID "HS23-SO-001" stands for: HS23 – location is hotspot #23; SO – soil; 001 – sequential number for the group of samples on the chain of custody.*

[2] *Seven-day turnaround time for preliminary analysis only.*

pCi/g denotes picocuries per gram.

Table 21
Soil Screening Evaluation Example

Depth bgs (feet)	Soil Screening (cpm)	Evaluation	Disposition
0.0 – 0.5	8,455	elevated	Discarded
0.5 – 1.0	9,231	highest	submitted to Lab for analysis
1.0 – 1.5	6,504	elevated	Discarded
1.5 – 2.0	5,231	background	submitted to Lab on hold
2.0 – 2.5	5,285	background	Discarded
2.5 – 3.0	5,257	background	submitted to Lab for analysis

Note(s):

In this example the intervals from 1.5 to 2.5 feet are the 1 foot of soil at background levels that are below the contaminated layer.

bgs denotes below ground surface.

cpm denotes counts per minute with Sodium Iodide 2 inch by 2 inch.

Table 22
Summary of Results from Storm Drain and Sanitary Sewer Systems

Surface	Number of Measurements[1]	Number of Measurements Exceeding Criteria	Total Activity Exceeding Project Cleanup criteria (dpm/100 cm^2)	
			Alpha Max	Beta/Gamma Max
Sanitary Sewer Manholes	31	0	--	--
Storm Drain Manholes	9	0	--	--
Storm Drain Catch Basins	37	1	--	10,534

Note(s):

[1] *The area scanned for each measurement was less than 1 square meter.*

dpm/100 cm^2 denotes disintegrations per 100 square centimeters.

Appendix A
Field Change Requests

(Found on attached compact disk.)

Appendix B
All Radiological Site Surveys (001 through 556)

(Found on attached compact disk.)

Appendix C
Video Logging

(Found on attached compact disk.)

Appendix D
Waste Manifests

(Found on attached compact disk.)

Appendix E
Data Quality Summary Report

(Found on attached compact disk.)

Attachment 1
Background Plan

Two general types of background data are necessary for this project:

- Sludge background to identify the statistical mean and standard deviation for the storm drain system and the gravity flow sanitary sewer system
- Surface backgrounds of appropriate structural material for comparison with Characterization or Final Status Survey measurements.

Background sludge samples will be collected from storm drain and gravity flow sanitary sewer line locations (manholes) identified to be upstream from the lines impacted by radium from Building 27 (Attachment 1). For surface backgrounds, reference areas for each radiological measurement method and matrix type will be selected consisting of similar structural materials from areas in the building that are not impacted. Reference locations will have similar physical, chemical, radiological, and biological characteristics as the impacted area(s) being investigated, and will not be identified as impacted by any previous surveys. All locations selected for reference will be approved by the Project RSO. The same survey methods and equipment that will be used for conducting a survey in an impacted area will be used for the background area survey. Reference area data will be identified to the RCT prior to the start of each survey.

This plan shall be reviewed and approved by RASO prior to execution.

Storm Drain and Sanitary Sewer Backgrounds

The goal is to collect six sludge samples from each of four different locations (manholes) for the storm drain system and from each of the four gravity-flow sanitary sewer system manholes. Shaw statisticians have identified these sample numbers as appropriate to perform analysis of variance to characterize the background variability between and within sampling locations. At each manhole the following background measurements and samples will be collected if possible in the following order:

- Six removable contamination smears will be taken from non-sludge coated surfaces
- Six one-minute total contamination (static) counts, co-located with the smear samples
- Surface alpha and beta/gamma surveys on pipe entrance and exit locations, if the surfaces are dry and are not sludge coated which would prevent accurate surface measurements
- Six sludge samples from random locations within the manhole (to the extent that uniquely different sample locations are possible).

All measurements will be performed using the same radiological survey instrumentation that will be used at the impacted locations.

Storm drain background locations have been identified as follows (see Table 1):

- MH 140
- MH 125
- MH 126
- MH 1013.

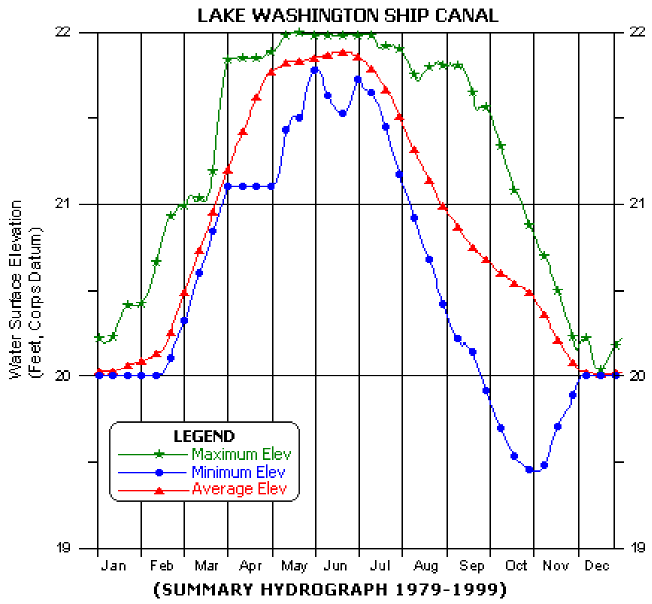
Each reference manhole was selected to assure the lowest channel (outlet) elevation exceeds the rim elevation of the highest manhole in the impacted system. For the storm drain system, this is shown in Table 1 and the attachments.

Table 1. Storm Drain Reference Locations

Manhole	Rim Elev.	Invert Elev. (lowest)	Drawing Sheet	Notes
Impacted (highest elevation)				
MH 141	26.99	19.03	SC1.7	Highest storm drain manhole
Reference Locations				
MH 140	51.07	37.78	SC1.7	Dry, large pipes, good sludge
MH 125	36.31 (by observation)	30.31 (by observation)	SC1.4	Brick
MH 126	39.85	34.30	SC1.3	Good, minimal sludge
MH 1013	38.61	32.76	SC1.4	Good sludge

The danger of flood induced movement of contaminants is precluded by the well-controlled Lake Washington level, maintained by the US Army Corps of Engineers-controlled Hiram M. Chittenden Locks (see Figure 1).

Figure 1. Lake Washington Level History



The abandoned pressurized sanitary sewer line (designated as a dotted line from Pump House 117 to Pump House 98) has not been characterized to allow accurate identification of an upstream reference location. Based on this lack of information, an individual background reference area for the pressurized sanitary sewer line cannot be identified and instead the background for the gravity flow sanitary sewer line will be used. The background for the gravity-flow sanitary sewer system will be used. If further characterization identifies non-impacted locations in this system, background samples can be taken if necessary.

Four gravity-flow sanitary sewer line background locations have been identified:

- COS[1] E6
- MH 215
- MH 212
- Unnumbered manhole 37 feet south of MH 140.

Again, these reference locations were selected to be above the rim level of the highest impacted manhole (see Table 2).

Table 2. Gravity-flow Sanitary Sewer Reference Locations

Manhole	Rim Elev.	Invert Elev. (lowest)	Drawing Sheet	Notes
Impacted (highest elevation)				
MH 223	25.48	20.84	SC1.6	At SE corner of B27
MH 224		21.84 (by observation)	SC1.6	Highest gravity-flow sewer manhole
Reference Locations				
COS E6	56.00	51.50	SC1.7	Good sewer
MH 215	48.55	40.55	SC1.3	Access thru Bayley Construction
MH 212	35.81	27.41	SC1.4	Minimal flow
Unnumbered manhole 37' south of MH 140	54 (by observation)	51 (by observation)	SC1.7	Channelized, minimal flow, minimal sludge

Samples and surveys as detailed above will be taken at these locations

Sludge samples will be sent to an off-site laboratory for analysis for ^{226}Ra. The background values for ^{226}Ra will be determined by laboratory analysis, using EPA Method 901.1 modified. Background values will be calculated using the reported activity, regardless if the value is below

---

[1] City of Seattle

laboratory MDA or less than zero. The project detection limits are specified in the approved QAPP/SAP as:

- Sludge MLCC = 0.7 pCi/g.

Facility Surface Backgrounds

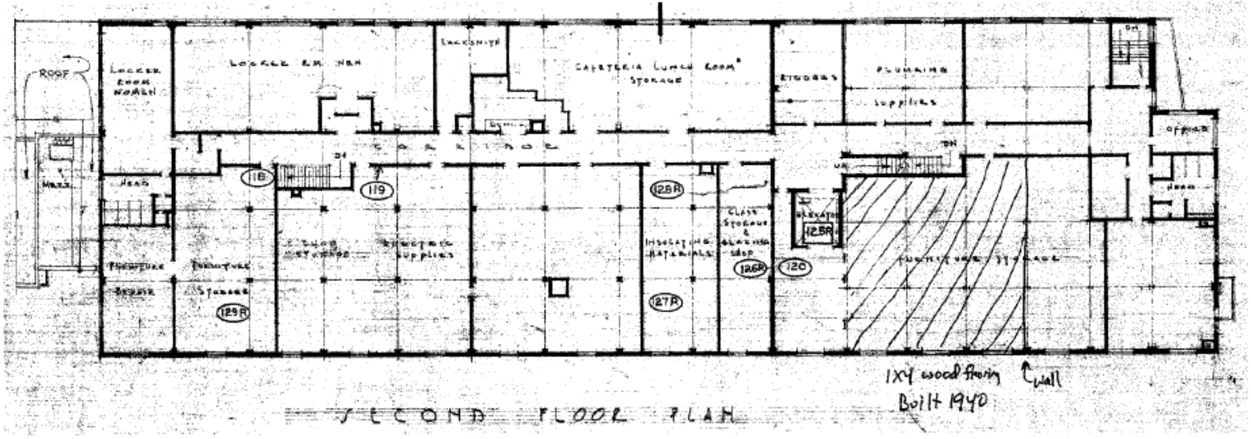
Background (reference) areas will be selected for each surface type to be surveyed. For Building 27 the identified surfaces to be monitored are:

- Subflooring – instrument shop (including the Ra Room)
- Wallboard – instrument shop
- Concrete
    - West stair tower
    - Welding shop
    - Hanger surface
- Roof
- Exhaust Vents and Ceilings.

Background surfaces have been identified as follows:

- Subflooring – all subflooring on the second floor of the B27 south shed appears to be constructed of the same material at the same time. An area in an adjacent building (Building 11 to the west of Building 27) built in approximately the same period has been identified to have similar material. This building is located in a non-impacted area. This area is a non-occupied artist's studio and is available for survey (see Figure 2).

Figure 2. Building 11 Floor Reference Area



- Wallboard – the plaster wallboard on the first floor of Building 11 appears to be similar material to that on the walls in the impacted area. This will be used as a reference area for Building 27 wallboard.

- Concrete (Southwest stair tower) – the northwest stair tower was constructed at the same time as the southwest tower and the second floor will be used as a reference location.
- Concrete (Welding shop) – the concrete floor in the first floor of Building 11 appears to be similar. This area will be used for a reference location.
- Concrete (Hanger surface) – the hanger floor concrete appears to be similar throughout the area near the welding shop wall. An area 4 meters – 7 meter out into the hanger from the wall common with the Welding Shop will be used as the reference area.
- Roof – the east half of the roof is not impacted. No building exhaust points exist in this area, only two 16-inch passive “General Issue” air vents that ventilate the furred space over the ceiling of this area are present (drawing 54080). There is no pathway for contamination release through these air vents. All of these vents have surveyed negative (RSS-075) and 100% gamma walkover (RSS-032) and 100% alpha and beta/gamma floor monitor survey (RSS-030) support this conclusion. The east half of the roof has been selected as the reference area. A 20-foot buffer area has been included to assure separation from any exhaust vents. The eastern 90 feet of the roof will be used as the reference location. It will be necessary to cut and remove the roofing in the reference sampling locations.
- Exhaust Vents and Ceilings – The roof of Building 11 hosts eleven “General Issue” roof vents and two powered ventilators. The internal surface of one ventilator is accessible from the roof (no bird screens). The external surfaces and fan blades of two others are accessible. The exhaust vents will be surveyed and directly compared with the project cleanup criteria. The reference ceiling location to be used is the ceiling directly above the subfloor reference location.

Surface measurement backgrounds will be determined by performing a minimum of eighteen measurements at systematic or random locations within each designated reference area. Additional background samples may be collected as directed by the Radiological Site Manager. Data collected in reference areas will be statistically evaluated using a graphical format, such as a frequency distribution chart, and approved for use by the Project RSO. The purpose of the evaluation is to ensure that the data collected in the reference area are consistent with a normal distribution and that the variability of the background is appropriate. Variability will be evaluated to determine if individual building material reference backgrounds are statistically different. If not, we will use the daily QC background as an “intrinsic” background value for each instrument. Variability in background will most likely impact the beta and gamma survey measurements, alpha backgrounds are expected to be near zero.

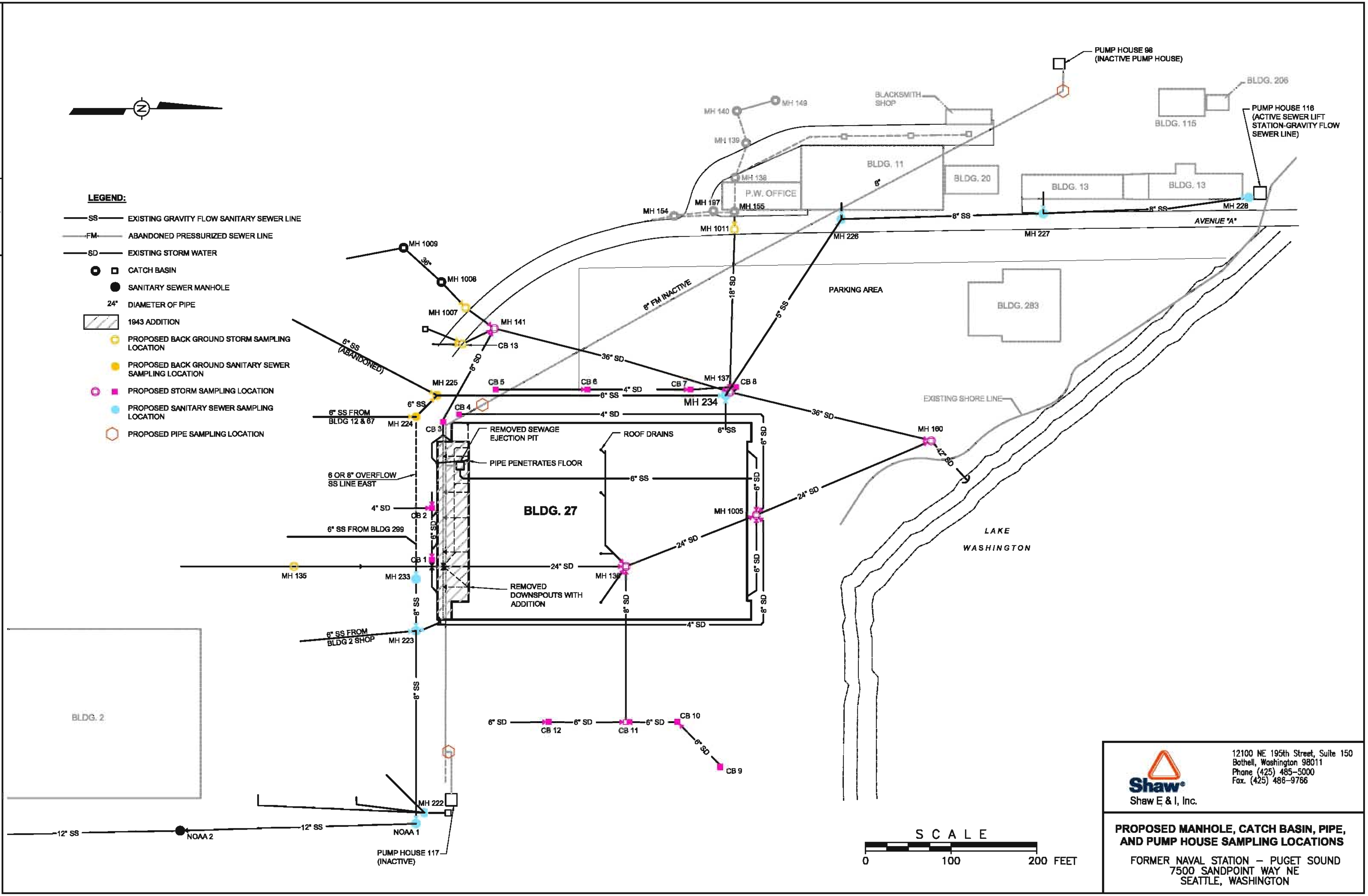
Measurements will be taken with the following instrumentation:

- Model 43-68 gas flow proportional counter
- Model 239-1F Floor monitor (for floor and roof only)
- Model 44-10 NaI gamma detector (for floor and roof only)
- Smear survey counted on Model 3030 alpha – beta/gamma counter.

Reference locations for Pump House surfaces and Building 2 will be determined when those facilities are investigated.

Attachments:

- 1. SD/SS drawing
- 2. Key Maps (Index Drawing)
- 3. Drawing Sheet SC1.3
- 4. Drawing Sheet SC1.4
- 5. Drawing Sheet SC1.7



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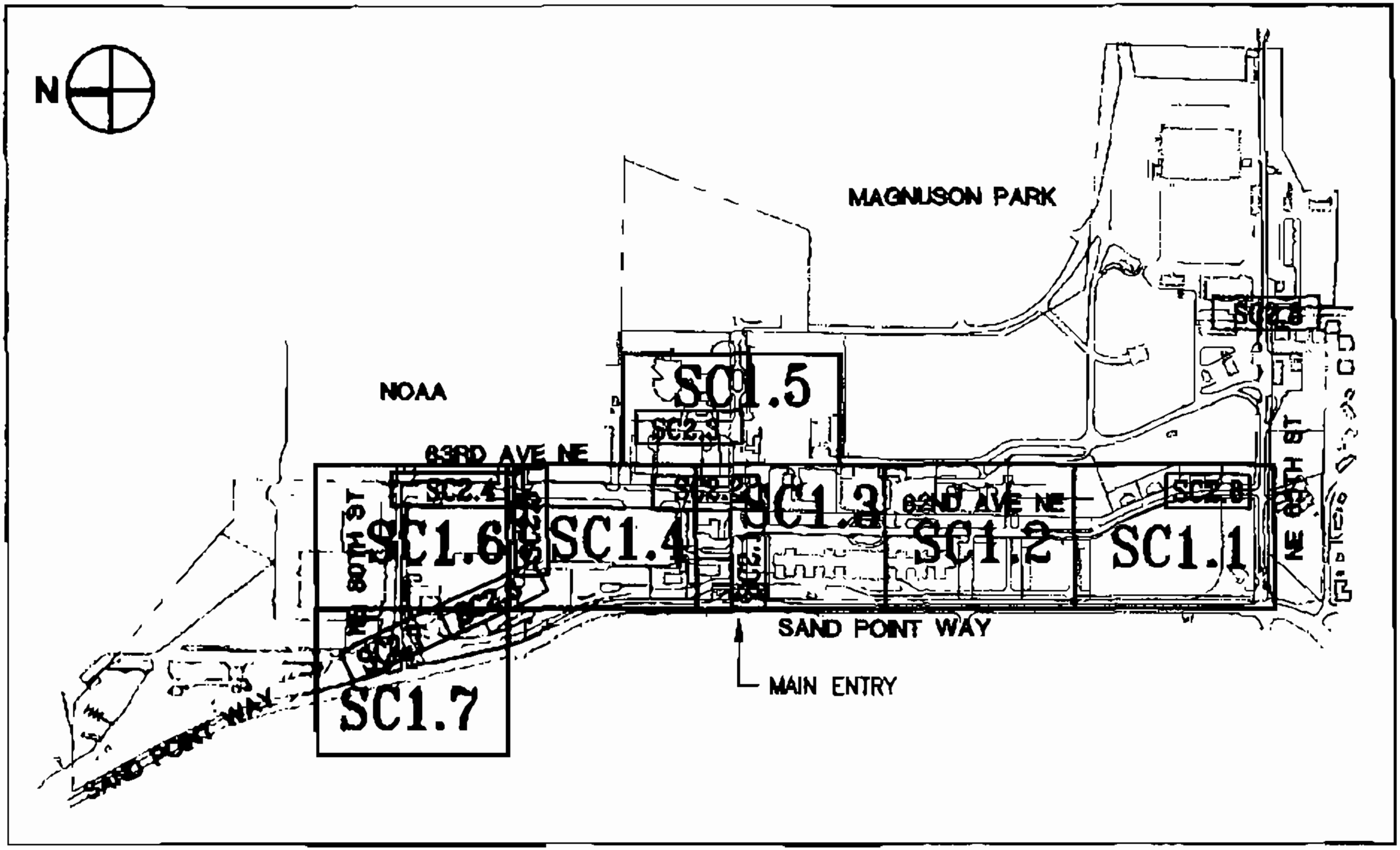
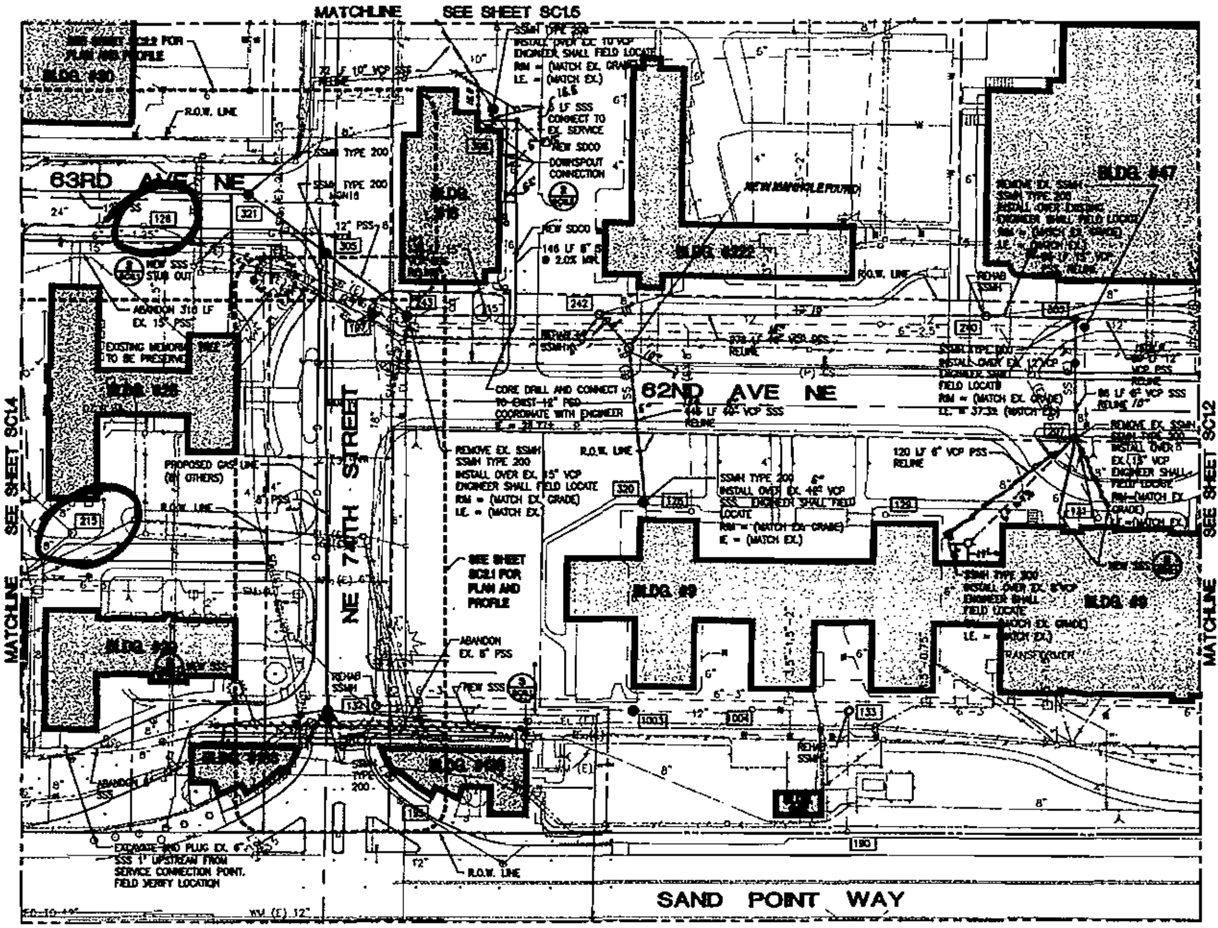
PROPOSED MANHOLE, CATCH BASIN, PIPE, AND PUMP HOUSE SAMPLING LOCATIONS

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

KEY MAPS


N
MAGNUSON PARK
NOAA
63RD AVE NE
62ND AVE NE
NE 80TH ST
NE 65TH ST
SAND POINT WAY
SAND POINT WAY
MAIN ENTRY
SC1.1
SC1.2
SC1.3
SC1.4
SC1.5
SC1.6
SC1.7
SC2.3
SC2.4
SC2.6
SC2.8



SANITARY SEWER MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
207	54.31	43.30 6" IN (W)	12
		42.90 6" OUT (E)	
		50.81 6" (W)	13
		45.31 6" (W)	
215	48.56	42.15 6" IN (NW)	10
		40.55 6" IN (N)	
		43.40 6" (SW)	
240	52.85	36.20 12" IN (S)	3
		36.00 12" OUT (N)	
		38.30 6" (E)	
		38.20 6" (SE)	
242	49.15	29.95 15" IN (S)	11
		29.82 15" OUT (N)	
		33.15 6" (S)	13
		32.75 10" (W)	
243	43.50	27.80 15" IN (S)	12
		27.80 15" OUT (N)	

NOTES

1. SEE SHEET SC1.1 FOR UTILITY PLAN NOTES AND REHABILITATION NOTES.

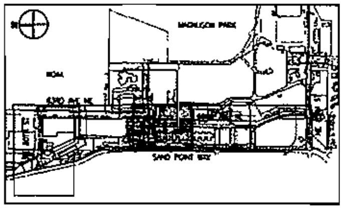
SCALE: 1" = 40'

CITY OF SEATTLE

STORM DRAIN MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
126	39.85	34.30 24" IN (S)	10
		34.20 24" OUT (N)	
		35.17 10"	
		36.37 6"	
127	44.28	39.29 18" IN (W)	7-12-
		39.17 24" OUT (N)	
		39.24 12" IN (S)	
		41.82 6" IN (NE)	
		41.37 6"	
		39.31 4"	
128			10
129	56.16	47.93 6" OUT (S)	10
		47.82 6" OUT (?)	
		47.93 6"	
		47.88 4"	
		48.05 2"	
130	55.98	51.96 8" IN (SW)	10
		45.04 12" OUT (N)	
		45.09 8" IN (W)	
		53.20 6"	
		53.36 6"	
		45.09 6"	
132	57.37	50.06 12" IN (W)	1,7
		49.82 18" OUT (E)	
		49.97 12" IN (S)	
133	57.21	53.35 12" IN (W)	7
		53.27 12" OUT (N)	
		53.27 12"	
190	64.17	60.37 12"	10
		60.69 12"	
195	61.06	56.96 12" IN (W)	10
		54.71 12" OUT (E)	
1003	57.06	51.61 12" IN (S)	12
		51.59 12" OUT (N)	
1004	57.24	52.42 12" IN (S)	10
		52.42 12" OUT (N)	

KEY MAP



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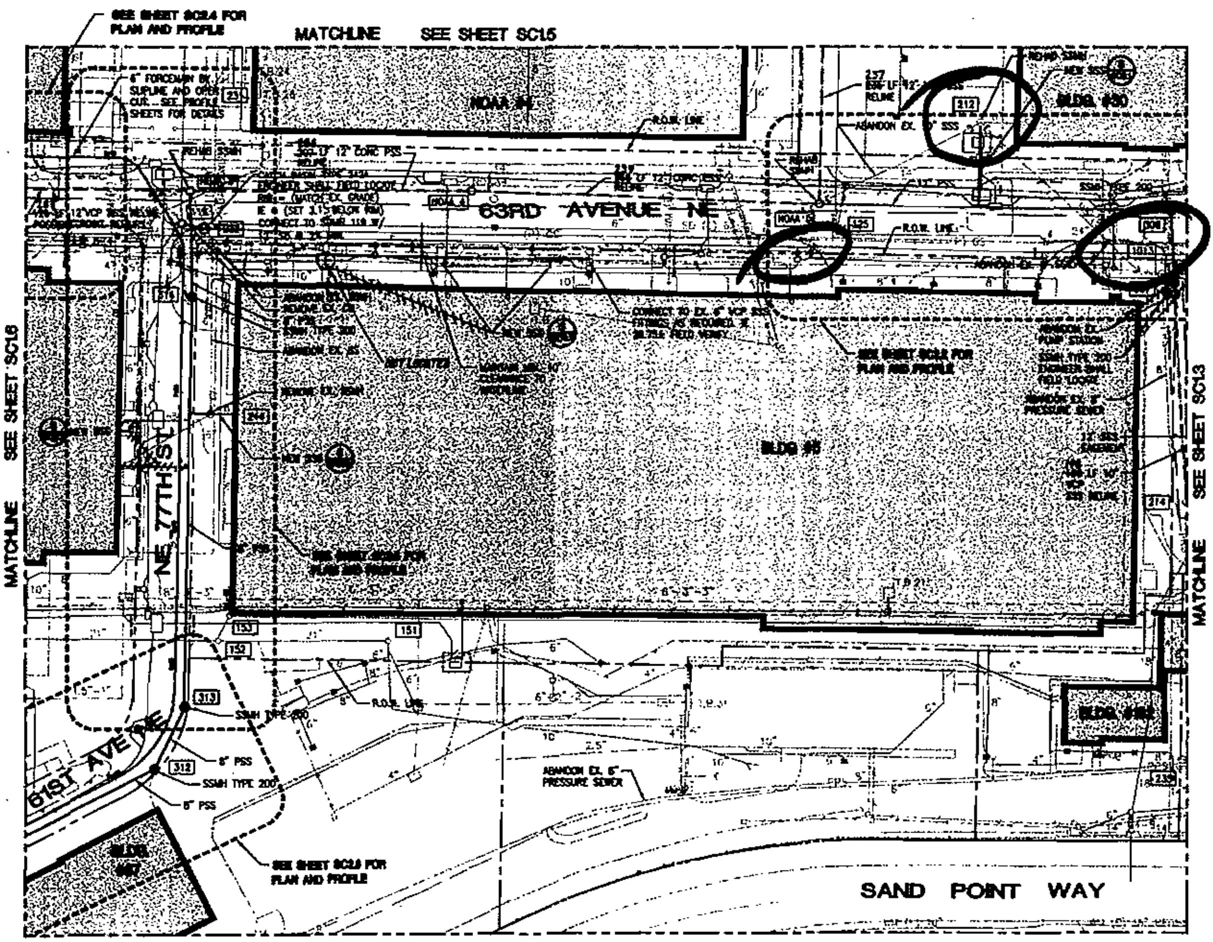


SANITARY SEWER MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
212	35.81	27.77 6" IN (S)	50
		27.41 10" OUT (E)	PLUG
		31.52 6" (W)	PLUG
214	41.86	35.86 8" IN (S)	10
		35.81 10" OUT (E)	
		35.81 6" (S)	
231	31.89	23.34 8" IN (W)	10
		23.29 8" OUT (E)	
		23.89 6" (N)	
		27.79 4" (S)	
232	31.94	25.09 8" IN (S)	10
		25.07 8" OUT (E)	
		25.09 8" (N)	
		26.09 6" (W)	
235			10
NOAA 3	31.45	19.25 12" IN (S)	10
		22.75 8" IN (SW)	
		19.25 8" OUT (N)	
NOAA 4	33.87	20.55 12" IN (S)	10
		20.45 12" OUT (N)	
NOAA 5	36.31	21.95 12" IN (S)	5
		22.35 12" IN (SE)	
		21.95 12" OUT (N)	

STORM DRAIN MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
119	31.47	25.97 12" IN (SW)	3,5,7
		25.87 15" OUT (E)	
		28.57 6" IN (N)	
		26.97 6" IN (S)	
		26.17 8" IN (W)	
		26.87 6" IN (SW)	
125	36.34	30.32 24" IN (S)	10
		30.27 24" OUT (E)	
		33.06 6" IN (SE)	
152	32.96	27.51 21" IN (S)	10
		27.41 21" OUT (N)	
		27.81 21" IN (E)	
153	33.13	32.13 12" IN (S)	10
		27.63 21" OUT (W)	
		28.03 8" IN (E)	
		28.63 6"	
151	32.97	28.39 10" IN (W)	10
		28.34 18" OUT (N)	
1013	38.61	32.80 24" IN (S)	10
		32.76 24" OUT (N)	

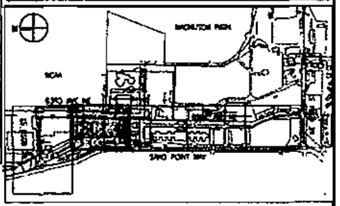
SCALE: 1" = 40'

CITY OF SEATTLE

NOTES:

1. SEE SHEET SC1.1 FOR UTILITY PLAN NOTES AND REHABILITATION NOTES.

KEY MAP



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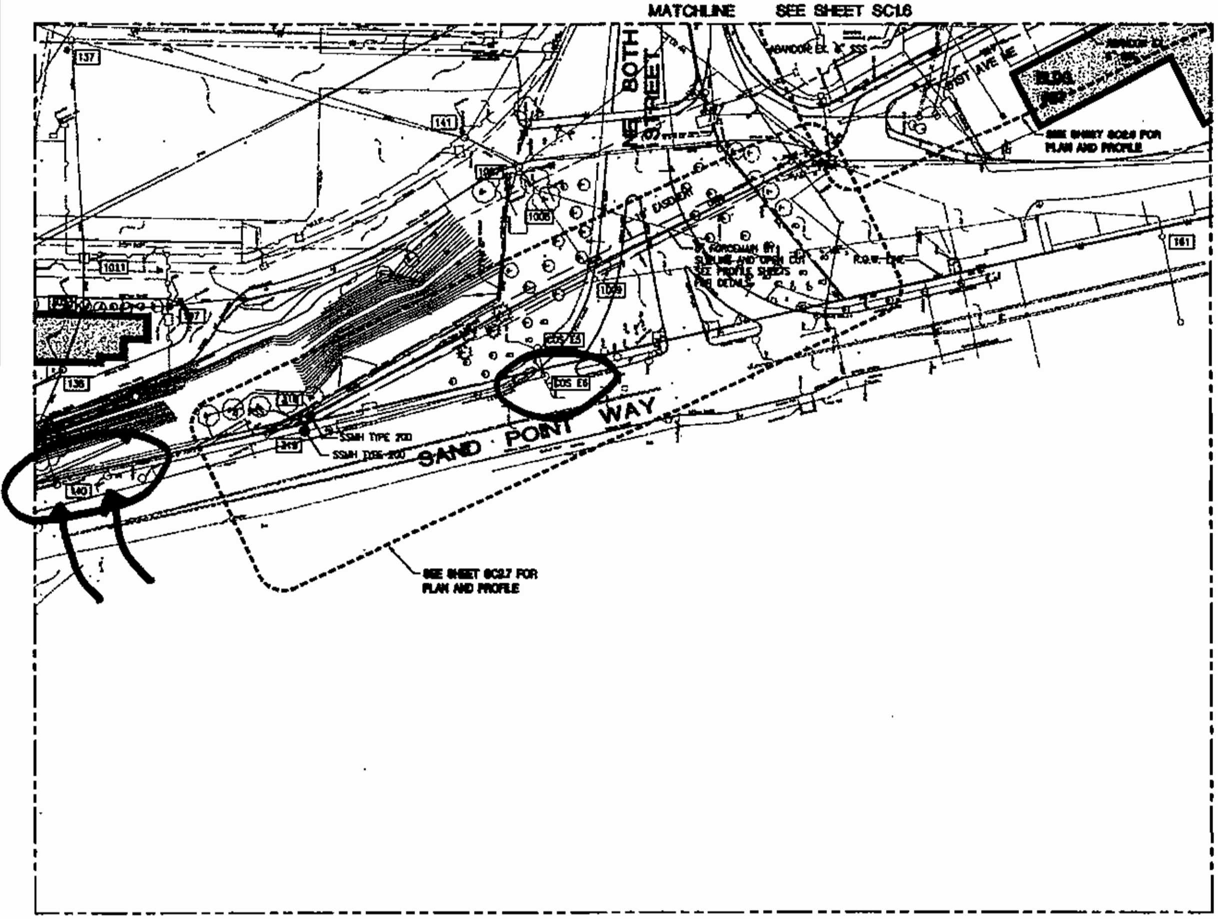
MATCHLINE SEE SHEET SC1.6



N

SCALE: 1" = 40'

CITY OF SEATTLE

SANITARY SEWER MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
COS E6	56.00	51.50 12" OUT (N)	10
		51.50 12" IN (E)	
COS E5	56.90	53.10 12" OUT (W)	10
		53.10 8" IN (E)	

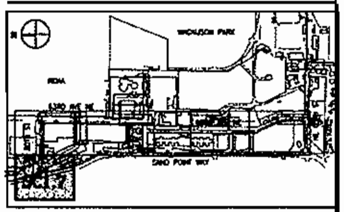
STORM DRAIN MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
137	22.24	15.55 36" IN (NE)	10
		15.55 36" OUT (SW)	
		17.00 16" IN (E)	
138	28.25	24.91 18" OUT (E)	10
		25.23 18" IN (NE)	
		25.23 6" IN (NNE)	
		26.43 6"	
		25.43 4"	
		25.65 4"	
139	31.70	25.97 18" IN (W)	10
		25.97 18" OUT (E)	
		25.97 18"	
		27.30 4"	
140	51.07	37.78 18" OUT (E)	10
		37.78 18" IN (N)	
141	26.99	19.03 36" IN (S)	10
		18.80 36" OUT (N)	
		18.80 6" IN (SE)	
161	58.80	54.36 24" OUT (E)	10
		54.01 18" IN (W)	
		54.58 12"	
		54.87 3"	
187			10
1007			10
1008			10
1009	44.12	37.38 24" IN (S)	10
		35.50 36" OUT (NE)	
		41.07 6"	
		40.18 8"	
		40.14 4"	
		42.59 3"	
1011			10
1023			10

NOTES:

1. SEE SHEET SC1.1 FOR UTILITY PLAN NOTES AND REHABILITATION NOTES.

KEY MAP



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62ND AVE NE, ET AL
PSS, PUMP STATION, PSD, ETC.
61ST AVE NE PLAN

PC EW94411

VAULT PLAN No. 777-478

SHEET SC1.7 OF

44034

From: Jensen, Jarvis K CIV SEA 04, 04NR
To: Langsted, Jim; Lowman, Laurie L CIV SEA 04 04N
Cc: Leisle, Dwight E CIV NAVFAC, RPM; Colyar, Kendra R CIV N44255, EV3; Generous, Christopher; Hamm, John
Subject: RE: Emailing: TCRA Former NAVSTA-PS Background Sampling Plan 2010Jun15.pdf
Date: Tuesday, June 22, 2010 2:25:27 PM

Jim,

I have reviewed the updated Background Sampling Plan. All of my comments have been addressed. I concur with the use of this plan.

Jarvis

Jarvis Jensen
NAVSEADET RASO
Yorktown Naval Weapons Station
(757) 887-4483
jarvis.jensen@navy.mil
-----Original Message-----
From: Langsted, Jim [mailto:Jim.Langsted@shawgrp.com]
Sent: Tuesday, June 15, 2010 7:40 PM
To: Jensen, Jarvis K CIV SEA 04, 04NR; Lowman, Laurie L CIV SEA 04 04N
Cc: Leisle, Dwight E CIV NAVFAC, RPM; Colyar, Kendra R CIV N44255, EV3; Generous, Christopher; Hamm, John
Subject: Emailing: TCRA Former NAVSTA-PS Background Sampling Plan 2010Jun15.pdf

<<TCRA Former NAVSTA-PS Background Sampling Plan 2010Jun15.pdf>> Jarvis,

Attached is the updated Background Sampling Plan incorporating your comments on the previous version. I have identified improved reference locations for your review.

Please review and provide your concurrence.

Thank you
Jim Langsted
Project RSO
303.870.2802

Attachment 2
Soil Characterization Sampling Plan

FINAL
SOIL CHARACTERIZATION SAMPLING PLAN
FOR
TIME CRITICAL REMOVAL ACTION
FORMER NAVAL STATION PUGET SOUND
SEATTLE WASHINGTON

Contract No. N62470-08-D-1007

Prepared for:
U.S. Department of the Navy
Naval Facilities Engineering Command Northwest
1101 Tautog Circle, Suite 203
Silverdale, Washington 98315

Prepared by:
Shaw Environmental & Infrastructure, Inc.
12100 NE 195th Street
Bothell, Washington 98296

Task Order FNZ4
Shaw Project No. 137165

NOVEMBER 2010

Table of Contents

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List of Abbreviations and Acronyms

Acronym	Meaning
bgs	below ground surface
COC	contaminant of concern
GIS	Geographic Information System
L	liter
NaI	sodium iodide
NAVSTA-PS	Former Naval Station Puget Sound
Navy	U.S. Department of the Navy
QAPP/SAP	Quality Assurance Project Plan/Sampling and Analysis Plan
RSO	Radiation Safety Officer
Shaw	Shaw Environmental & Infrastructure, Inc.
SSHP	Site Safety and Health Plan
SCSP	Soil Characterization Sampling Plan

1.0 Introduction

This Soil Characterization Sampling Plan (SCSP) has been prepared for the U.S. Department of the Navy (Navy) by Shaw Environmental & Infrastructure, Inc. (Shaw), to define the scope of work for the soil sampling activities to be conducted at the former Naval Station Puget Sound (NAVSTA-PS) site (Sand Point). Walkover radiological surveys and preliminary soil sampling indicate that radiologically contaminated soil exceeding background levels is present south and west of Building 27 and at locations near Building 2. The primary objective of this sampling plan is to define the lateral and vertical extent of radiologically contaminated soil for future use in evaluating remedial action alternatives.

This SCSP describes the rationale and methods for conducting the fieldwork activities at the former NAVSTA-PS site in order to:

- Collect and evaluate reference area soil samples and derive a soil release criterion to assess radiological contaminants of concern (COC) concentrations in soil
- Obtain sufficient data in order to characterize the property for COCs to support remedial design, risk assessment, and/or regulatory closure

2.0 Property and Survey History

In order to evaluate the potential for radiological soil contamination present within the project site, walkover surveys of the exposed soil were performed in the vicinity of the impacted buildings. Information obtained from these surveys was used to define proposed boring locations.

Initial survey of the soil areas next to the temporary Shaw construction trailer using a 2-inch-by-2-inch sodium iodide (NaI) detector indicated elevated readings in three areas. Access control and appropriate posting were implemented. A data recording/GPS system was interfaced to the NaI detector system, allowing dense area data collection while performing the walkover survey. The resulting data was plotted using geographic information system (GIS) software, and the hot spots were emphasized by manipulating the display colors the relevant radiological surveys are listed in Table 1.

Table 1
Relevant Radiological Surveys

Survey	Date
RSS-262 soil hot spot detection	7-29-2010
RSS-273 soil reference area	8-2-2010
RSS-308 B27 soil gamma walkover survey	8-12-2010
RSS-331 B27 soil microR and static cpm readings on areas of elevated activity	8-31-2010
RSS-344 B27 soil and pavement gamma walkover survey	9-9-2010
RSS-347 B27 pavement and soil microR and static CPM readings on areas of elevated activity	9-13-2010
RSS-374 B27 hillside soil excavation hot spots #16 and 17	9-22-2010
RSS-379 B27 hillside soil excavation hot spot #1	9-23-2010
RSS-388 B27 proposed soil reference area 10 locations static counts	9-22-2010
RSS-397 B27 hillside soil excavation hot spot #23-24	9-28-2010
RSS-403 Bldg 27 soil sampling	9-30-2010
RSS-409 Bldg 27 soil hot spot post shielding survey	10-1-2010
RSS-410 Bldg 27 soil hot spot post shielding survey	10-5-2010
RSS-422 Bldg 2 gamma walkover survey	10-27-2010

The resulting survey plots (Figure 1 through Figure 9) indicate the presence of multiple locations exceeding two to three times the measured soil background count rate (mean plus three standard deviations equaled 5,110 cpm). These locations have been identified as hot spots and are assigned identification numbers.

Three locations were hand-excavated on September 22 – 28, 2010, to determine if buried objects or waste material could be identified (Table 1, RSS-374 and RSS-379). Excavation to a depth of 6 to 10 inches in these locations identified no objects or discoloration that would indicate burial of waste material. The soil and rock encountered during this excavation was more indicative of fill material consistent with construction of the site. These three locations plus two additional locations were hand-augered to a depth of 8 to 16 inches to collect soil samples at 6-inch intervals. These samples have been submitted to an analytical laboratory for analysis. On October 6, 2010, these samples were counted to provide the preliminary results as shown in Table 2. These samples will be stored for the 28-day ingrowth period necessary to provide final results at a later date.

Table 2
Preliminary Soil Sampling Results - Ra-226 (pCi/g)

Sample ID	Ra-226 (pCi/g)	Total Uncertainty[a]	MDL[b]	Sample Interval
HS23-SO-001	1.89	0.315	0.093	0 – 6 inches
HS23-SO-002	0.621	0.127	0.0479	6 – 8 inches
HS1-SO-003	1,190	69.7	1.24	6 – 12 inches
HS6-SO-004	23.9	1.68	0.173	6 – 12 inches
HS16-SO-005	2.95	0.319	0.0676	10 – 16 inches
HS17-SO-006	1.37	0.221	0.0756	6 – 12 inches

pCi/g = picoCurie(s) per gram.
a 2 times the count standard deviation (σ).
b Minimum detection level (pCi/g).

3.0 Scope of Work

The soil sampling scope of work for the former NAVSTA-PS site includes:

- Performing hand augering in 6-inch segments at those locations to obtain a continuous sample
- Performing and documenting gamma measurements on each hand auger segment
- Identifying elevated count rate sample locations
- Performing a down-hole gamma scan (if possible)
- Collecting soil samples from alternate sample segments for analytical laboratory analysis

Boring locations were selected to characterize each hot spot identified by walkover surveys. Hand augering will be performed to a depth necessary to assess the vertical extent of radiological contamination or to the groundwater surface. Boring locations are all within a few vertical feet of the level of Lake Washington, and it is anticipated that groundwater will be within approximately 2 to 8 feet below ground surface (bgs). Boring locations were generally positioned to:

- Assess the magnitude of radium concentrations at the hot spot location by collecting and analyzing soil samples with the highest count rates measured in the field
- Attempt to delineate the extent of the contamination by sampling at locations around the anticipated periphery of the contamination

Figures 10 through 13 indicate the proposed boring locations, and Table 3 identifies the boring location selection rationale. Adjustments may be made to the planned borehole locations depending on obstruction and operational interferences. Target depths may be adjusted as necessary, depending on field readings and depth to groundwater.

Table 3
Planned Boring Locations for NAVSTA-PS

Boring #	WA State Plane		Purpose
1	392,602.760	77,351.354	Boundary
2	392,604.617	77,345.566	Hot spot
3	392,604.344	77,339.344	Hot spot
4	392,601.902	77,339.527	Boundary
5	392,604.559	77,337.421	Boundary
6	392,604.128	77,332.513	Boundary
7	392,602.635	77,329.370	Hot spot
8	392,601.285	77,334.594	Boundary

Boring #	WA State Plane		Purpose
9	392,604.743	77,327.997	Hot spot
10	392,604.786	77,323.551	Hot spot
11	392,602.717	77,324.733	Hot spot
12	392,601.713	77,320.864	Boundary
13	392,610.990	77,316.163	Hot spot
14	392,608.102	77,310.963	Boundary
15	392,621.842	77,302.369	Hot spot
16	392,619.572	77,303.193	Boundary
17	392,626.692	77,297.186	Hot spot
18	392,626.457	77,303.744	Boundary
19	392,628.486	77,301.839	Boundary
20	392,628.865	77,308.005	Location biased
21	392,646.159	77,308.952	Location biased
22	392,649.310	77,309.430	Boundary
23	392,659.746	77,310.224	Hot spot
24	392,656.726	77,304.937	Hot spot
25	392,654.506	77,305.140	Boundary
26	392,652.155	77,302.210	Location biased
27	392,658.936	77,303.470	Location biased
28	392,669.490	77,306.008	Boundary
29	392,675.963	77,308.125	Hot spot
30	392,678.029	77,307.960	Boundary
31	392,685.846	77,308.010	Boundary
32	392,583.902	77,361.519	Hot spot
33	392,582.886	77,364.793	Boundary
34	392,587.350	77,362.628	Boundary
35	392,580.067	77,360.594	Boundary
36	392,585.006	77,355.856	Boundary
37	392,586.092	77,350.538	Hot spot
38	392,589.669	77,351.231	Boundary
39	392,582.221	77,349.463	Boundary
40	392,586.066	77,346.514	Boundary
41	392,585.899	77,342.122	Hot spot
42	392,589.764	77,342.327	Boundary
43	392,586.428	77,338.065	Boundary
44	392,582.452	77,341.842	Boundary
45	392,581.766	77,312.025	Boundary
46	392,576.642	77,315.638	Hot spot
47	392,610.333	77,272.837	Boundary
48	392,606.036	77,266.579	Boundary
49	392,611.319	77,266.871	Hot spot
50	392,614.352	77,267.161	Boundary
51	392,610.328	77,254.259	Hot spot
52	392,642.111	77,270.384	Hot spot
53	392,645.019	77,274.653	Boundary

Boring #	WA State Plane		Purpose
54	392,638.599	77,270.463	Boundary
55	392,642.627	77,266.051	Boundary
56	392,703.018	77,141.990	Hot spot
57	392,699.058	77,142.006	Boundary
58	392,701.957	77,143.240	Boundary
59	392,704.290	77,142.000	Boundary
60	392,754.783	77,148.287	Hot spot
61	392,754.849	77,150.129	Boundary
62	392,755.607	77,146.799	Boundary
63	392718.5328	77310.8353	Reference (static location #6)
64	392740.1388	77310.8353	Reference (static location #8)
65	392734.7373	77301.4797	Reference (static location #3)
66	392756.3433	77301.4797	Reference (static location #5)

The specific order of sampling and the exact sample locations will be determined in the field by Shaw depending on available data.

Four soil borings will also be drilled in a soil reference area located east of Building 27 and west of Pump House 117. This area was selected based on the findings of the gamma walkover survey (background readings). Four soil samples will be collected at approximately 1-foot intervals in each boring starting from the surface.

4.0 Drilling and Sampling

4.1 Utility Clearance

Utilities will be located in accordance with Shaw procedure *HS308 - Underground/Overhead Utility Contact Prevention* (Shaw, 2006). Locating of utilities will be performed by a professional utility location subcontractor using appropriate methods, which may include ground-penetrating radar or electromagnetic methods (as required).

4.2 Traffic Control

In order to safely execute sampling activities in site locations accessible by vehicles, traffic will be controlled in accordance with Section 6.5 of *Site Safety and Health Plan, Time Critical Removal Action, Former Naval Station Puget Sound* (SSHP) (Shaw, 2010). Traffic control plans, as appropriate, will be developed in conjunction with the Navy Technical Representative, City of Seattle Parks and Recreation and City of Seattle Department of Public Works (U.S. Navy, 2010).

4.3 Drilling/Sampling Approach

Due to limited site access because of structures, steep topography, and anticipated presence of gravel and cobbles in the shallow substrate that precludes the use of a drilling rig and split spoon sampling, the proposed method of soil sampling is hand augering. Hand augers or other hand tools will be used to collect soil in 6-inch increments for gamma scanning and soil sampling as required. The specific methods for collection of soil samples using hand augers are presented below. In some instances, soil conditions may limit the use of hand tools for collecting soil samples at a particular sample location. Alternate methods may be used in such instances. If field conditions preclude the use of a hand auger, a post hole digger or other tool may be used to obtain soil samples from a particular sample location.

4.3.1 Hand Auger Segment Retrieval and Logging

From each boring, 6-inch (length) hand auger segments will be retrieved continuously from the ground surface to 6 inches below the water table or an unaffected depth as identified by the field geologist and the Project Radiation Safety Officer (RSO). A minimum of 2-inch-diameter hand auger will be used. Each hand auger segment will be logged for soil type, surveyed for gamma count rate, and considered for collection for laboratory analysis. Every other 6-inch auger sample will be collected for laboratory analysis.

Upon recovery of the hand augering device (sampler) from the boring hole, the soil will be removed and placed into a cleaned stainless steel bowl. To ensure that no “slough” material originating from upper hand auger segments is collected for analysis, the field geologist will visually assess soil from each hand auger segment and discard material determined to be "slough." For each hand auger segment, the recovered material must be representative of that specific depth interval. Each discrete soil sample shall be representative of the materials recovered from that depth, including debris and large particles.

If soil recovery is incomplete (and it is suspected that the unrecovered material has remained in the borehole), an attempt should be made to obtain the unrecovered soil by advancing a clean sampler to a depth slightly greater than the depth of the prior advance. The field geologist will be responsible for determining whether the recovered soil is representative of the hand auger segment. If the soil sample is not considered representative, hand augering and sampling an adjacent boring (i.e., a boring no greater than 10 feet from the initial boring, unless otherwise approved by the Navy) may be required. In the adjacent boring, a representative sample shall be obtained from the missing hand auger segment(s). The samples obtained for this purpose from the adjacent boring shall replace those samples previously collected from the same hand auger segment in the original boring.

Each hand auger segment will also be screened for volatile organic compounds (VOC) in accordance with the SSHP (Shaw, 2010). This VOC screening will involve monitoring the breathing zone air for health and safety purposes during sample collection activities. This air monitoring will be performed using either a flame ionization detector or a photoionization detector.

The recovered hand auger segment will be field-screened for gamma count rate using a Ludlum Model 2221 coupled with a Ludlum Model 44-10 (2x2 NaI detector) in a standard geometry using a stainless steel bowl. The purpose of the radiological field screening is to provide real-time radiological activity data to guide the radiological COC delineation efforts.

Each hand auger segment will be examined and lithologically described (logged) by the field geologist in accordance with geologic description guidance provided in Appendix E of EM 1110-1-1906 (U.S. Army Corps of Engineers, 1996). A drilling log form will be completed for each boring and will include the geological description and radiological field-screening results.

Upon completion of the boring/sampling, the determination of whether additional samples should be submitted for laboratory analysis will be made by the field geologist in consultation with the Project RSO or designee and the Navy. Samples will be sent for analyses to an offsite analytical laboratory.

Following completion of boring, a 1-inch-by-1-inch NaI detector will be lowered down the borehole to log the gamma count rate at 6-inch intervals.

4.3.2 Gamma Survey

Each hand auger segment shall be placed in a standard stainless steel bowl and monitored with a 2-inch-by-2-inch NaI detector (one-minute count) at a distance of 1 foot above the surface of the soil. This measurement shall be performed in a "background" area that does not show elevated gamma count rate resulting from hot spot contamination. The background shall be measured (10 each one-minute counts) and documented prior to performing these gamma count rate measurements. The soil level in the bowl shall be documented for each measurement. The shape of the bowl shall be recorded and the levels in the bowl shall be calibrated (with water or sand) to determine the volume of soil for each level used.

A 1-inch-by-1-inch NaI detector shall be lowered down each borehole that remains open, performing and documenting a one-minute count at each 6-inch depth (bgs). Care should be taken to position the detector crystal at the measured depth.

4.3.3 Sampling Methods

Soil Coring Method or Scoop – Surface Soil Samples (to 15 centimeters [6 inches] bgs)

- Place plastic sheeting on the ground around the sampling location.
- Using a pre-cleaned or decontaminated stainless steel soil coring tool (or stainless steel scoop) and proceed to composite a 6-inch-deep soil sample in a stainless steel bowl.
- For radionuclide analyses, collect a ½- to 1-liter (L) volume of soil.
- Perform and document the gamma count rate measurement.
- Label the sample bottles using a pre-determined sample identification system consistent with that provided in the project Quality Assurance Project Plan/Sampling and Analysis Plan (QAPP/SAP).
- Complete all chain-of-custody documents and record the sampling event in the field logbook.
- Decontaminate sampling equipment after use and between sample locations.

Hand Auger – Subsurface Soil Samples

- Place plastic sheeting on the ground around the sampling location.
- Using the hand auger, hand auger to a 6-inch depth. Remove accumulated soil from around the auger hole to prevent loose soil from falling back into the borehole.

- Take care to avoid scraping the sidewalls of the auger hole.
- Remove the auger and collect the soil sample and discard any material collected by the probe before the target soil layer.
- Proceed to composite the sample in a stainless steel bowl.
- For radionuclide analyses, collect a ½- to 1-L volume of soil.
- Perform and document the gamma count rate measurement.
- Label the sample bottles using a pre-determined sample identification system consistent with that provided in the QAPP/SAP.
- Complete all chain-of-custody documents and record the sampling event in the field logbook.
- Decontaminate sampling equipment after use and between sample locations.

4.3.4 Laboratory Analyses

As stated previously, soil samples will be collected at 6-inch intervals and will be monitored in the field using 2-inch-by-2-inch NaI detector (one-minute count) at a distance of 1 foot above the soil sample. Soil samples shall consist of ½ to 1 liter of soil in a stainless steel bowl. Every other soil sample (one every foot) will be sealed in a sample container, labeled, and packaged for shipment to the laboratory for radionuclide analyses under chain-of-custody documentation according to QAPP/SAP requirements. In general, borings where count rate measurements are near background levels (perimeter borings) shall have the one soil sample with the highest count rate analyzed for radionuclides. In borings where readings exceed background levels (hot spot borings), the soil sample containing the highest field reading collected from the boring will be analyzed for radionuclides. In addition, a soil sample collected 1 foot below the last sample containing readings exceeding background levels will be analyzed for radionuclides. Additional soil samples may also be selected for analysis depending on interpretation of field readings to define the lateral and vertical extent. All samples sent to the laboratory for radionuclide analyses shall be analyzed for Radium 226 according to EPA 901.1 and for Strontium 90 according to EPA 905.

4.3.5 Radiological Controls

Radiological conditions will be carefully monitored as with all other evolutions performed on site. A specific Radiological Work Permit (RWP) will be written to address the radiological controls for this task. Elements of the RWP will include proper PPE, dosimetry, radiation, contamination, and airborne monitoring requirements, and other special instructions.

General area dose rates at the Radiologically Controlled Area (RCA) boundary may not exceed 10 µR/hr. If higher levels are anticipated, the RCA boundaries must first be expanded to ensure that dose rates are less than 10 µR/hr at the RCA boundary. Contamination will be controlled so that levels in unrestricted areas will remain less than the limits established in the Radiation Protection Plan Table 3.12 for alpha activity and a more conservative Sr-90 beta limit:

Re	movable dpm/100 cm^2	Total dpm/100 cm^2
Alpha 20		100
Beta/gamma 200		1,000

All spoils from soil sampling will be containerized in 55 gallon drums and stored in a Radioactive Material Storage Area. A senior Radiological Controls Technician will provide job coverage throughout the soil sampling activity and monitor contamination levels and dose rates in the work areas and RCA boundary. Air samples will be taken at the soil boring locations, the soil screening and sample preparation area, and at the boundary of the RCA.

5.0 Boring Abandonment

Soil borings will be backfilled with bentonite chips and hydrated. The bentonite chips will be backfilled to within approximately 1 foot of ground surface. Imported sand or soil will be placed above the bentonite or asphalt shall be replaced with cold-patch asphalt to a depth equal to the original asphalt paving.

6.0 Sampling Equipment Decontamination

Equipment decontamination procedures will be implemented in accordance with the Project QAPP/SAP, RPP, any field instruction written specifically for this activity, and the SSHP (Shaw, 2010). Specifically, down-hole drilling equipment will be decontaminated subsequent to drilling, and non-disposable hand-sampling equipment will be decontaminated prior to re-use.

7.0 References

Shaw Environmental and Infrastructure, Inc., 2006, *HS308, Underground/Overhead Utility Contact Prevention,* Shaw Corporate Procedure, Revision 1, Baton Rouge, Louisiana, February 20.

Shaw Environmental and Infrastructure, Inc., 2010, *Site Safety and Health Plan, Time Critical Removal Action, Former Naval Station Puget Sound* (SSHP), Bothell, Washington, January.

U.S. Army Corps of Engineers, 1996, Engineer Manual (EM) EM 1110-1-1906, *Engineering and Design - Soil Sampling*, Washington DC, September 30.

U.S. Navy, 2009, *Scope of Work*, Revised, Naval Facilities Engineering Command Northwest Silverdale, Washington, September 3.

FIGURES

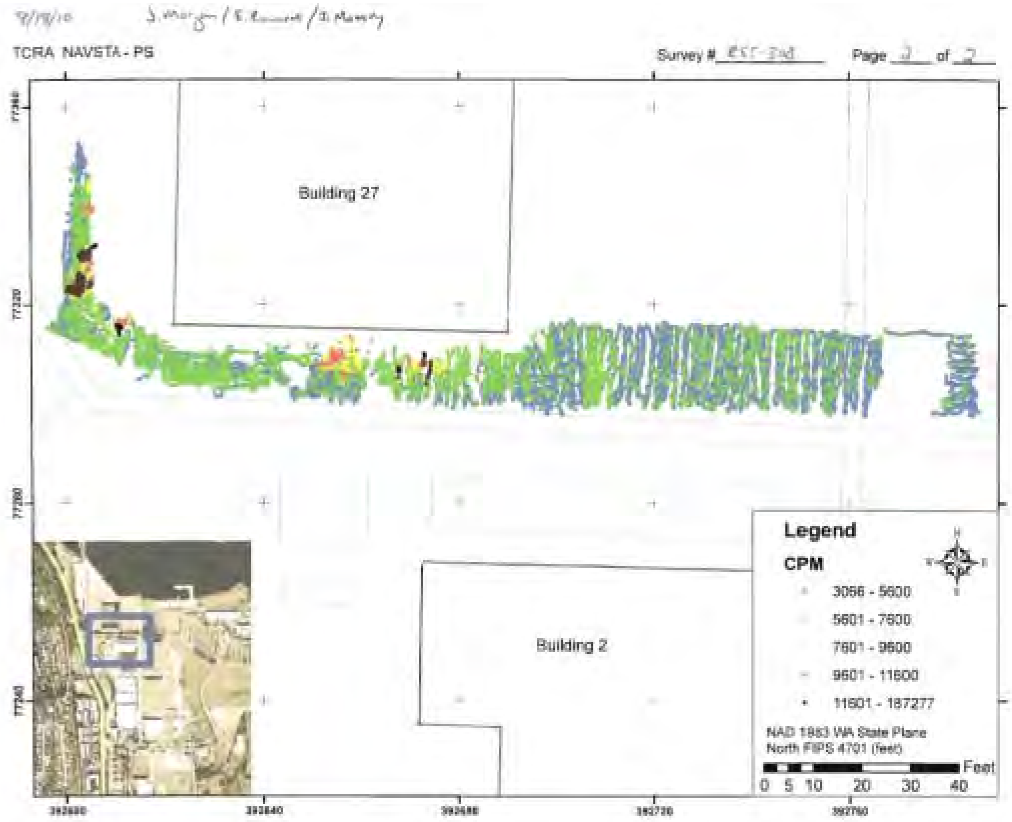


Figure 1
Gamma Walkover Survey - South and West of Building 27

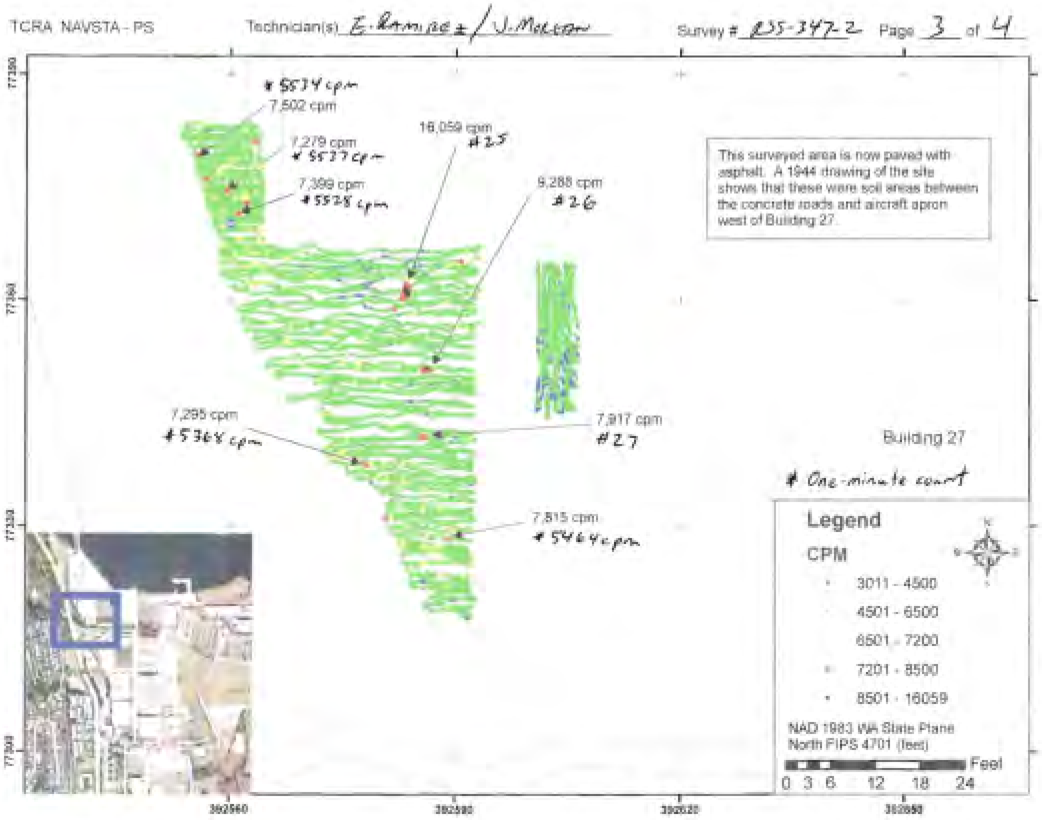


Figure 2
Gamma Walkover Survey - West of Building 27

TCRA NAVSTA - PS

Technician(s) J Morgan

Survey RSS-388
Page 2 of 3

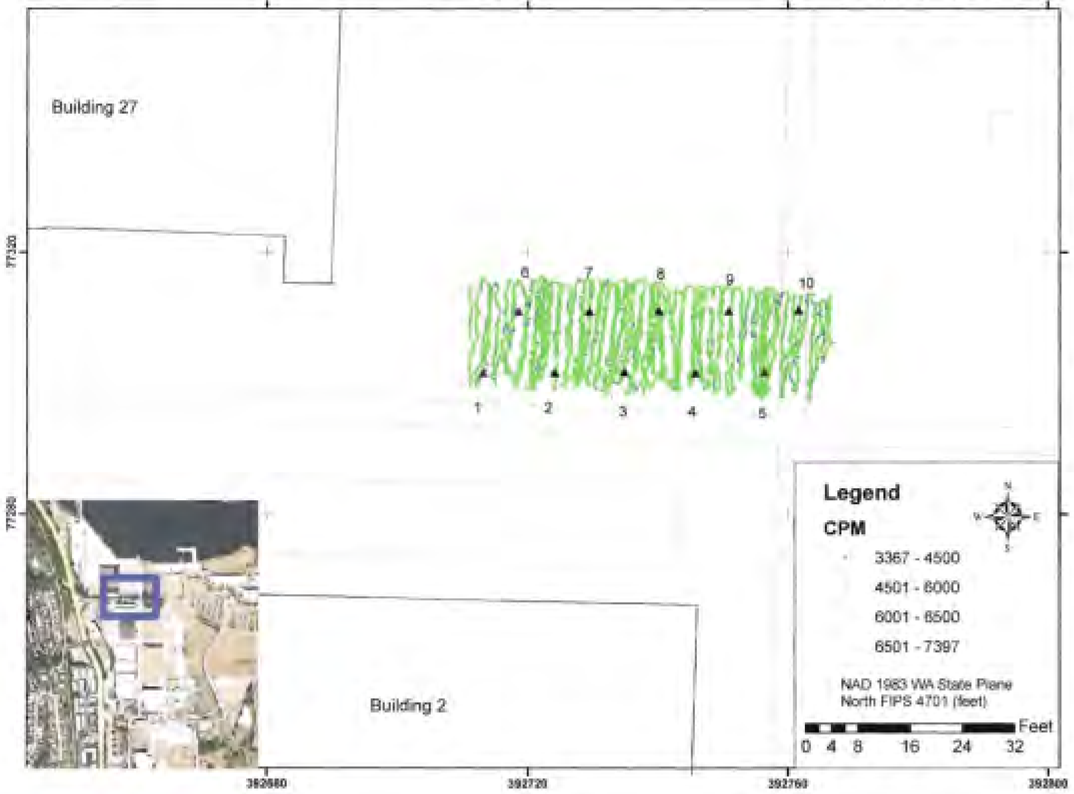
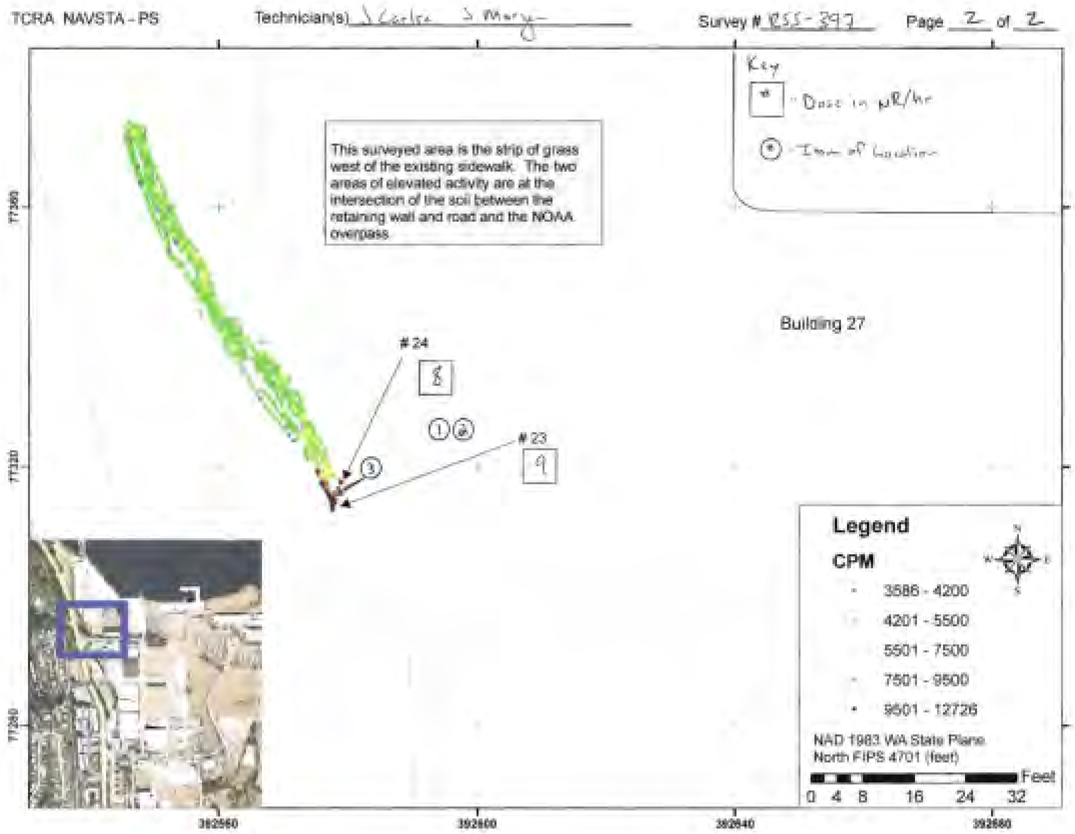


Figure 3
Gamma Walkover Survey - Soil Reference Area



TCRA NAVSTA - PS Technician(s) J Carlsc S Morg Survey # RSS-397 Page 2 of 2

This surveyed area is the strip of grass west of the existing sidewalk. The two areas of elevated activity are at the intersection of the soil between the retaining wall and road and the NOAA overpass.

Figure 4
Gamma Walkover Survey - Grass Strip West of Building 27

Figure 5
Gamma Walkover Survey - West of Building 12

Figure 6
Gamma Walkover Survey - North of Building 12

Figure 7
Gamma Walkover Survey - South and East of Building 2

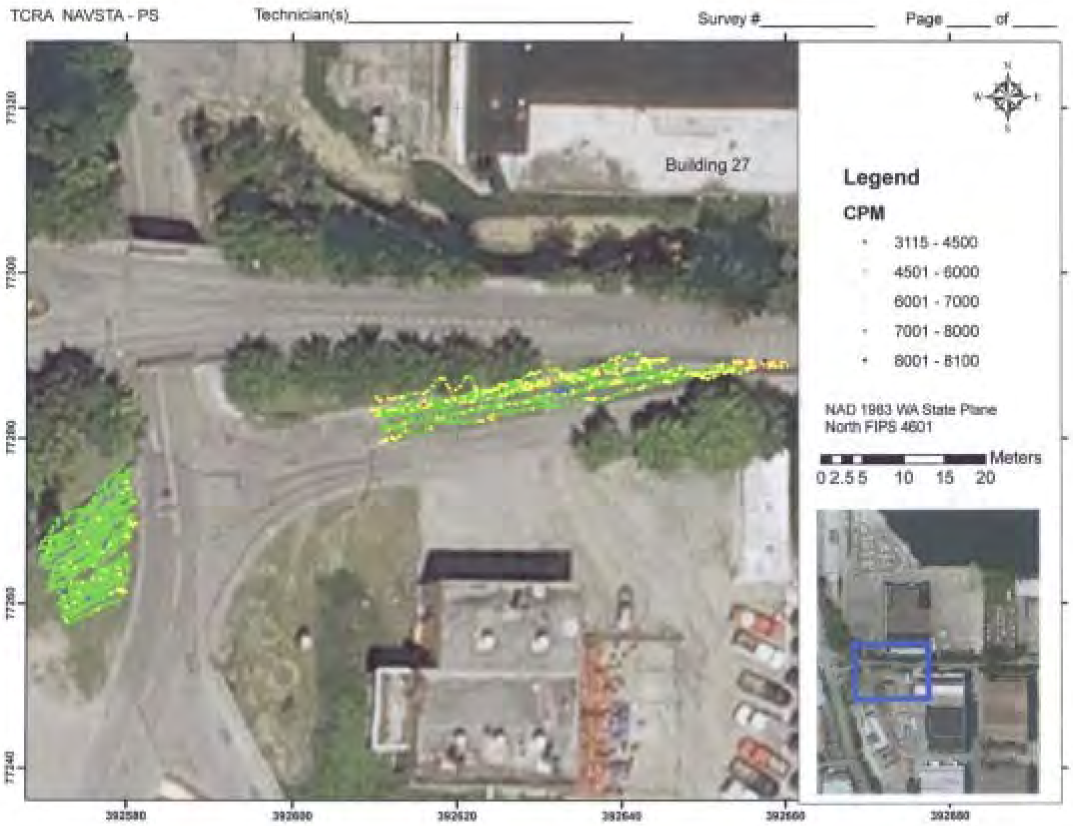


Figure 8
Gamma Walkover Survey - North of Building 12

Figure 9
Gamma Walkover Survey - Northwest of Building 2


Shaw
Shaw E & I, Inc.
12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766
Legend
▲ Proposed Sample Locations
CPM
● 3586 - 5600
● 5601 - 7600
● 7601 - 9600
● 9601 - 11600
● 11601 - 187277
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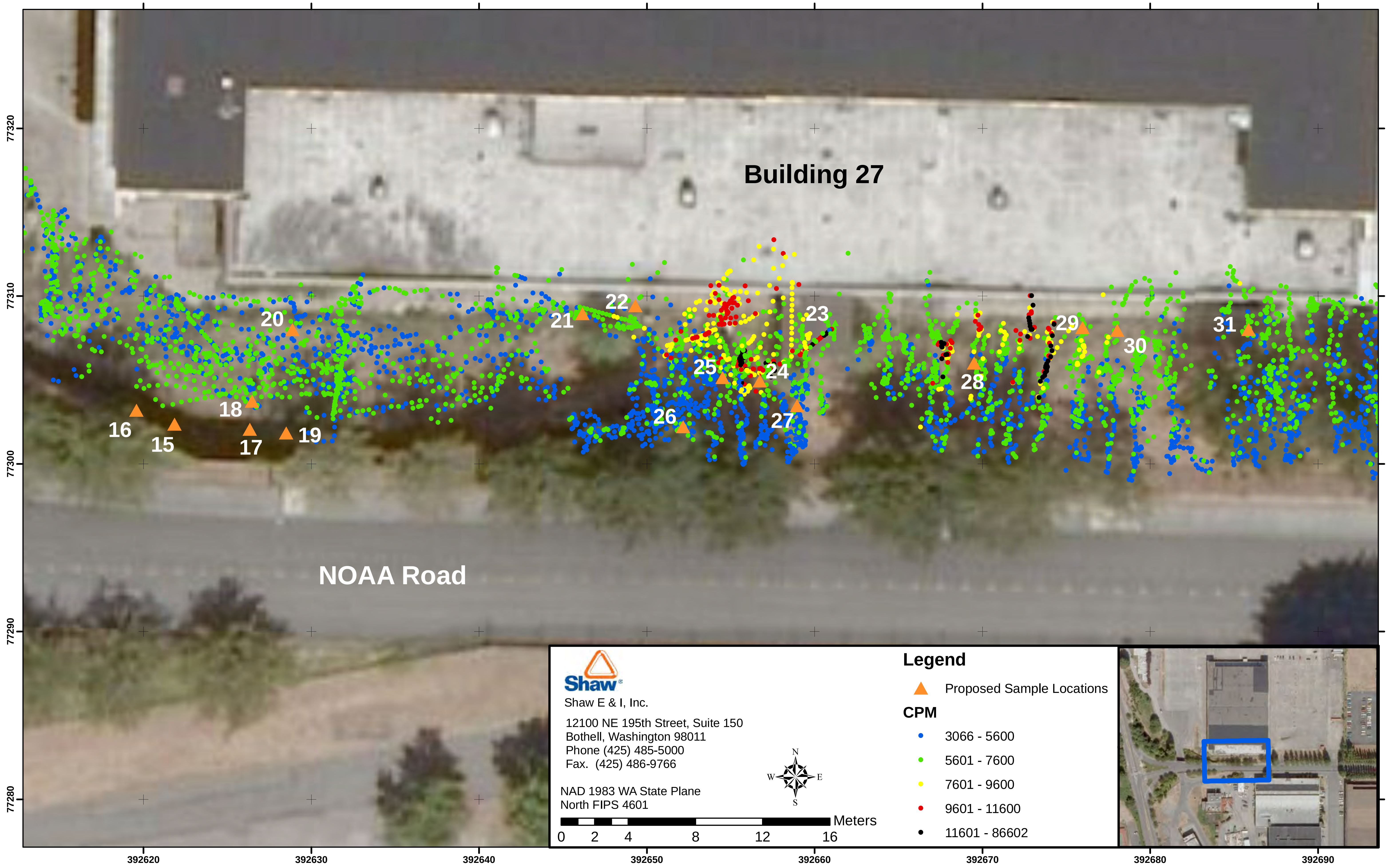
Building 27
NOAA Road
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Shaw
Shaw E & I, Inc.
12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766
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North FIPS 4601
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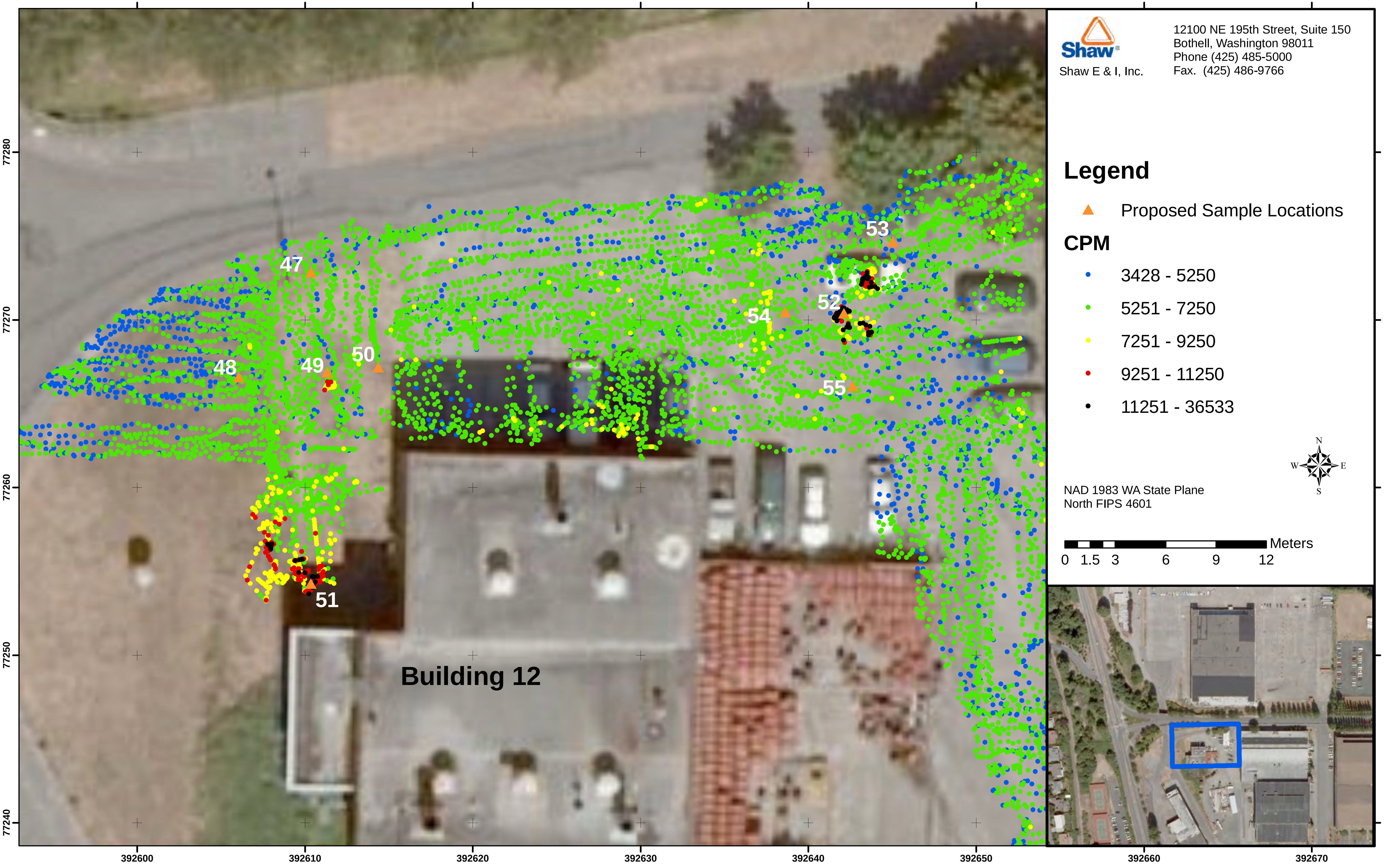
Shaw
Shaw E & I, Inc.
12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766
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Proposed Sample Locations
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Shaw®
Shaw E & I, Inc.
12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766
Building 2
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Legend
Proposed Sample Locations
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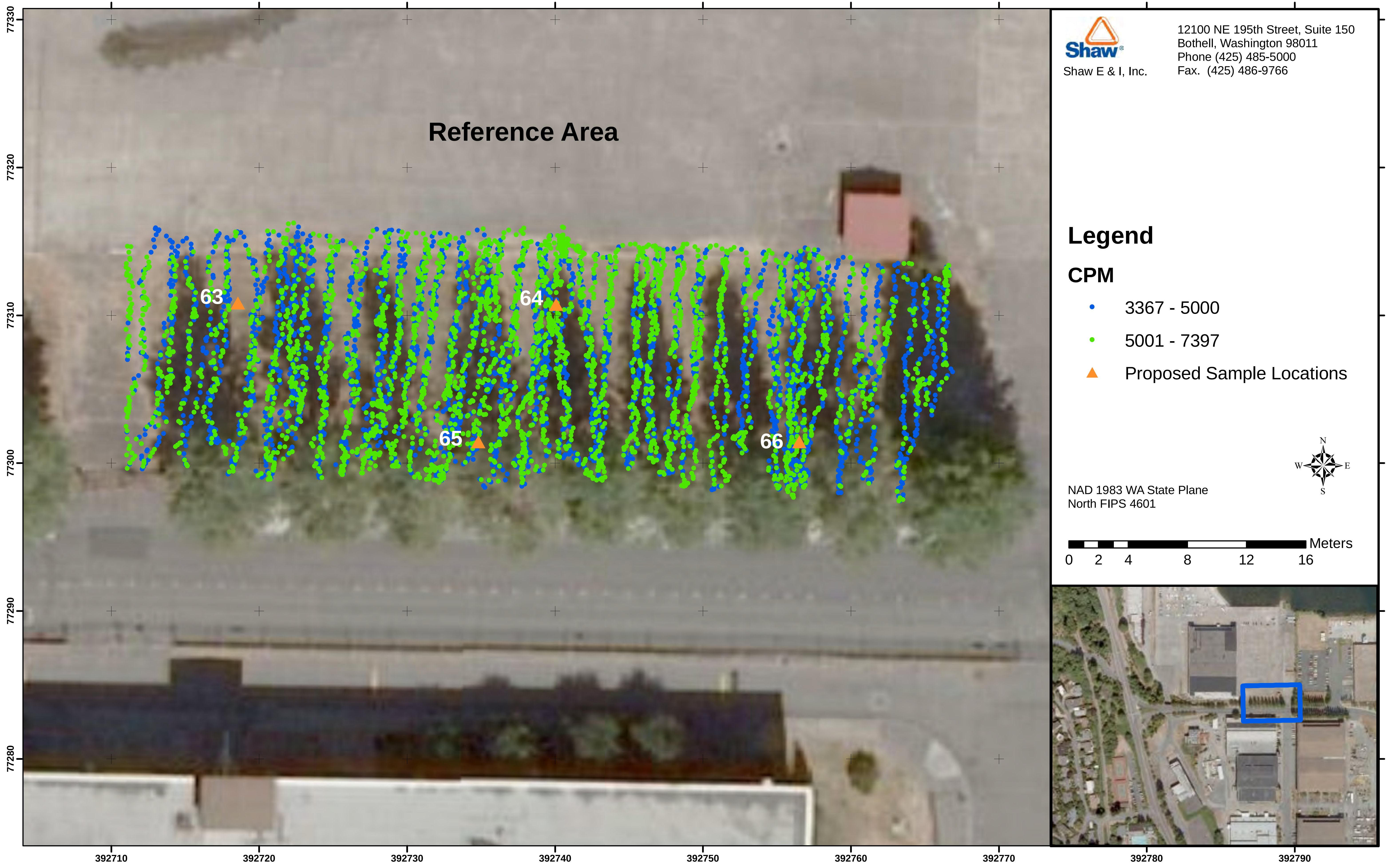
Reference Area
63
64
65
66
12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766
Shaw E & I, Inc.
Legend
CPM
● 3367 - 5000
● 5001 - 7397
▲ Proposed Sample Locations
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Attachment 3
Background Soil Concentration Determination

Introduction

Radium-226 (Ra-226) occurs naturally and Strontium -90 (Sr-90) is a fallout nuclide. Both are present in soils throughout the world. Analytical results from surface and subsurface soil samples collected at an identified reference area at the former Naval Station Puget Sound (NAVSTA-PS) were used to determine the reference (background) concentrations. The following sections describe how reference concentrations were determined for the site and how fixed "bright line" criteria values were derived. "Bright line" means a single value against which impacted (downgradient) data can be compared. Values above the "bright line" are contaminated; those below the "bright line" are background.

Analysis

Criteria

The Navy has defined the comparison criteria as follows:

> "The Contractor shall establish radiological background as appropriate for implementation of the cleanup action. Radiological contamination is expected to contain Radium-226. Should any soil or sediment exceeding the mean statistical background level plus three standard deviations be encountered they will be removed, inventoried, packaged, labeled, and stored in a secure dedicated Radioactive Materials Storage Area in accordance with all appropriate regulations pending disposal by a separate contractor managed by the Navy." (Revised SOW, Section 2.5)

Reference Soil Collection

Shaw developed a Soil Characterization Sampling Plan for review and approval by the Navy. This plan identifies the soil reference area and the sampling to be performed (Attachment 1.)

Underground utility interferences necessitated moving each of the reference locations. Reference soil sampling was performed at locations indicated in Table 1. A diagram of these locations is included as Attachment 2.

Table 1. Reference Soil Locations

Boring #	**WA State Plane (m)**		**Purpose**
	Easting	Northing	
63	392,717.897	77,314.357	Reference (static location #6)
64	392,738.714	77,313.023	Reference (static location #8)
65	392,733.376	77,303.682	Reference (static location #3)
66	392,754.194	77,302.881	Reference (static location #5)

Taken from Table 3 of Attachment 1

Samples were taken at the surface and at alternating six-inch depths (one-foot intervals) until four samples were collected or groundwater was encountered. At reference boring location 64, groundwater was encountered at 33 inches below ground surface.

Analytical Data

Reference soil samples were submitted to a contract radioanalytical laboratory (TestAmerica Laboratories, Inc. – St. Louis) for analysis of Ra-226 using method EML GA-01-R MOD Gamma Spectroscopy and for Sr-90 using USEPA method 905 MOD Gas-Flow Proportional Counter. The results are presented in Table 2.

Table 2. Analytical Results – Reference Soil Data

Boring Number	depth	Sample ID	Ra-226 (pCi/g)	Lab Flag	Sr-90 (pCi/g)	Lab Flag
63	0-0.5'	63-SC-R-0-0.5'	0.407		0.171	
	1.0-1.5'	63-SC-R-1.0-1.5'	0.572		-0.109	U
	2.0-2.5'	63-SC-R-2.0-2.5'	0.414		0.0622	U
	3.0-3.5'	63-SC-R-3.0-3.5'	0.305		-0.0233	U
64	0-0.5'	64-SC-R-0-0.5'	0.391		-0.0317	U
	0.5-1.0'	64-SC-R-0.5-1.0'	0.375		0.13	U
	1.0-1.5'	64-SC-R-1.0-1.5'	0.573		0.176	
	2.0-2.5'	64-SC-R-2.0-2.5'	0.274		-0.066	U
65	0-0.5'	65-SC-R-0-0.5'	0.562		0.089	U
	1.0-1.5'	65-SC-R-1.0-1.5'	0.658		0.215	
	2.0-2.5'	65-SC-R-2.0-2.5'	0.418		0.00542	U
	3.0-3.5'	65-SC-R-3.0-3.5'	0.596		0.0645	U
66	0-0.5'	66-SC-R-0-0.5'	0.341		0.192	
	1.0-1.5'	66-SC-R-1.0-1.5'	0.711		-0.122	U
	2.0-2.5'	66-SC-R-2.0-2.5'	0.399		0.179	U
	3.0-3.5'	66-SC-R-3.0-3.5'	0.478		-0.0571	U

Lab Flag “U” indicates that the result is less than the sample detection limit.

The Sr-90 minimum detectable concentration (MDC) varies for each analysis in the range 0.119-0. 207 (average is 0.159). In accordance with MARSSIM, Section N.4, it is appropriate to report values below the MDC and use these values in calculated values. The magnitude of the MDC with respect to the concentration guide limit determined for the project (later in this paper) determines the confidence in the values used. It will later be demonstrated that MDCs for Sr-90 analysis are appropriate.

The data in Table 2 have been validated by the Shaw project chemist. The complete lab data packages are available from the Project.

Data Analysis

Radium-226

The reference data are presented in Figure 1.

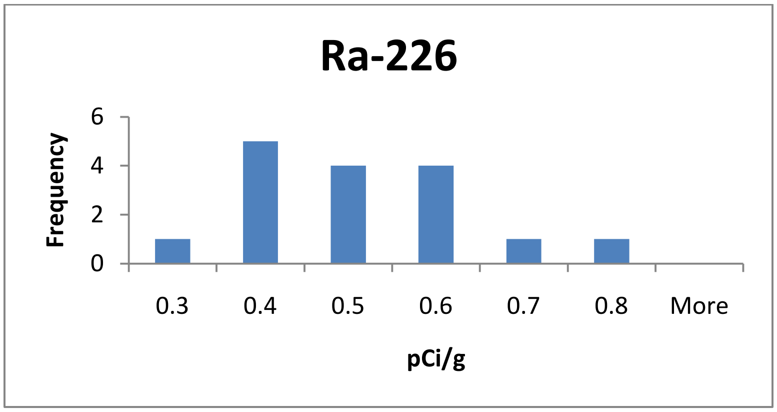

Figure 1. Reference Soil Results – Ra-226

For this data:

- Statistical mean = 0.467 pCi/g Ra-226
- Standard Deviation = 0.129 pCi/g Ra-226
- Statistical mean plus three standard deviations = 0.855 pCi/g Ra-226.

Strontium-90

The reference data are presented in Figure 2.

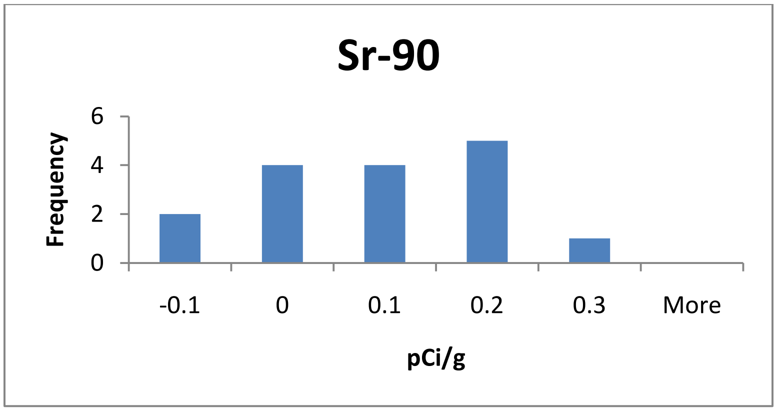

Figure 2. Reference Soil Results – Sr-90

For this data:

- Statistical mean = 0.055 pCi/g Sr-90
- Standard Deviation = 0.114 pCi/g Sr-90
- Statistical mean plus three standard deviations = 0.398 pCi/g Sr-90.

Random Effect Modeling

Statistical analysis was performed to evaluate these data, better understand the variance, and identify an accurate method to determine if downgradient samples fall within the reference background population (Attachment 3). This analysis determined that there is no random effect (the means and the variances are statistically equivalent) due to the locations of the boreholes. Thus, use of the mean + three standard deviations as the "bright line" comparison value is appropriate.

Conclusion

There is no significant difference between the reference soil borehole locations, thus they have been pooled into one group. For comparison of one sample in accordance with the criterion defined in the revised SOW:

	Ra-226 (pCi/g)	**Sr-90 (pCi/g)**
Statistical mean + 3 standard deviations	0.855	0.398

References

MARSSIM, Multi-Agency Radiation Survey and Site Investigation Manual, NUREG-1575, Revision 1, Washington, DC, August 2000.

Revised SOW, Scope of Work, Time Critical Removal Action At Former Naval Station Puget Sound, Contract N62470-08-D-1007, PTO XX24, Naval Facilities Engineering Command Northwest, September 3, 2009.

Attachments

a) Attachment 1 – Soil Characterization Sampling Plan
b) Attachment 2 – Reference Soil Borehole Locations
c) Attachment 3 –Statistical Analysis

Attachment 1

FINAL
SOIL CHARACTERIZATION SAMPLING PLAN
FOR
TIME CRITICAL REMOVAL ACTION
FORMER NAVAL STATION PUGET SOUND
SEATTLE WASHINGTON

Contract No. N62470-08-D-1007

Prepared for:
U.S. Department of the Navy
Naval Facilities Engineering Command Northwest
1101 Tautog Circle, Suite 203
Silverdale, Washington 98315

Prepared by:
Shaw Environmental & Infrastructure, Inc.
12100 NE 195th Street
Bothell, Washington 98296

Task Order FNZ4

Shaw Project No. 137165

NOVEMBER 2010

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List of Abbreviations and Acronyms

Acronym	Meaning
bgs	below ground surface
COC	contaminant of concern
GIS	Geographic Information System
L	liter
NaI	sodium iodide
NAVSTA-PS	Former Naval Station Puget Sound
Navy	U.S. Department of the Navy
QAPP/SAP	Quality Assurance Project Plan/Sampling and Analysis Plan
RSO	Radiation Safety Officer
Shaw	Shaw Environmental & Infrastructure, Inc.
SSHP	Site Safety and Health Plan
SCSP	Soil Characterization Sampling Plan

1.0 Introduction

This Soil Characterization Sampling Plan (SCSP) has been prepared for the U.S. Department of the Navy (Navy) by Shaw Environmental & Infrastructure, Inc. (Shaw), to define the scope of work for the soil sampling activities to be conducted at the former Naval Station Puget Sound (NAVSTA-PS) site (Sand Point). Walkover radiological surveys and preliminary soil sampling indicate that radiologically contaminated soil exceeding background levels is present south and west of Building 27 and at locations near Building 2. The primary objective of this sampling plan is to define the lateral and vertical extent of radiologically contaminated soil for future use in evaluating remedial action alternatives.

This SCSP describes the rationale and methods for conducting the fieldwork activities at the former NAVSTA-PS site in order to:

- Collect and evaluate reference area soil samples and derive a soil release criterion to assess radiological contaminants of concern (COC) concentrations in soil
- Obtain sufficient data in order to characterize the property for COCs to support remedial design, risk assessment, and/or regulatory closure

2.0 Property and Survey History

In order to evaluate the potential for radiological soil contamination present within the project site, walkover surveys of the exposed soil were performed in the vicinity of the impacted buildings. Information obtained from these surveys was used to define proposed boring locations.

Initial survey of the soil areas next to the temporary Shaw construction trailer using a 2-inch-by-2-inch sodium iodide (NaI) detector indicated elevated readings in three areas. Access control and appropriate posting were implemented. A data recording/GPS system was interfaced to the NaI detector system, allowing dense area data collection while performing the walkover survey. The resulting data was plotted using geographic information system (GIS) software, and the hot spots were emphasized by manipulating the display colors the relevant radiological surveys are listed in Table 1.

Table 1
Relevant Radiological Surveys

Survey	Date
RSS-262 soil hot spot detection	7-29-2010
RSS-273 soil reference area	8-2-2010
RSS-308 B27 soil gamma walkover survey	8-12-2010
RSS-331 B27 soil microR and static cpm readings on areas of elevated activity	8-31-2010
RSS-344 B27 soil and pavement gamma walkover survey	9-9-2010
RSS-347 B27 pavement and soil microR and static CPM readings on areas of elevated activity	9-13-2010
RSS-374 B27 hillside soil excavation hot spots #16 and 17	9-22-2010
RSS-379 B27 hillside soil excavation hot spot #1	9-23-2010
RSS-388 B27 proposed soil reference area 10 locations static counts	9-22-2010
RSS-397 B27 hillside soil excavation hot spot #23-24	9-28-2010
RSS-403 Bldg 27 soil sampling	9-30-2010
RSS-409 Bldg 27 soil hot spot post shielding survey	10-1-2010
RSS-410 Bldg 27 soil hot spot post shielding survey	10-5-2010
RSS-422 Bldg 2 gamma walkover survey	10-27-2010

The resulting survey plots (Figure 1 through Figure 9) indicate the presence of multiple locations exceeding two to three times the measured soil background count rate (mean plus three standard deviations equaled 5,110 cpm). These locations have been identified as hot spots and are assigned identification numbers.

Three locations were hand-excavated on September 22 – 28, 2010, to determine if buried objects or waste material could be identified (Table 1, RSS-374 and RSS-379). Excavation to a depth of 6 to 10 inches in these locations identified no objects or discoloration that would indicate burial of waste material. The soil and rock encountered during this excavation was more indicative of fill material consistent with construction of the site. These three locations plus two additional locations were hand-augered to a depth of 8 to 16 inches to collect soil samples at 6-inch intervals. These samples have been submitted to an analytical laboratory for analysis. On October 6, 2010, these samples were counted to provide the preliminary results as shown in Table 2. These samples will be stored for the 28-day ingrowth period necessary to provide final results at a later date.

Table 2
Preliminary Soil Sampling Results - Ra-226 (pCi/g)

Sample ID	Ra-226 (pCi/g)	Total Uncertainty[a]	MDL[b]	Sample Interval
HS23-SO-001	1.89	0.315	0.093	0 – 6 inches
HS23-SO-002	0.621	0.127	0.0479	6 – 8 inches
HS1-SO-003	1,190	69.7	1.24	6 – 12 inches
HS6-SO-004	23.9	1.68	0.173	6 – 12 inches
HS16-SO-005	2.95	0.319	0.0676	10 – 16 inches
HS17-SO-006	1.37	0.221	0.0756	6 – 12 inches

pCi/g = picoCurie(s) per gram.
a 2 times the count standard deviation (σ).
b Minimum detection level (pCi/g).

3.0 Scope of Work

The soil sampling scope of work for the former NAVSTA-PS site includes:

- Performing hand augering in 6-inch segments at those locations to obtain a continuous sample
- Performing and documenting gamma measurements on each hand auger segment
- Identifying elevated count rate sample locations
- Performing a down-hole gamma scan (if possible)
- Collecting soil samples from alternate sample segments for analytical laboratory analysis

Boring locations were selected to characterize each hot spot identified by walkover surveys. Hand augering will be performed to a depth necessary to assess the vertical extent of radiological contamination or to the groundwater surface. Boring locations are all within a few vertical feet of the level of Lake Washington, and it is anticipated that groundwater will be within approximately 2 to 8 feet below ground surface (bgs). Boring locations were generally positioned to:

- Assess the magnitude of radium concentrations at the hot spot location by collecting and analyzing soil samples with the highest count rates measured in the field
- Attempt to delineate the extent of the contamination by sampling at locations around the anticipated periphery of the contamination

Figures 10 through 13 indicate the proposed boring locations, and Table 3 identifies the boring location selection rationale. Adjustments may be made to the planned borehole locations depending on obstruction and operational interferences. Target depths may be adjusted as necessary, depending on field readings and depth to groundwater.

Table 3
Planned Boring Locations for NAVSTA-PS

Boring #	WA State Plane		Purpose
1	392,602.760	77,351.354	Boundary
2	392,604.617	77,345.566	Hot spot
3	392,604.344	77,339.344	Hot spot
4	392,601.902	77,339.527	Boundary
5	392,604.559	77,337.421	Boundary
6	392,604.128	77,332.513	Boundary
7	392,602.635	77,329.370	Hot spot
8	392,601.285	77,334.594	Boundary

Boring #	WA State Plane		Purpose
9	392,604.743	77,327.997	Hot spot
10	392,604.786	77,323.551	Hot spot
11	392,602.717	77,324.733	Hot spot
12	392,601.713	77,320.864	Boundary
13	392,610.990	77,316.163	Hot spot
14	392,608.102	77,310.963	Boundary
15	392,621.842	77,302.369	Hot spot
16	392,619.572	77,303.193	Boundary
17	392,626.692	77,297.186	Hot spot
18	392,626.457	77,303.744	Boundary
19	392,628.486	77,301.839	Boundary
20	392,628.865	77,308.005	Location biased
21	392,646.159	77,308.952	Location biased
22	392,649.310	77,309.430	Boundary
23	392,659.746	77,310.224	Hot spot
24	392,656.726	77,304.937	Hot spot
25	392,654.506	77,305.140	Boundary
26	392,652.155	77,302.210	Location biased
27	392,658.936	77,303.470	Location biased
28	392,669.490	77,306.008	Boundary
29	392,675.963	77,308.125	Hot spot
30	392,678.029	77,307.960	Boundary
31	392,685.846	77,308.010	Boundary
32	392,583.902	77,361.519	Hot spot
33	392,582.886	77,364.793	Boundary
34	392,587.350	77,362.628	Boundary
35	392,580.067	77,360.594	Boundary
36	392,585.006	77,355.856	Boundary
37	392,586.092	77,350.538	Hot spot
38	392,589.669	77,351.231	Boundary
39	392,582.221	77,349.463	Boundary
40	392,586.066	77,346.514	Boundary
41	392,585.899	77,342.122	Hot spot
42	392,589.764	77,342.327	Boundary
43	392,586.428	77,338.065	Boundary
44	392,582.452	77,341.842	Boundary
45	392,581.766	77,312.025	Boundary
46	392,576.642	77,315.638	Hot spot
47	392,610.333	77,272.837	Boundary
48	392,606.036	77,266.579	Boundary
49	392,611.319	77,266.871	Hot spot
50	392,614.352	77,267.161	Boundary
51	392,610.328	77,254.259	Hot spot
52	392,642.111	77,270.384	Hot spot
53	392,645.019	77,274.653	Boundary

Boring #	WA State Plane		Purpose
54	392,638.599	77,270.463	Boundary
55	392,642.627	77,266.051	Boundary
56	392,703.018	77,141.990	Hot spot
57	392,699.058	77,142.006	Boundary
58	392,701.957	77,143.240	Boundary
59	392,704.290	77,142.000	Boundary
60	392,754.783	77,148.287	Hot spot
61	392,754.849	77,150.129	Boundary
62	392,755.607	77,146.799	Boundary
63	392718.5328	77310.8353	Reference (static location #6)
64	392740.1388	77310.8353	Reference (static location #8)
65	392734.7373	77301.4797	Reference (static location #3)
66	392756.3433	77301.4797	Reference (static location #5)

The specific order of sampling and the exact sample locations will be determined in the field by Shaw depending on available data.

Four soil borings will also be drilled in a soil reference area located east of Building 27 and west of Pump House 117. This area was selected based on the findings of the gamma walkover survey (background readings). Four soil samples will be collected at approximately 1-foot intervals in each boring starting from the surface.

4.0 Drilling and Sampling

4.1 Utility Clearance

Utilities will be located in accordance with Shaw procedure *HS308 - Underground/Overhead Utility Contact Prevention* (Shaw, 2006). Locating of utilities will be performed by a professional utility location subcontractor using appropriate methods, which may include ground-penetrating radar or electromagnetic methods (as required).

4.2 Traffic Control

In order to safely execute sampling activities in site locations accessible by vehicles, traffic will be controlled in accordance with Section 6.5 of *Site Safety and Health Plan, Time Critical Removal Action, Former Naval Station Puget Sound* (SSHP) (Shaw, 2010). Traffic control plans, as appropriate, will be developed in conjunction with the Navy Technical Representative, City of Seattle Parks and Recreation and City of Seattle Department of Public Works (U.S. Navy, 2010).

4.3 Drilling/Sampling Approach

Due to limited site access because of structures, steep topography, and anticipated presence of gravel and cobbles in the shallow substrate that precludes the use of a drilling rig and split spoon sampling, the proposed method of soil sampling is hand augering. Hand augers or other hand tools will be used to collect soil in 6-inch increments for gamma scanning and soil sampling as required. The specific methods for collection of soil samples using hand augers are presented below. In some instances, soil conditions may limit the use of hand tools for collecting soil samples at a particular sample location. Alternate methods may be used in such instances. If field conditions preclude the use of a hand auger, a post hole digger or other tool may be used to obtain soil samples from a particular sample location.

4.3.1 Hand Auger Segment Retrieval and Logging

From each boring, 6-inch (length) hand auger segments will be retrieved continuously from the ground surface to 6 inches below the water table or an unaffected depth as identified by the field geologist and the Project Radiation Safety Officer (RSO). A minimum of 2-inch-diameter hand auger will be used. Each hand auger segment will be logged for soil type, surveyed for gamma count rate, and considered for collection for laboratory analysis. Every other 6-inch auger sample will be collected for laboratory analysis.

Upon recovery of the hand augering device (sampler) from the boring hole, the soil will be removed and placed into a cleaned stainless steel bowl. To ensure that no “slough” material originating from upper hand auger segments is collected for analysis, the field geologist will visually assess soil from each hand auger segment and discard material determined to be "slough." For each hand auger segment, the recovered material must be representative of that specific depth interval. Each discrete soil sample shall be representative of the materials recovered from that depth, including debris and large particles.

If soil recovery is incomplete (and it is suspected that the unrecovered material has remained in the borehole), an attempt should be made to obtain the unrecovered soil by advancing a clean sampler to a depth slightly greater than the depth of the prior advance. The field geologist will be responsible for determining whether the recovered soil is representative of the hand auger segment. If the soil sample is not considered representative, hand augering and sampling an adjacent boring (i.e., a boring no greater than 10 feet from the initial boring, unless otherwise approved by the Navy) may be required. In the adjacent boring, a representative sample shall be obtained from the missing hand auger segment(s). The samples obtained for this purpose from the adjacent boring shall replace those samples previously collected from the same hand auger segment in the original boring.

Each hand auger segment will also be screened for volatile organic compounds (VOC) in accordance with the SSHP (Shaw, 2010). This VOC screening will involve monitoring the breathing zone air for health and safety purposes during sample collection activities. This air monitoring will be performed using either a flame ionization detector or a photoionization detector.

The recovered hand auger segment will be field-screened for gamma count rate using a Ludlum Model 2221 coupled with a Ludlum Model 44-10 (2x2 NaI detector) in a standard geometry using a stainless steel bowl. The purpose of the radiological field screening is to provide real-time radiological activity data to guide the radiological COC delineation efforts.

Each hand auger segment will be examined and lithologically described (logged) by the field geologist in accordance with geologic description guidance provided in Appendix E of EM 1110-1-1906 (U.S. Army Corps of Engineers, 1996). A drilling log form will be completed for each boring and will include the geological description and radiological field-screening results.

Upon completion of the boring/sampling, the determination of whether additional samples should be submitted for laboratory analysis will be made by the field geologist in consultation with the Project RSO or designee and the Navy. Samples will be sent for analyses to an offsite analytical laboratory.

Following completion of boring, a 1-inch-by-1-inch NaI detector will be lowered down the borehole to log the gamma count rate at 6-inch intervals.

4.3.2 Gamma Survey

Each hand auger segment shall be placed in a standard stainless steel bowl and monitored with a 2-inch-by-2-inch NaI detector (one-minute count) at a distance of 1 foot above the surface of the soil. This measurement shall be performed in a "background" area that does not show elevated gamma count rate resulting from hot spot contamination. The background shall be measured (10 each one-minute counts) and documented prior to performing these gamma count rate measurements. The soil level in the bowl shall be documented for each measurement. The shape of the bowl shall be recorded and the levels in the bowl shall be calibrated (with water or sand) to determine the volume of soil for each level used.

A 1-inch-by-1-inch NaI detector shall be lowered down each borehole that remains open, performing and documenting a one-minute count at each 6-inch depth (bgs). Care should be taken to position the detector crystal at the measured depth.

4.3.3 Sampling Methods

Soil Coring Method or Scoop – Surface Soil Samples (to 15 centimeters [6 inches] bgs)

- Place plastic sheeting on the ground around the sampling location.
- Using a pre-cleaned or decontaminated stainless steel soil coring tool (or stainless steel scoop) and proceed to composite a 6-inch-deep soil sample in a stainless steel bowl.
- For radionuclide analyses, collect a ½- to 1-liter (L) volume of soil.
- Perform and document the gamma count rate measurement.
- Label the sample bottles using a pre-determined sample identification system consistent with that provided in the project Quality Assurance Project Plan/Sampling and Analysis Plan (QAPP/SAP).
- Complete all chain-of-custody documents and record the sampling event in the field logbook.
- Decontaminate sampling equipment after use and between sample locations.

Hand Auger – Subsurface Soil Samples

- Place plastic sheeting on the ground around the sampling location.
- Using the hand auger, hand auger to a 6-inch depth. Remove accumulated soil from around the auger hole to prevent loose soil from falling back into the borehole.

- Take care to avoid scraping the sidewalls of the auger hole.
- Remove the auger and collect the soil sample and discard any material collected by the probe before the target soil layer.
- Proceed to composite the sample in a stainless steel bowl.
- For radionuclide analyses, collect a ½- to 1-L volume of soil.
- Perform and document the gamma count rate measurement.
- Label the sample bottles using a pre-determined sample identification system consistent with that provided in the QAPP/SAP.
- Complete all chain-of-custody documents and record the sampling event in the field logbook.
- Decontaminate sampling equipment after use and between sample locations.

4.3.4 Laboratory Analyses

As stated previously, soil samples will be collected at 6-inch intervals and will be monitored in the field using 2-inch-by-2-inch NaI detector (one-minute count) at a distance of 1 foot above the soil sample. Soil samples shall consist of ½ to 1 liter of soil in a stainless steel bowl. Every other soil sample (one every foot) will be sealed in a sample container, labeled, and packaged for shipment to the laboratory for radionuclide analyses under chain-of-custody documentation according to QAPP/SAP requirements. In general, borings where count rate measurements are near background levels (perimeter borings) shall have the one soil sample with the highest count rate analyzed for radionuclides. In borings where readings exceed background levels (hot spot borings), the soil sample containing the highest field reading collected from the boring will be analyzed for radionuclides. In addition, a soil sample collected 1 foot below the last sample containing readings exceeding background levels will be analyzed for radionuclides. Additional soil samples may also be selected for analysis depending on interpretation of field readings to define the lateral and vertical extent. All samples sent to the laboratory for radionuclide analyses shall be analyzed for Radium 226 according to EPA 901.1 and for Strontium 90 according to EPA 905.

4.3.5 Radiological Controls

Radiological conditions will be carefully monitored as with all other evolutions performed on site. A specific Radiological Work Permit (RWP) will be written to address the radiological controls for this task. Elements of the RWP will include proper PPE, dosimetry, radiation, contamination, and airborne monitoring requirements, and other special instructions.

General area dose rates at the Radiologically Controlled Area (RCA) boundary may not exceed 10 µR/hr. If higher levels are anticipated, the RCA boundaries must first be expanded to ensure that dose rates are less than 10 µR/hr at the RCA boundary. Contamination will be controlled so that levels in unrestricted areas will remain less than the limits established in the Radiation Protection Plan Table 3.12 for alpha activity and a more conservative Sr-90 beta limit:

Re	movable dpm/100 cm^2	Total dpm/100 cm^2
Alpha 20		100
Beta/gamma 200		1,000

All spoils from soil sampling will be containerized in 55 gallon drums and stored in a Radioactive Material Storage Area. A senior Radiological Controls Technician will provide job coverage throughout the soil sampling activity and monitor contamination levels and dose rates in the work areas and RCA boundary. Air samples will be taken at the soil boring locations, the soil screening and sample preparation area, and at the boundary of the RCA.

5.0 Boring Abandonment

Soil borings will be backfilled with bentonite chips and hydrated. The bentonite chips will be backfilled to within approximately 1 foot of ground surface. Imported sand or soil will be placed above the bentonite or asphalt shall be replaced with cold-patch asphalt to a depth equal to the original asphalt paving.

6.0 Sampling Equipment Decontamination

Equipment decontamination procedures will be implemented in accordance with the Project QAPP/SAP, RPP, any field instruction written specifically for this activity, and the SSHP (Shaw, 2010). Specifically, down-hole drilling equipment will be decontaminated subsequent to drilling, and non-disposable hand-sampling equipment will be decontaminated prior to re-use.

7.0 References

Shaw Environmental and Infrastructure, Inc., 2006, *HS308, Underground/Overhead Utility Contact Prevention,* Shaw Corporate Procedure, Revision 1, Baton Rouge, Louisiana, February 20.

Shaw Environmental and Infrastructure, Inc., 2010, *Site Safety and Health Plan, Time Critical Removal Action, Former Naval Station Puget Sound* (SSHP), Bothell, Washington, January.

U.S. Army Corps of Engineers, 1996, Engineer Manual (EM) EM 1110-1-1906, *Engineering and Design - Soil Sampling*, Washington DC, September 30.

U.S. Navy, 2009, *Scope of Work*, Revised, Naval Facilities Engineering Command Northwest Silverdale, Washington, September 3.

FIGURES

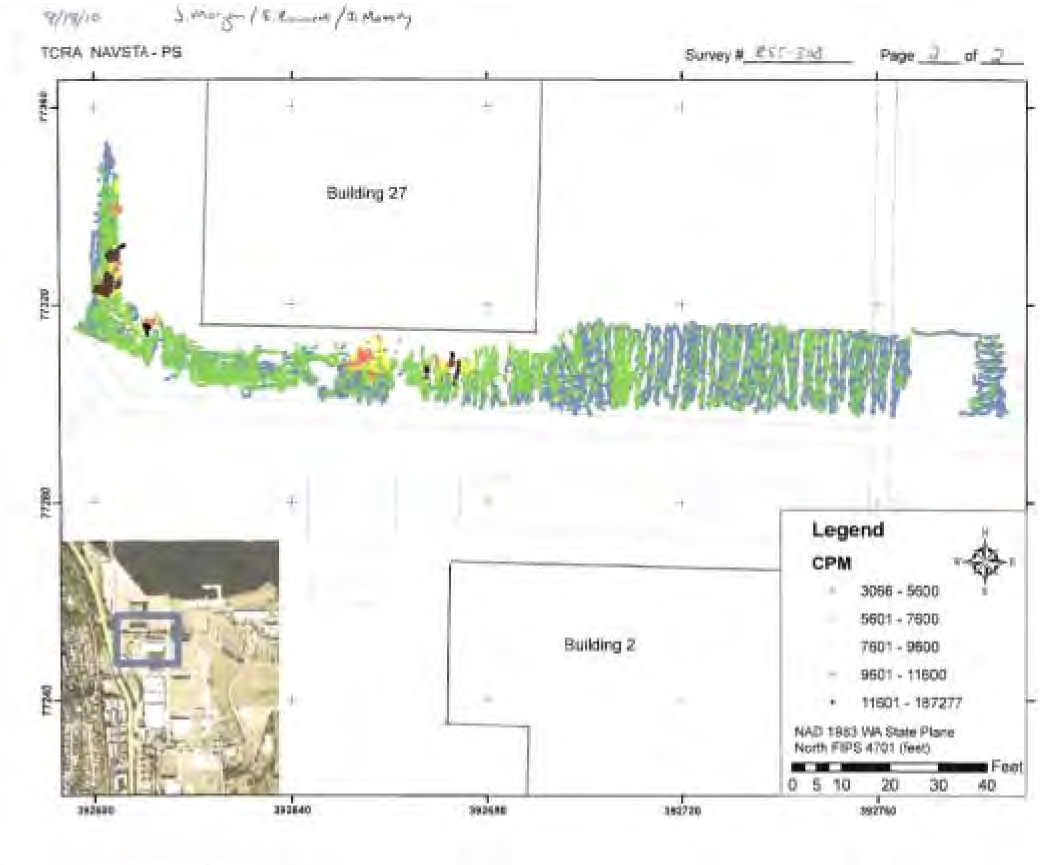
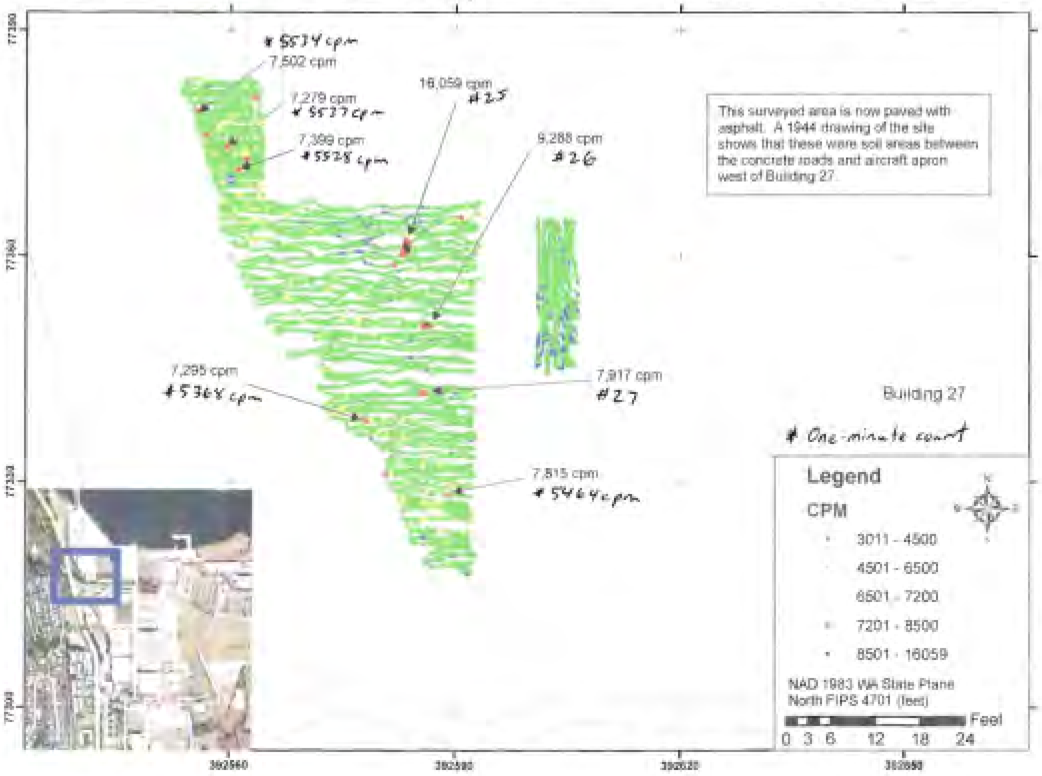


Figure 1
Gamma Walkover Survey - South and West of Building 27

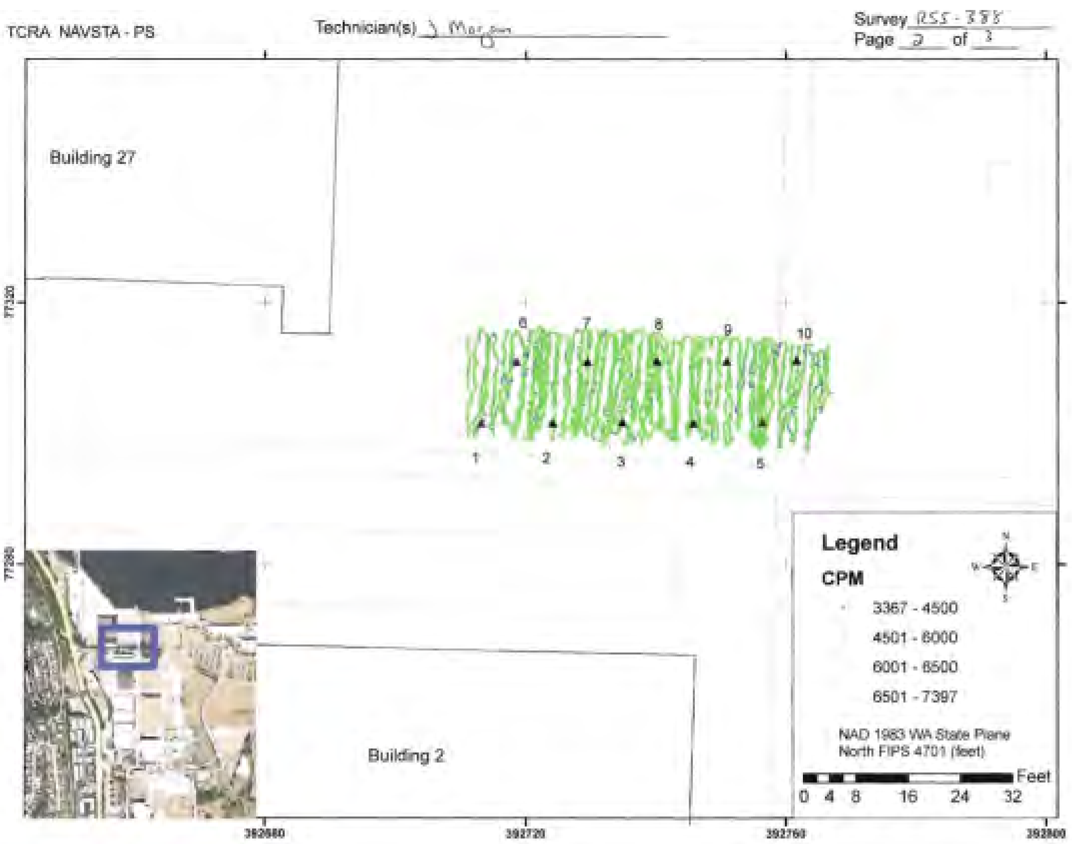
TCRA NAVSTA - PS   Technician(s) E. Ramirez / J. Morgan   Survey # 035-347-2   Page 3 of 4



This surveyed area is now paved with asphalt. A 1944 drawing of the site shows that these were soil areas between the concrete roads and aircraft apron west of Building 27.

One-minute count

Figure 2
Gamma Walkover Survey - West of Building 27



TCRA NAVSTA - PS

Technician(s) J Morgan

Survey RSS - 388

Page 2 of 3

Figure 3
Gamma Walkover Survey - Soil Reference Area

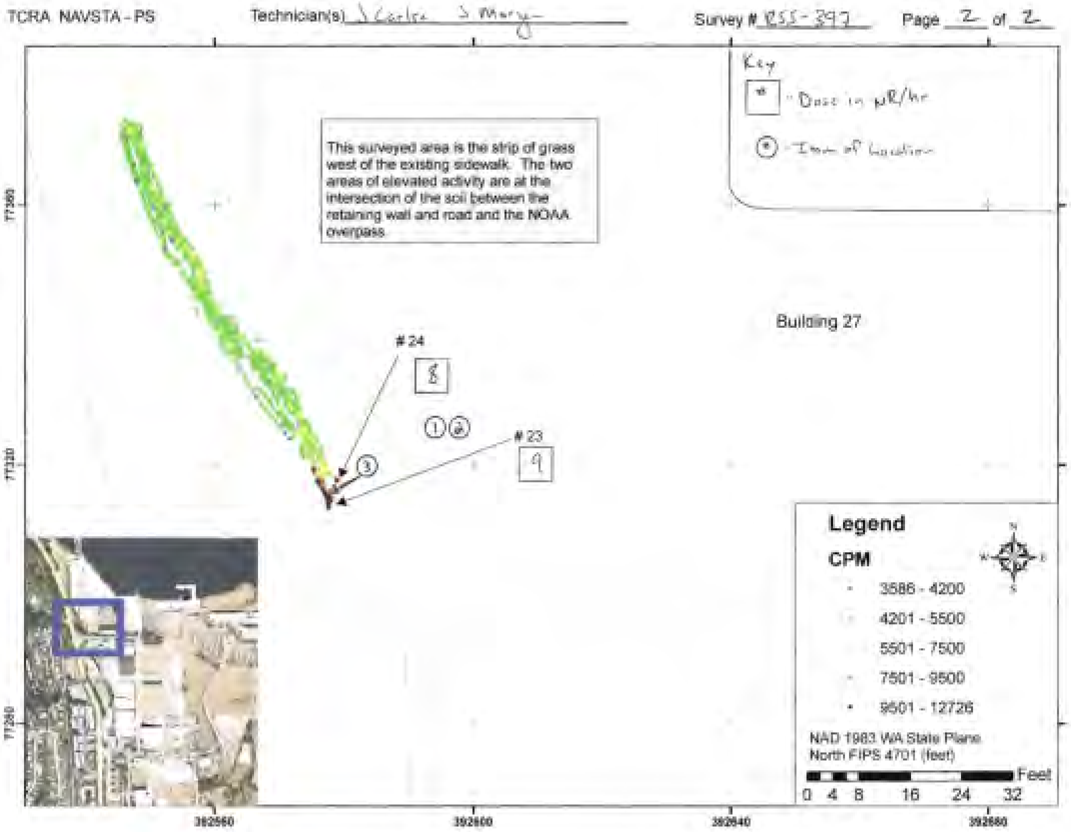


Figure 4
Gamma Walkover Survey - Grass Strip West of Building 27

Figure 5
Gamma Walkover Survey - West of Building 12

Figure 6
Gamma Walkover Survey - North of Building 12

Figure 7
Gamma Walkover Survey - South and East of Building 2

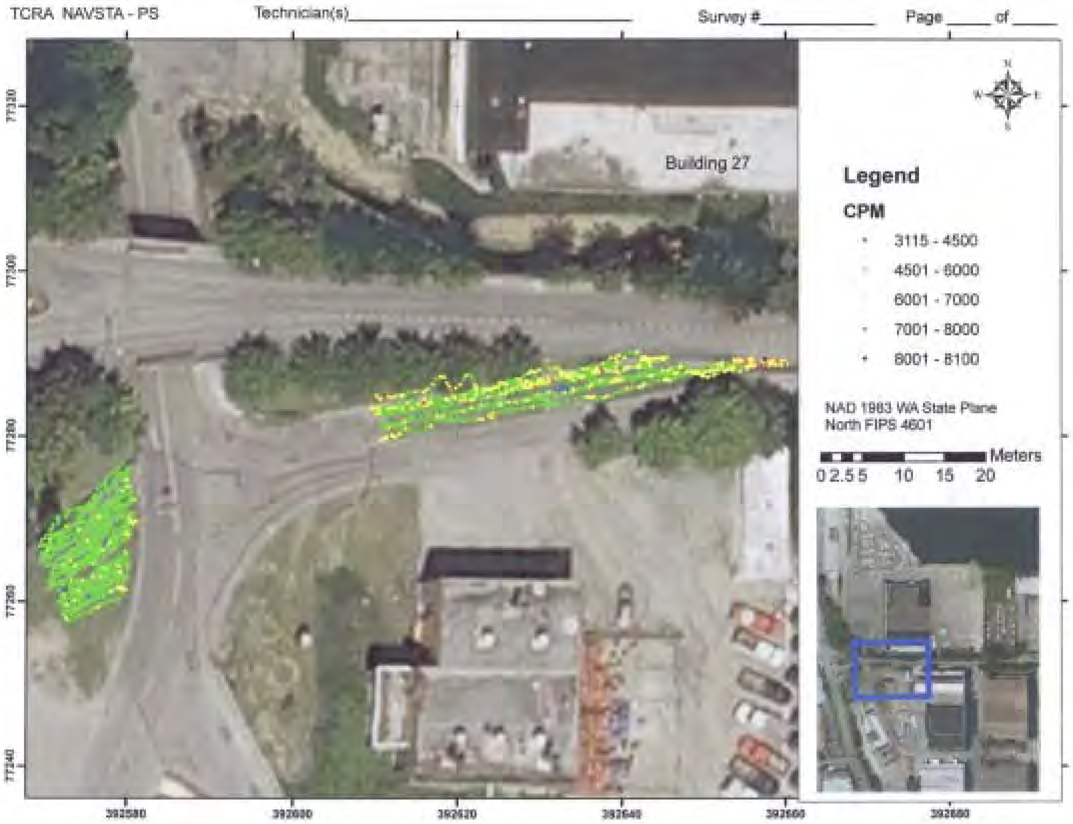


Figure 8
Gamma Walkover Survey - North of Building 12

Figure 9
Gamma Walkover Survey - Northwest of Building 2

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Phone (425) 485-5000
Fax. (425) 486-9766

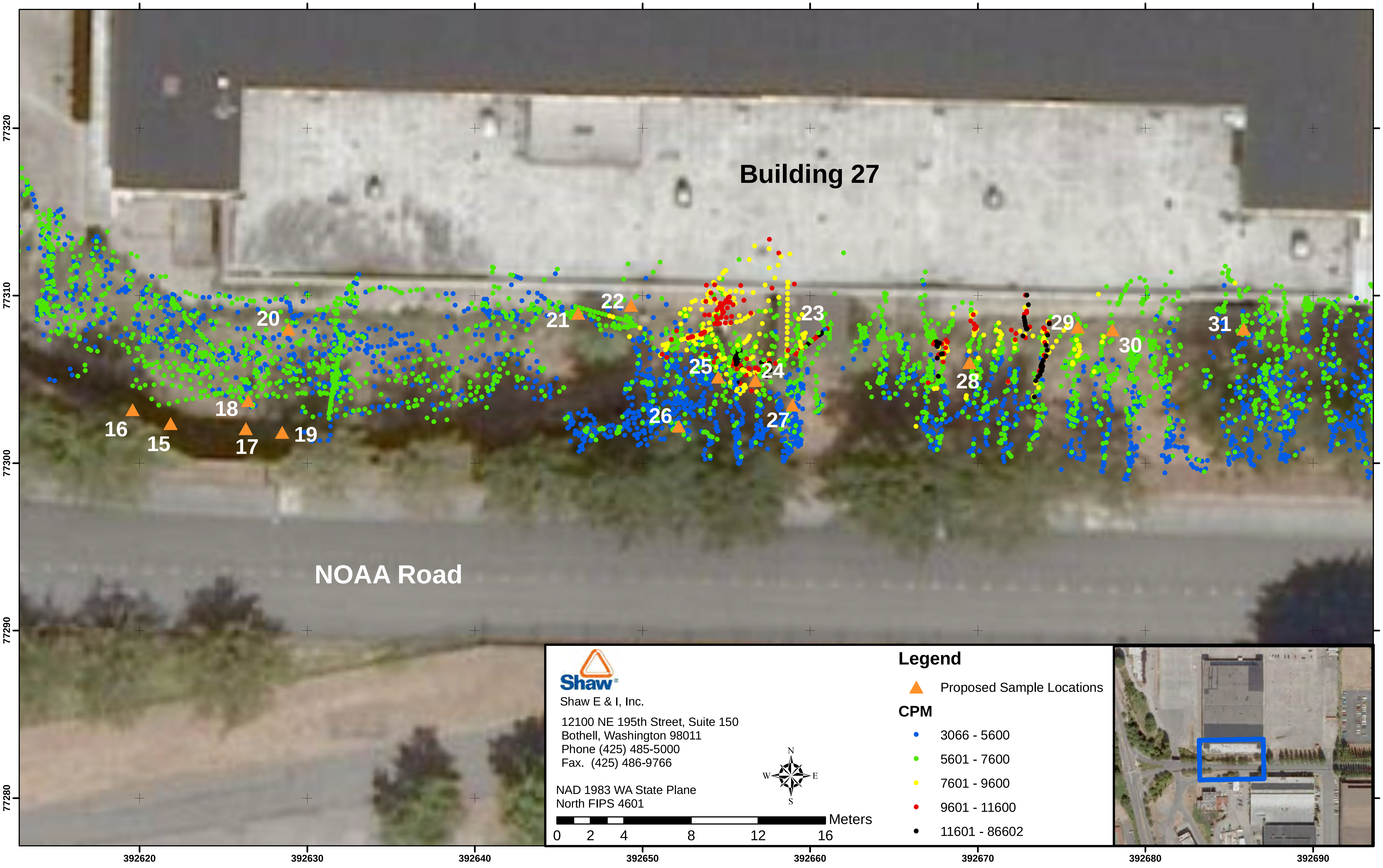
Legend

▲ Proposed Sample Locations

CPM

- ● 3586 - 5600
- ● 5601 - 7600
- ● 7601 - 9600
- ● 9601 - 11600
- ● 11601 - 187277

NAD 1983 WA State Plane
North FIPS 4601


Building 27
NOAA Road
15
16
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31
77320
77310
77300
77290
77280
392620
392630
392640
392650
392660
392670
392680
392690
Shaw
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Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766
NAD 1983 WA State Plane
North FIPS 4601
N
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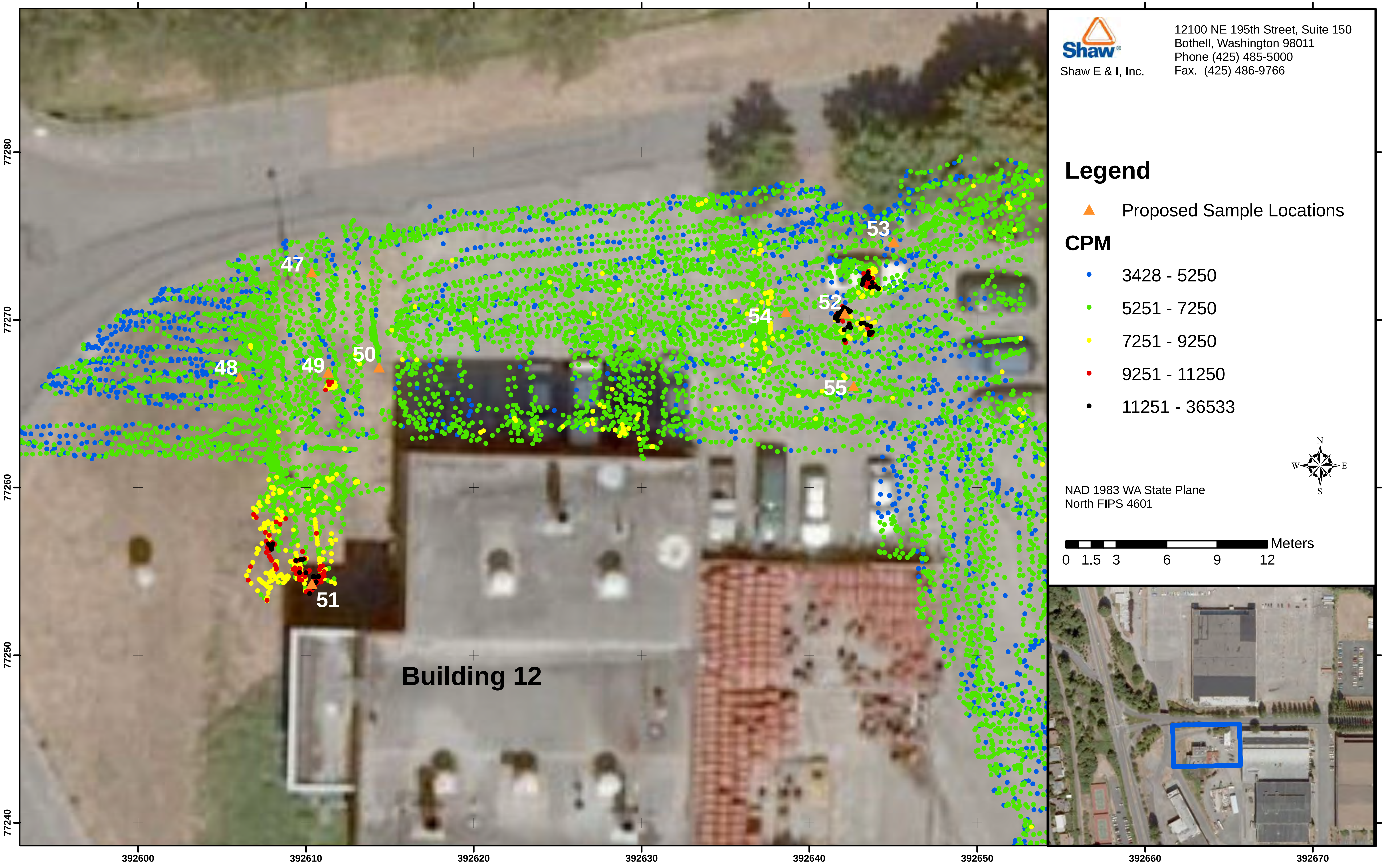
12
16
Meters
Legend
Proposed Sample Locations
CPM
3066 - 5600
5601 - 7600
7601 - 9600
9601 - 11600
11601 - 86602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Phone (425) 485-5000
Fax. (425) 486-9766
Legend
▲ Proposed Sample Locations
CPM
● 3428 - 5250
● 5251 - 7250
● 7251 - 9250
● 9251 - 11250
● 11251 - 36533
N
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NAD 1983 WA State Plane
North FIPS 4601
0
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Building 12
77280
77270
77260
77250
77240
392600
392610
392620
392630
392640
392650
392660
392670

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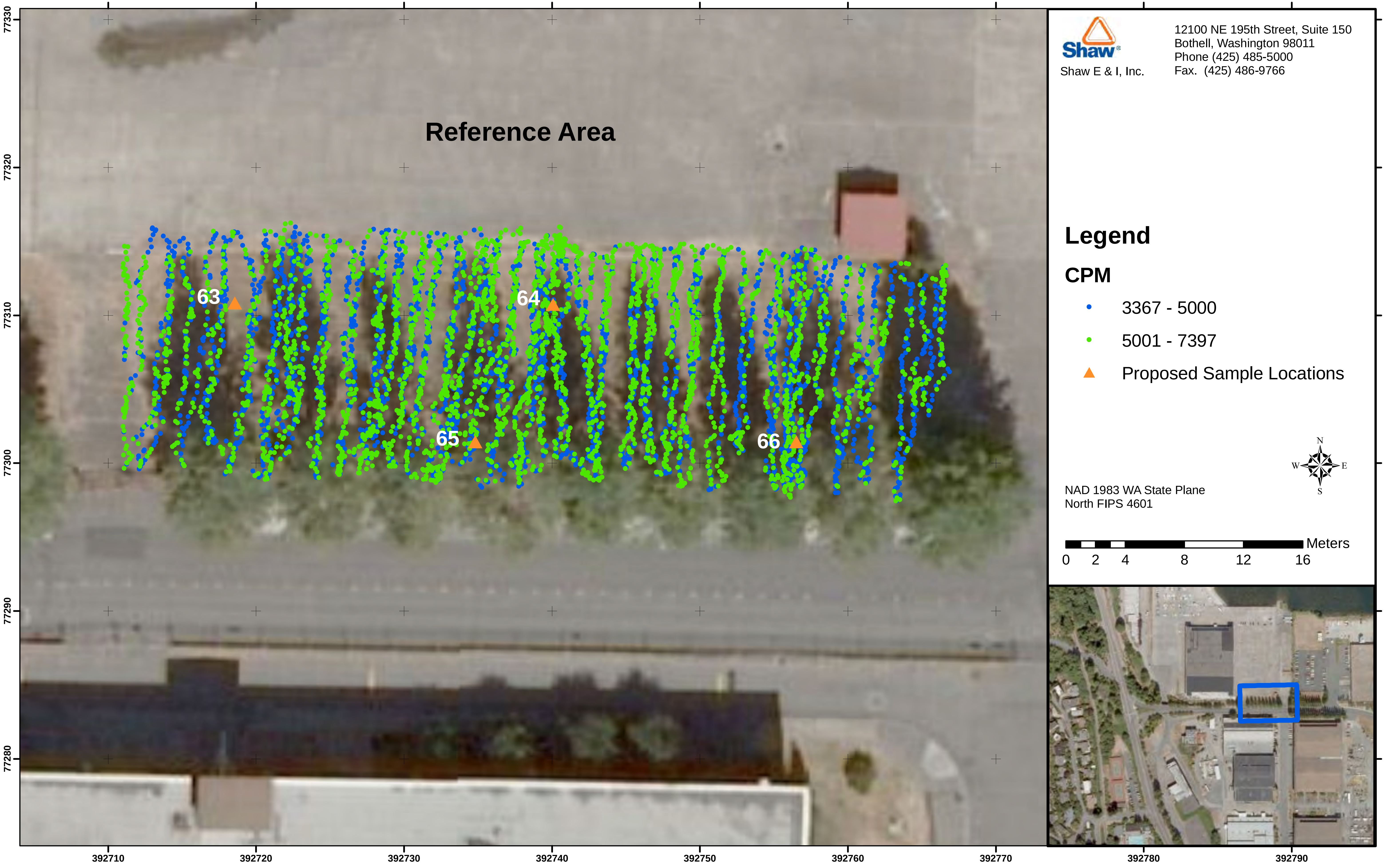

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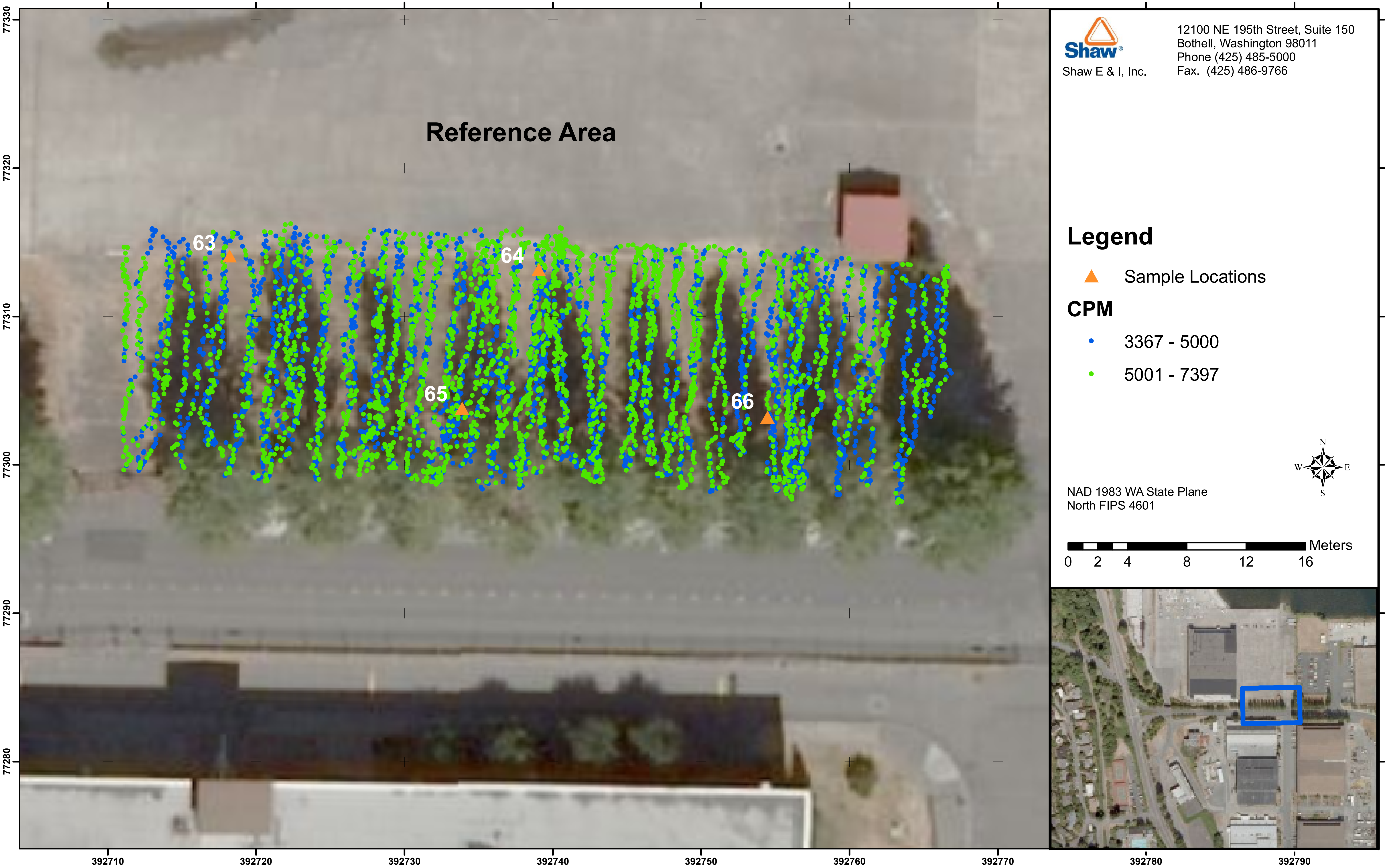
Attachment 2

Time Critical Removal Action Naval Station Puget Sound



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Attachment 3

Shaw Environmental & Infrastructure, Inc.

Shaw The Shaw Group Inc.™

717 Redwood Lane
Richland, WA 99354
509-375-0982

Memorandum

Date: **12 January 2011**

To: **Jim Langsted**

CC: **John Carson, Guy Gallello**

From: **Robert O'Brien**

RE: **Creating Screening Values for Ra-226 and Sr-90 for soils from Backround Soils data for NAVSTA PS**

Upper threshold "bright line" screening values from background soil concentrations of Ra-226 and Sr-90 at the NAVSTA PS will be established using the statistical methodology for creating background threshold concentrations for sewer line sediments as discussed in a previous memorandum for this project titled *"Statistical Analysis for Creating a "Bright Line" Screening Value to be used in Comparisons to Background Data for NAVSTA PS Sewer Lines"* dated 27 August 2010. Based on the results of this memorandum it was decided by project staff to use a value of the mean concentration of an analyte plus 3 times the standard deviation as a background "bright line" screening level to compare future sewer sediments collected down-gradient to those from up-gradient background conditions

Since we are now considering comparison of site soils to background, a background soils data set has been compiled to represent background conditions at the site for Ra-226 and Sr-90. Table 1 below gives the background data set for soils to be used at NAVSTA PS. There are four samples from each of 4 locations for each of Ra-226 and Sr-90 to be used as reference data representing background.

Soil screening levels are computed as the mean plus three standard deviations of background as discussed in the 27 August 2010 memorandum. As the means and variances at each of the locations are statistically equivalent (based on an analysis of variance and Fligner's test) the data has been pooled by location to estimate the mean and standard deviation of background for Ra-226 and Sr-90.

Thus we obtain the following "bright line" screening values to be used for comparing site soils to background;

Analyte	Mean + 3* Standard deviation
Ra-226	0.855
Sr-90	0.398

Table 1: Background Concentrations for Ra-226 and Sr-90References

Sample ID	Ra-226	Sr-90	Bore Number	Depth
63-SC-R-0-0.5'	0.407	0.171	63	0-0.5'
63-SC-R-1.0-1.5'	0.572	-0.109	63	1.0-1.5'
63-SC-R-2.0-2.5'	0.414	0.0622	63	2.0-2.5'
63-SC-R-3.0-3.5'	0.305	-0.0233	63	3.0-3.5'
64-SC-R-0.5-1.0'	0.375	0.13	64	0.5-1.0'
64-SC-R-0-0.5'	0.391	-0.0317	64	0-0.5'
64-SC-R-1.0-1.5'	0.573	0.176	64	1.0-1.5'
64-SC-R-2.0-2.5'	0.274	-0.066	64	2.0-2.5'
65-SC-R-0-0.5'	0.562	0.089	65	0-0.5'
65-SC-R-1.0-1.5'	0.658	0.215	65	1.0-1.5'
65-SC-R-2.0-2.5'	0.418	0.00542	65	2.0-2.5'
65-SC-R-3.0-3.5'	0.596	0.0645	65	3.0-3.5'
66-SC-R-0-0.5'	0.341	0.192	66	0-0.5'
66-SC-R-1.0-1.5'	0.711	-0.122	66	1.0-1.5'
66-SC-R-2.0-2.5'	0.399	0.179	66	2.0-2.5'
66-SC-R-3.0-3.5'	0.478	-0.0571	66	3.0-3.5'
Mean	**0.467**	**0.055**		
Standard Deviation	**0.129**	**0.114**		
Fligner's Test (p-value)	0.808	0.322		
ANOVA (p-value)	0.352	0.889		

References:

NRC, 2000. *MARSSIM:* *Multi-Agency Radiation Survey and Site Investigation Manual*. NUREG 1575, Washington, DC

NRC, 1998. *A Non-Parametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys*. NUREG-1505, Washington, DC

Attachment 4
Background Sludge Concentration Determination

Background Sludge Concentration Determination

Introduction

Radium-226 (Ra-226) occurs naturally and therefore analytical results from sludge sampling in the Storm Drain and Sanitary Sewer systems at the former Naval Station Puget Sound (NAVSTA-PS) were compared with sludge samples collected from background reference locations (upgradient locations) to assess if the levels are above background. The following sections describe the steps on how background was determined for the site and how a fixed "bright line" background value was derived.

Analysis

Criteria

The Navy has defined the comparison criteria as follows:

> "The Contractor shall establish radiological background as appropriate for implementation of the cleanup action. Radiological contamination is expected to contain Radium-226. Should any soil or sediment exceeding the mean statistical background level plus three standard deviations be encountered they will be removed, inventoried, packaged, labeled, and stored in a secure dedicated Radioactive Materials Storage Area in accordance with all appropriate regulations pending disposal by a separate contractor managed by the Navy." (Revised SOW, Section 2.5)

Background Sludge Collection

To determine the radiological background Shaw developed a background sampling plan that was approved by the Navy. This document has been updated to resolve an error in manhole identification (Attachment 1.) These changes do not affect the sampling or analysis of the background data.

Samples were collected from four Storm Drain manholes that were identified sufficiently upgradient from the downgradient "impacted" area to assure no cross-contamination:

- MH 140
- MH 125
- MH 126
- MH 1013.

Four Sanitary Sewer manholes were sampled. These were also identified as sufficiently upgradient to represent background:

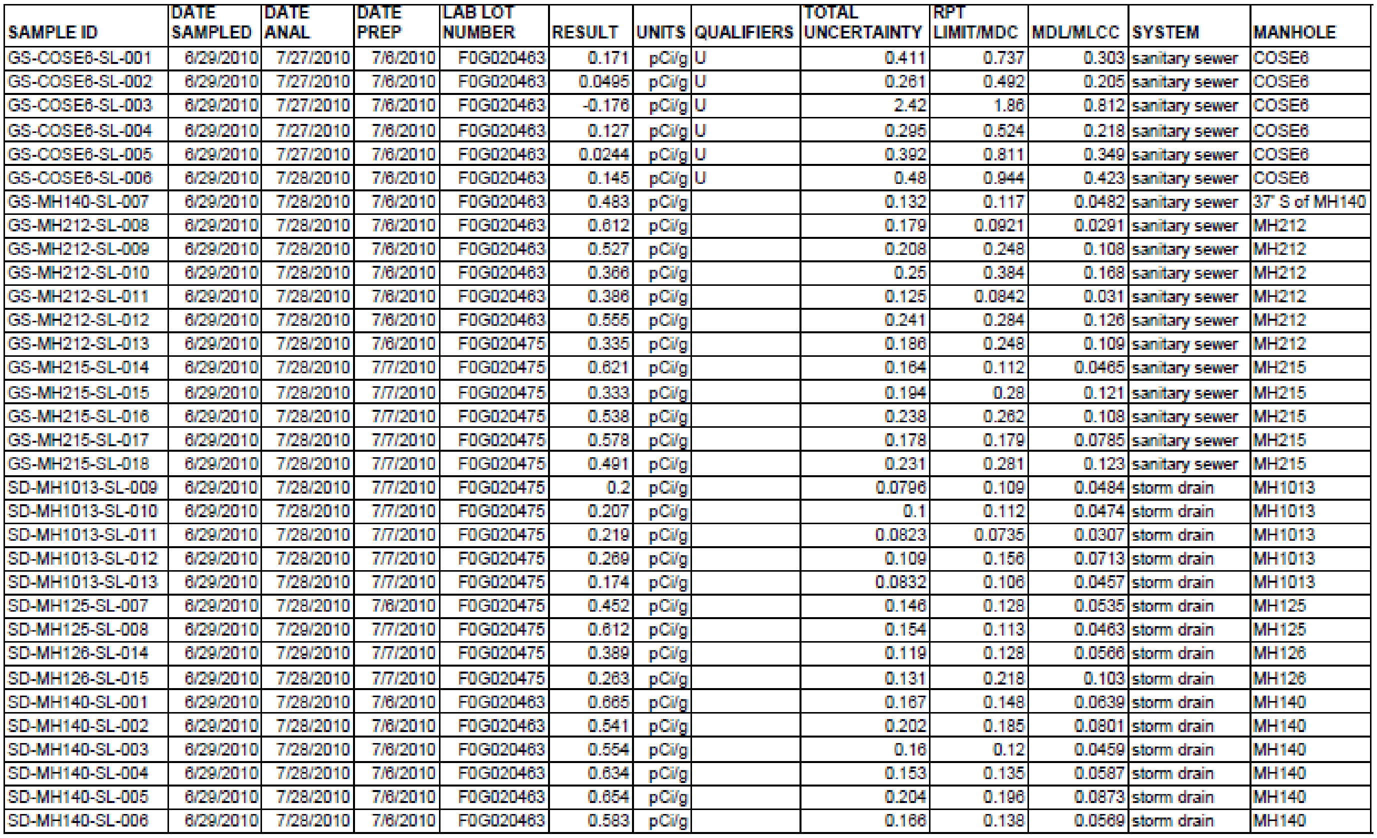
- COS E6
- MH 215
- MH 212
- Unnumbered manhole 37 feet south of MH 140.

A diagram of these locations in included as Attachment 2.

Analytical Data

Sludge samples were submitted to a contract radioanalytical laboratory for analysis. The results are presented in Table 1.

Table 1. Analytical Results - Sludge Background Data



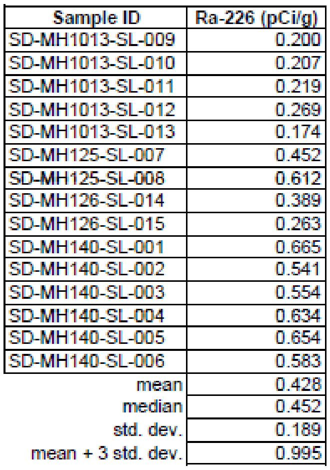
SAMPLE ID	DATE SAMPLED	DATE ANAL	DATE PREP	LAB LOT NUMBER	RESULT	UNITS	QUALIFIERS	TOTAL UNCERTAINTY	RPT LIMIT/MDC	MDL/MLCC	SYSTEM	MANHOLE
GS-COSE6-SL-001	6/29/2010	7/27/2010	7/6/2010	F0G020463	0.171	pCi/g	U	0.411	0.737	0.303	sanitary sewer	COSE6
GS-COSE6-SL-002	6/29/2010	7/27/2010	7/6/2010	F0G020463	0.0495	pCi/g	U	0.261	0.492	0.205	sanitary sewer	COSE6
GS-COSE6-SL-003	6/29/2010	7/27/2010	7/6/2010	F0G020463	-0.176	pCi/g	U	2.42	1.86	0.812	sanitary sewer	COSE6
GS-COSE6-SL-004	6/29/2010	7/27/2010	7/6/2010	F0G020463	0.127	pCi/g	U	0.295	0.524	0.218	sanitary sewer	COSE6
GS-COSE6-SL-005	6/29/2010	7/27/2010	7/6/2010	F0G020463	0.0244	pCi/g	U	0.392	0.811	0.349	sanitary sewer	COSE6
GS-COSE6-SL-006	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.145	pCi/g	U	0.48	0.944	0.423	sanitary sewer	COSE6
GS-MH140-SL-007	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.483	pCi/g		0.132	0.117	0.0482	sanitary sewer	37' S of MH140
GS-MH212-SL-008	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.612	pCi/g		0.179	0.0921	0.0291	sanitary sewer	MH212
GS-MH212-SL-009	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.527	pCi/g		0.208	0.248	0.108	sanitary sewer	MH212
GS-MH212-SL-010	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.366	pCi/g		0.25	0.384	0.168	sanitary sewer	MH212
GS-MH212-SL-011	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.386	pCi/g		0.125	0.0842	0.031	sanitary sewer	MH212
GS-MH212-SL-012	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.555	pCi/g		0.241	0.284	0.126	sanitary sewer	MH212
GS-MH212-SL-013	6/29/2010	7/28/2010	7/6/2010	F0G020475	0.335	pCi/g		0.186	0.248	0.109	sanitary sewer	MH212
GS-MH215-SL-014	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.621	pCi/g		0.164	0.112	0.0465	sanitary sewer	MH215
GS-MH215-SL-015	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.333	pCi/g		0.194	0.28	0.121	sanitary sewer	MH215
GS-MH215-SL-016	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.538	pCi/g		0.238	0.262	0.108	sanitary sewer	MH215
GS-MH215-SL-017	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.578	pCi/g		0.178	0.179	0.0785	sanitary sewer	MH215
GS-MH215-SL-018	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.491	pCi/g		0.231	0.281	0.123	sanitary sewer	MH215
SD-MH1013-SL-009	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.2	pCi/g		0.0796	0.109	0.0484	storm drain	MH1013
SD-MH1013-SL-010	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.207	pCi/g		0.1	0.112	0.0474	storm drain	MH1013
SD-MH1013-SL-011	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.219	pCi/g		0.0823	0.0735	0.0307	storm drain	MH1013
SD-MH1013-SL-012	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.269	pCi/g		0.109	0.156	0.0713	storm drain	MH1013
SD-MH1013-SL-013	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.174	pCi/g		0.0832	0.106	0.0457	storm drain	MH1013
SD-MH125-SL-007	6/29/2010	7/28/2010	7/6/2010	F0G020475	0.452	pCi/g		0.146	0.128	0.0535	storm drain	MH125
SD-MH125-SL-008	6/29/2010	7/29/2010	7/7/2010	F0G020475	0.612	pCi/g		0.154	0.113	0.0463	storm drain	MH125
SD-MH126-SL-014	6/29/2010	7/29/2010	7/7/2010	F0G020475	0.389	pCi/g		0.119	0.128	0.0566	storm drain	MH126
SD-MH126-SL-015	6/29/2010	7/28/2010	7/7/2010	F0G020475	0.263	pCi/g		0.131	0.218	0.103	storm drain	MH126
SD-MH140-SL-001	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.665	pCi/g		0.167	0.148	0.0639	storm drain	MH140
SD-MH140-SL-002	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.541	pCi/g		0.202	0.185	0.0801	storm drain	MH140
SD-MH140-SL-003	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.554	pCi/g		0.16	0.12	0.0459	storm drain	MH140
SD-MH140-SL-004	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.634	pCi/g		0.153	0.135	0.0587	storm drain	MH140
SD-MH140-SL-005	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.654	pCi/g		0.204	0.196	0.0873	storm drain	MH140
SD-MH140-SL-006	6/29/2010	7/28/2010	7/6/2010	F0G020463	0.583	pCi/g		0.166	0.138	0.0569	storm drain	MH140

These data have not yet been validated by the Shaw project chemist. The complete lab data packages are available from the Project. Note that the COS E6 manhole data are noted with a “U” qualifier. This indicates that the result was less than the sample detection limit. Review of the data package indicates that several of these samples contained insufficient sample weight for analysis. The samples from COS E6 averaged 64 grams while the balance of the samples analyzed in this data package averaged 264 grams. Thus, the COS E6 values were not used in the background analysis.

Data Analysis

Storm Drain System

The Storm Drain system data are presented in Figure 1.



Sample ID	Ra-226 (pCi/g)
SD-MH1013-SL-009	0.200
SD-MH1013-SL-010	0.207
SD-MH1013-SL-011	0.219
SD-MH1013-SL-012	0.269
SD-MH1013-SL-013	0.174
SD-MH125-SL-007	0.452
SD-MH125-SL-008	0.612
SD-MH126-SL-014	0.389
SD-MH126-SL-015	0.263
SD-MH140-SL-001	0.665
SD-MH140-SL-002	0.541
SD-MH140-SL-003	0.554
SD-MH140-SL-004	0.634
SD-MH140-SL-005	0.654
SD-MH140-SL-006	0.583
mean	0.428
median	0.452
std. dev.	0.189
mean + 3 std. dev.	0.995

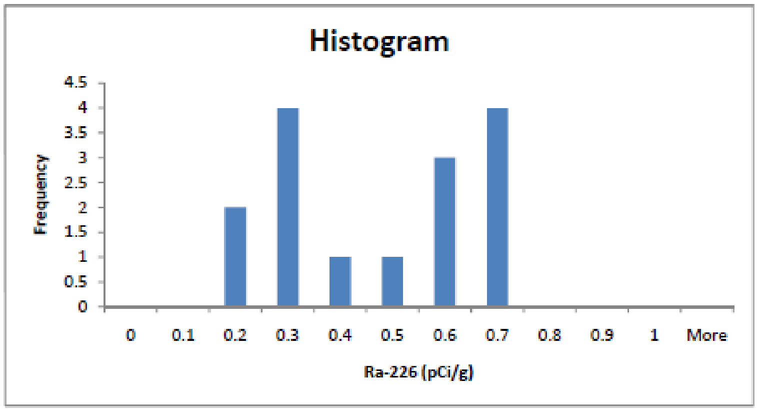
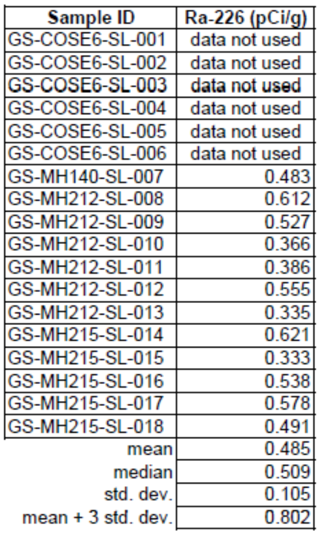


Figure 1. Storm Drain Sludge Background Results

The mean plus three standard deviations value for Storm Drain sludge is 0.995 pCi/g Ra-226.

Sanitary Sewer System

The Sanitary Sewer system data is presented in Figure 2.



Sample ID	Ra-226 (pCi/g)
GS-COSE6-SL-001	data not used
GS-COSE6-SL-002	data not used
GS-COSE6-SL-003	data not used
GS-COSE6-SL-004	data not used
GS-COSE6-SL-005	data not used
GS-COSE6-SL-006	data not used
GS-MH140-SL-007	0.483
GS-MH212-SL-008	0.612
GS-MH212-SL-009	0.527
GS-MH212-SL-010	0.366
GS-MH212-SL-011	0.386
GS-MH212-SL-012	0.555
GS-MH212-SL-013	0.335
GS-MH215-SL-014	0.621
GS-MH215-SL-015	0.333
GS-MH215-SL-016	0.538
GS-MH215-SL-017	0.578
GS-MH215-SL-018	0.491
mean	0.485
median	0.509
std. dev.	0.105
mean + 3 std. dev.	0.802

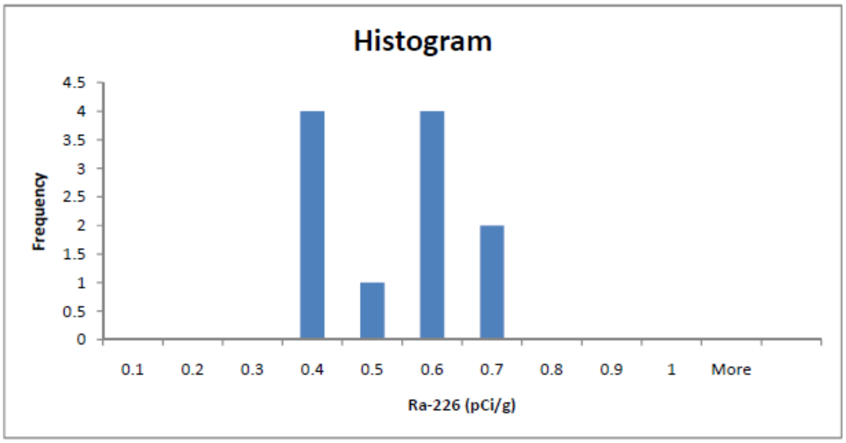


Figure 2. Sanitary Sewer Sludge Background Results

The mean plus three standard deviations value for Sanitary Sewer sludge is 0.802 pCi/g Ra-226.

Statistical evaluation of this data (see Attachment 3) indicates that there is no significant difference between the Storm Drain system and the Sanitary Sewer system data. Thus, the data were combined and are presented in Figure 3.

Sample ID	Ra-226 (pCi/g)
GS-COSE6-SL-003	data not used
GS-COSE6-SL-005	data not used
GS-COSE6-SL-002	data not used
GS-COSE6-SL-004	data not used
GS-COSE6-SL-006	data not used
GS-COSE6-SL-001	data not used
SD-MH1013-SL-013	0.174
SD-MH1013-SL-009	0.200
SD-MH1013-SL-010	0.207
SD-MH1013-SL-011	0.219
SD-MH126-SL-015	0.263
SD-MH1013-SL-012	0.269
GS-MH215-SL-015	0.333
GS-MH212-SL-013	0.335
GS-MH212-SL-010	0.366
GS-MH212-SL-011	0.386
SD-MH126-SL-014	0.389
SD-MH125-SL-007	0.452
GS-MH140-SL-007	0.483
GS-MH215-SL-018	0.491
GS-MH212-SL-009	0.527
GS-MH215-SL-016	0.538
SD-MH140-SL-002	0.541
SD-MH140-SL-003	0.554
GS-MH212-SL-012	0.555
GS-MH215-SL-017	0.578
SD-MH140-SL-006	0.583
SD-MH125-SL-008	0.612
GS-MH212-SL-008	0.612
GS-MH215-SL-014	0.621
SD-MH140-SL-004	0.634
SD-MH140-SL-005	0.654
SD-MH140-SL-001	0.665
mean	0.453
median	0.491
std. dev.	0.157
mean + 3 std. dev.	0.926

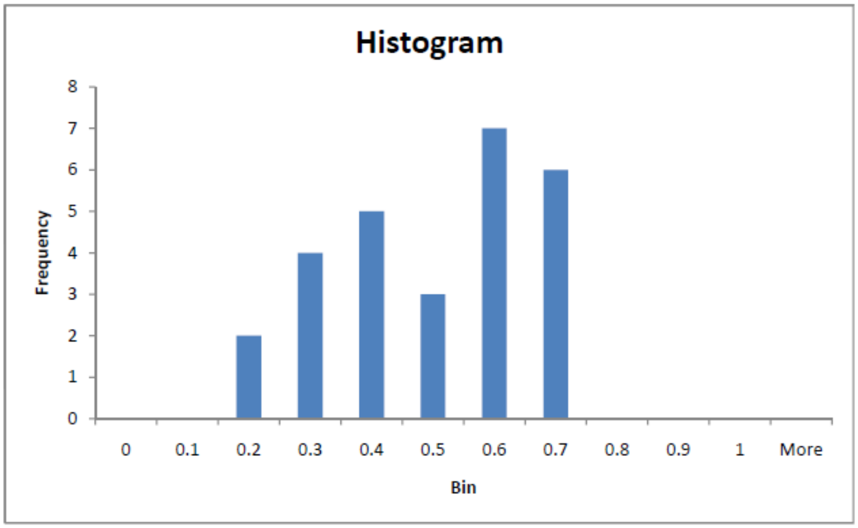


Figure 3 Combined Sludge Background Results

The mean plus three standard deviation value for the combined data is 0.926 pCi/g Ra-226. When the background distribution is normally distributed, this provides a point estimate of the upper 99.9th percentile. These data are not normally distributed, as can be seen in Figure 3 and demonstrated by statistical testing.

Random Effect Modeling

Statistical analysis was performed to evaluate these data, better understand the variance, and more accurately determine if downgradient samples fall within the reference background population (Attachment 3). This analysis identified a random effect due to manholes that is modeled to obtain an estimate of the overall variance of the combined background data set. This included dropping one manhole with only a single data point and a log transformation of the data to stabilize the variance. The back-transformed result yields a mean plus three standard deviation “bright line” value of 1.61 pCi/g Ra-226. The significance level varies depending on the number of samples compared with background. For example, for one sample the significance level is 99.7% and for six samples the significance level drops to 97.9%. See Attachment 3 for additional detail. This bright line value can be used as a threshold with which to compare downgradient samples. This approach using the observed reference background variance provides a better comparison value but does vary the statistical significance of the test depending on the number of samples compared.

MARSSIM-Recommended Upper Prediction Limit

The MARSSIM process recognizes that the variability in contaminants (in samples taken from the background area as well as samples taken downgradient) can complicate the decision making process (MARSSIM, Section 2.6.2). Still, the question that must be answered is, "Are these samples collected downgradient significantly different from background?" MARSSIM addresses this problem (Section 5.5.2.2) and refers the analyst to NUREG-1505 to estimate the background variance. EPA also recommends the use of prediction intervals when comparing several samples to background in order to control the false positive rate. To this end, a Shaw statistician has evaluated this data and identified an alternate approach for data comparison (see Attachment 3).

This approach considers the variability that is exhibited by background and the probability that as the more samples that are taken at a downgradient sample location the comparison level increases below which all of these samples must fall to be 99% certain that the samples come from the background population.

For example:

- If the background population is normally distributed and the statistical mean plus three standard deviations from background is used as the comparison, if you compare one downgradient sample to this value, you can be 99.9% certain that this one downgradient sample is at or below background if it is below that value. However, if you compare more than one sample to this value, the probability decreases from 99.9%. This is a typical statistical problem when more than one comparison is made.
- Given the background population that was sampled on this project, and using the 99% upper prediction limit (UPL) from Table 2 as the comparison, you can be 99% certain that any number (*k*) downgradient samples are all background if all are below that value.

Table 2. Upper 99% Prediction Intervals to contain all *k* downgradient measurements (from Attachment 3)

k	UPL 99%	k	UPL 99%	k	UPL 99%	k	UPL 99%
1	1.306	26	2.414	51	2.722	76	2.922
2	1.500	27	2.430	52	2.732	77	2.928
3	1.622	28	2.446	53	2.741	78	2.935
4	1.713	29	2.462	54	2.750	79	2.942
5	1.787	30	2.477	55	2.759	80	2.948
6	1.848	31	2.491	56	2.768	81	2.955
7	1.902	32	2.505	57	2.776	82	2.961
8	1.949	33	2.519	58	2.785	83	2.967
9	1.992	34	2.533	59	2.793	84	2.974

k	UPL 99%	k	UPL 99%	k	UPL 99%	k	UPL 99%
10	2.031	35	2.546	60	2.802	85	2.980
11	2.067	36	2.559	61	2.810	86	2.986
12	2.100	37	2.571	62	2.818	87	2.992
13	2.130	38	2.583	63	2.826	88	2.998
14	2.159	39	2.595	64	2.834	89	3.004
15	2.186	40	2.607	65	2.842	90	3.010
16	2.212	41	2.619	66	2.849	91	3.016
17	2.236	42	2.630	67	2.857	92	3.022
18	2.260	43	2.641	68	2.865	93	3.028
19	2.282	44	2.652	69	2.872	94	3.033
20	2.303	45	2.662	70	2.879	95	3.039
21	2.323	46	2.673	71	2.887	96	3.045
22	2.343	47	2.683	72	2.894	97	3.050
23	2.362	48	2.693	73	2.901	98	3.056
24	2.380	49	2.703	74	2.908	99	3.061
25	2.397	50	2.713	75	2.915	100	3.067

Conclusion

There is no significant difference between the Storm Drain and Sanitary Sewer sludge background samples collected, thus they have been combined together into one group. For comparison of one sample in accordance with the criterion defined in the revised SOW:

- Statistical mean plus three standard deviations = 0.926 pCi/g Ra-226.

To use this approach but consider the random effect of background sampling from multiple manholes:

- Mean plus three standard deviations (modeling the random effects) bright line = 1.61 pCi/g Ra-226.

Using the more statistically defensible UPL approach (MARSSIM-recommended), the reference background data collected:

- For one downgradient sample the UPL = 1.31 pCi/g Ra-226
- For two downgradient samples the UPL = 1.50 pCi/g Ra-226
- For three downgradient samples, the UPL = 1.62 pCi/g Ra-226
- etc. (see Table 2).

It should be noted that analytical results from some manholes and catch basins indicate that radium concentrations can vary with depth when sediments are over 6 inches thick and therefore statistical analysis may be applied to specific layers in those cases.

References

EPA, *Unified Guidance: Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*, EPA 530/R-09-007, Washington, DC, March 2009.

MARSSIM, *Multi-Agency Radiation Survey and Site Investigation Manual,* NUREG-1575, Revision 1, Washington, DC, August 2000.

NUREG-1505, *A Non-Parametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys,* NUREG-1505, Washington, DC**,** undated.

Revised SOW, *Scope of Work, Time Critical Removal Action At Former Naval Station Puget Sound,* Contract N62470-08-D-1007, PTO XX24, Naval Facilities Engineering Command Northwest, September 3, 2009.

Attachments

a) Attachment 1 – Background plan (update)
b) Attachment 2 – diagram
c) Attachment 3 –Statistical Analysis

Attachment 1

Two general types of background data are necessary for this project:

- Sludge background to identify the statistical mean and standard deviation for the storm drain system and the gravity flow sanitary sewer system
- Surface backgrounds of appropriate structural material for comparison with Characterization or Final Status Survey measurements.

Background sludge samples will be collected from storm drain and gravity flow sanitary sewer line locations (manholes) identified to be upstream from the lines impacted by radium from Building 27 (Attachment 1). For surface backgrounds, reference areas for each radiological measurement method and matrix type will be selected consisting of similar structural materials from areas in the building that are not impacted. Reference locations will have similar physical, chemical, radiological, and biological characteristics as the impacted area(s) being investigated, and will not be identified as impacted by any previous surveys. All locations selected for reference will be approved by the Project RSO. The same survey methods and equipment that will be used for conducting a survey in an impacted area will be used for the background area survey. Reference area data will be identified to the RCT prior to the start of each survey.

This plan shall be reviewed and approved by RASO prior to execution.

Storm Drain and Sanitary Sewer Backgrounds

The goal is to collect six sludge samples from each of four different locations (manholes) for the storm drain system and from each of the four gravity-flow sanitary sewer system manholes. Shaw statisticians have identified these sample numbers as appropriate to perform analysis of variance to characterize the background variability between and within sampling locations. At each manhole the following background measurements and samples will be collected if possible in the following order:

- Six removable contamination smears will be taken from non-sludge coated surfaces
- Six one-minute total contamination (static) counts, co-located with the smear samples
- Surface alpha and beta/gamma surveys on pipe entrance and exit locations, if the surfaces are dry and are not sludge coated which would prevent accurate surface measurements
- Six sludge samples from random locations within the manhole (to the extent that uniquely different sample locations are possible).

All measurements will be performed using the same radiological survey instrumentation that will be used at the impacted locations.

Storm drain background locations have been identified as follows (see Table 1):

- MH 140
- MH 125
- MH 126
- MH 1013.

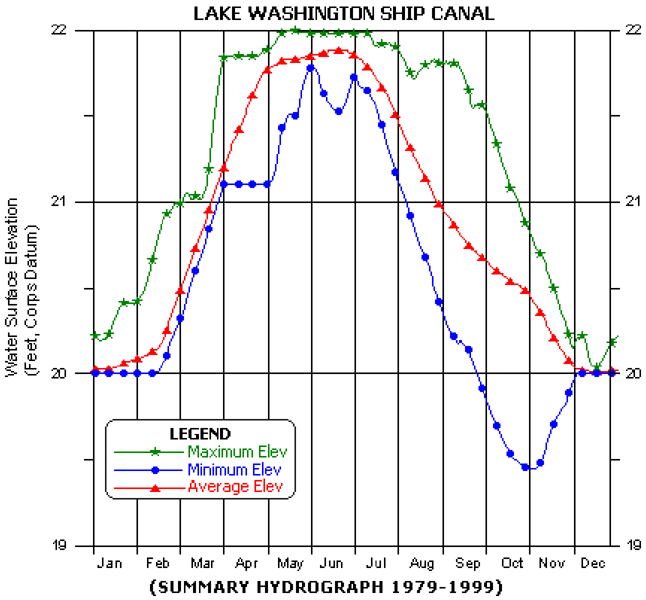
Each reference manhole was selected to assure the lowest channel (outlet) elevation exceeds the rim elevation of the highest manhole in the impacted system. For the storm drain system, this is shown in Table 1 and the attachments.

Table 1. Storm Drain Reference Locations

Manhole	Rim Elev.	Invert Elev. (lowest)	Drawing Sheet	Notes
Impacted (highest elevation)				
MH 141	26.99	19.03	SC1.7	Highest storm drain manhole
Reference Locations				
MH 140	51.07	37.78	SC1.7	Dry, large pipes, good sludge
MH 125	36.31 (by observation)	30.31 (by observation)	SC1.4	Brick
MH 126	39.85	34.30	SC1.3	Good, minimal sludge
MH 1013	38.61	32.76	SC1.4	Good sludge

The danger of flood induced movement of contaminants is precluded by the well-controlled Lake Washington level, maintained by the US Army Corps of Engineers-controlled Hiram M. Chittenden Locks (see Figure 1).

Figure 1. Lake Washington Level History



The abandoned pressurized sanitary sewer line (designated as a dotted line from Pump House 117 to Pump House 98) has not been characterized to allow accurate identification of an upstream reference location. Based on this lack of information, an individual background reference area for the pressurized sanitary sewer line cannot be identified and instead the background for the gravity flow sanitary sewer line will be used. The background for the gravity-flow sanitary sewer system will be used. If further characterization identifies non-impacted locations in this system, background samples can be taken if necessary.

Four gravity-flow sanitary sewer line background locations have been identified:

- COS[1] E6
- MH 215
- MH 212
- Unnumbered manhole 37 feet south of MH 140.

Again, these reference locations were selected to be above the rim level of the highest impacted manhole (see Table 2).

Table 2. Gravity-flow Sanitary Sewer Reference Locations

Manhole	Rim Elev.	Invert Elev. (lowest)	Drawing Sheet	Notes
Impacted (highest elevation)				
MH 223	25.48	20.84	SC1.6	At SE corner of B27
MH 224		21.84 (by observation)	SC1.6	Highest gravity-flow sewer manhole
Reference Locations				
COS E6	56.00	51.50	SC1.7	Good sewer
MH 215	48.55	40.55	SC1.3	Access thru Bayley Construction
MH 212	35.81	27.41	SC1.4	Minimal flow
Unnumbered manhole 37' south of MH 140	54 (by observation)	51 (by observation)	SC1.7	Channelized, minimal flow, minimal sludge

Samples and surveys as detailed above will be taken at these locations

Sludge samples will be sent to an off-site laboratory for analysis for ^{226}Ra. The background values for ^{226}Ra will be determined by laboratory analysis, using EPA Method 901.1 modified. Background values will be calculated using the reported activity, regardless if the value is below

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[1] City of Seattle

laboratory MDA or less than zero. The project detection limits are specified in the approved QAPP/SAP as:

- Sludge MLCC = 0.7 pCi/g.

Facility Surface Backgrounds

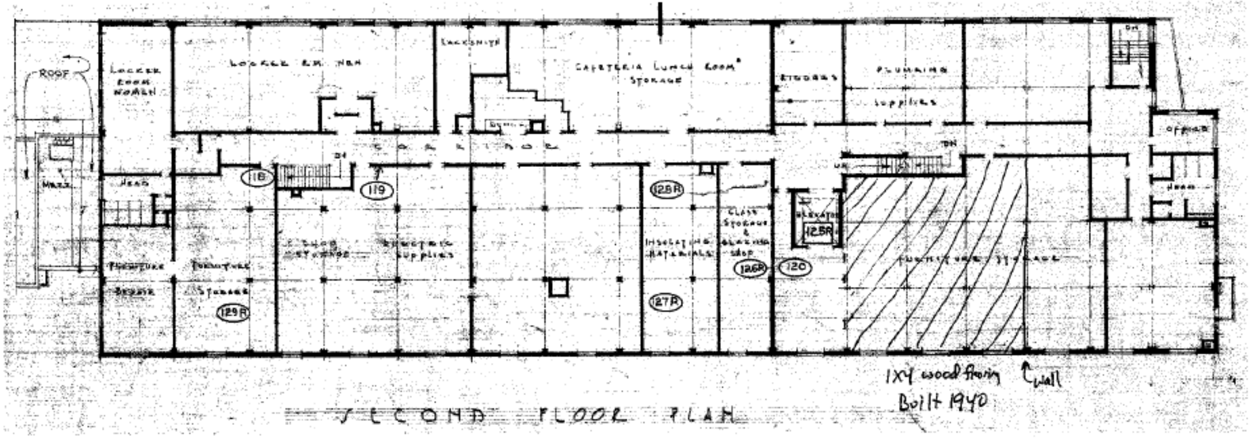
Background (reference) areas will be selected for each surface type to be surveyed. For Building 27 the identified surfaces to be monitored are:

- Subflooring – instrument shop (including the Ra Room)
- Wallboard – instrument shop
- Concrete
  - West stair tower
  - Welding shop
  - Hanger surface
- Roof
- Exhaust Vents and Ceilings.

Background surfaces have been identified as follows:

- Subflooring – all subflooring on the second floor of the B27 south shed appears to be constructed of the same material at the same time. An area in an adjacent building (Building 11 to the west of Building 27) built in approximately the same period has been identified to have similar material. This building is located in a non-impacted area. This area is a non-occupied artist's studio and is available for survey (see Figure 2).

Figure 2. Building 11 Floor Reference Area



- Wallboard – the plaster wallboard on the first floor of Building 11 appears to be similar material to that on the walls in the impacted area. This will be used as a reference area for Building 27 wallboard.

- Concrete (Southwest stair tower) – the northwest stair tower was constructed at the same time as the southwest tower and the second floor will be used as a reference location.
- Concrete (Welding shop) – the concrete floor in the first floor of Building 11 appears to be similar. This area will be used for a reference location.
- Concrete (Hanger surface) – the hanger floor concrete appears to be similar throughout the area near the welding shop wall. An area 4 meters – 7 meter out into the hanger from the wall common with the Welding Shop will be used as the reference area.
- Roof – the east half of the roof is not impacted. No building exhaust points exist in this area, only two 16-inch passive "General Issue" air vents that ventilate the furred space over the ceiling of this area are present (drawing 54080). There is no pathway for contamination release through these air vents. All of these vents have surveyed negative (RSS-075) and 100% gamma walkover (RSS-032) and 100% alpha and beta/gamma floor monitor survey (RSS-030) support this conclusion. The east half of the roof has been selected as the reference area. A 20-foot buffer area has been included to assure separation from any exhaust vents. The eastern 90 feet of the roof will be used as the reference location. It will be necessary to cut and remove the roofing in the reference sampling locations.
- Exhaust Vents and Ceilings – The roof of Building 11 hosts eleven "General Issue" roof vents and two powered ventilators. The internal surface of one ventilator is accessible from the roof (no bird screens). The external surfaces and fan blades of two others are accessible. The exhaust vents will be surveyed and directly compared with the project cleanup criteria. The reference ceiling location to be used is the ceiling directly above the subfloor reference location.

Surface measurement backgrounds will be determined by performing a minimum of eighteen measurements at systematic or random locations within each designated reference area. Additional background samples may be collected as directed by the Radiological Site Manager. Data collected in reference areas will be statistically evaluated using a graphical format, such as a frequency distribution chart, and approved for use by the Project RSO. The purpose of the evaluation is to ensure that the data collected in the reference area are consistent with a normal distribution and that the variability of the background is appropriate. Variability will be evaluated to determine if individual building material reference backgrounds are statistically different. If not, we will use the daily QC background as an "intrinsic" background value for each instrument. Variability in background will most likely impact the beta and gamma survey measurements, alpha backgrounds are expected to be near zero.

Measurements will be taken with the following instrumentation:

- Model 43-68 gas flow proportional counter
- Model 239-1F Floor monitor (for floor and roof only)
- Model 44-10 NaI gamma detector (for floor and roof only)
- Smear survey counted on Model 3030 alpha – beta/gamma counter.

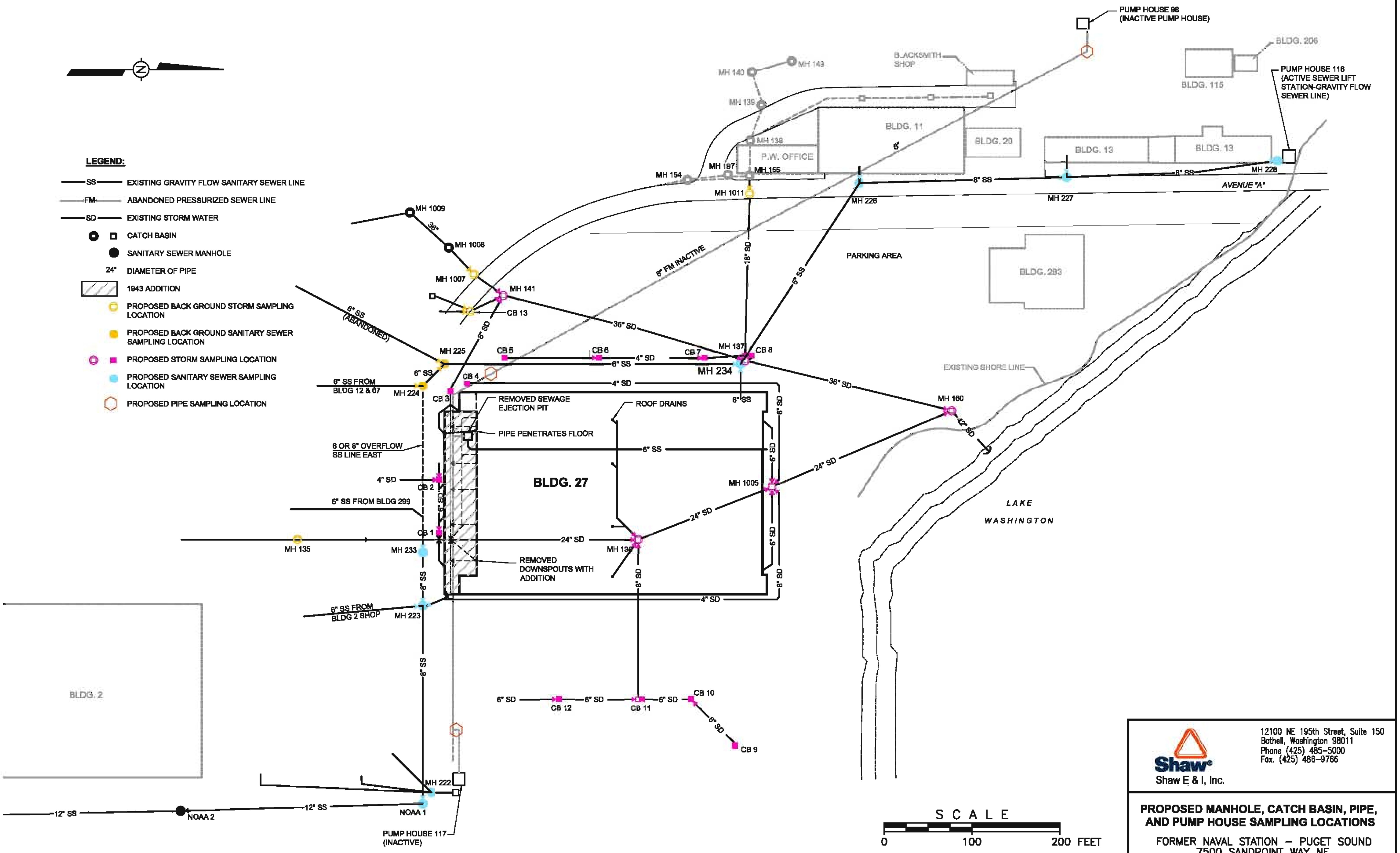
Reference locations for Pump House surfaces and Building 2 will be determined when those facilities are investigated.

Attachments:

- 1. SD/SS drawing
- 2. Key Maps (Index Drawing)
- 3. Drawing Sheet SC1.3
- 4. Drawing Sheet SC1.4
- 5. Drawing Sheet SC1.7

OFFICE *Bothell, WA*

DRAWING NUMBER BT-137165-B27-F9



LEGEND:

- —SS— EXISTING GRAVITY FLOW SANITARY SEWER LINE
- —FM— ABANDONED PRESSURIZED SEWER LINE
- —SD— EXISTING STORM WATER
- ◉ □ CATCH BASIN
- ● SANITARY SEWER MANHOLE
- 24" DIAMETER OF PIPE
- ▨ 1943 ADDITION
- ○ PROPOSED BACK GROUND STORM SAMPLING LOCATION
- ● PROPOSED BACK GROUND SANITARY SEWER SAMPLING LOCATION
- ○ ■ PROPOSED STORM SAMPLING LOCATION
- ● PROPOSED SANITARY SEWER SAMPLING LOCATION
- ⬡ PROPOSED PIPE SAMPLING LOCATION

S C A L E

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Shaw E & I, Inc.

12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766

PROPOSED MANHOLE, CATCH BASIN, PIPE, AND PUMP HOUSE SAMPLING LOCATIONS

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

XREF Files: IMAGE Files: 2835_001_Page_1.jpg
54076.tif BLDG27-1943.jpg ss_Page_2.jpg ss_Page_3.jpg
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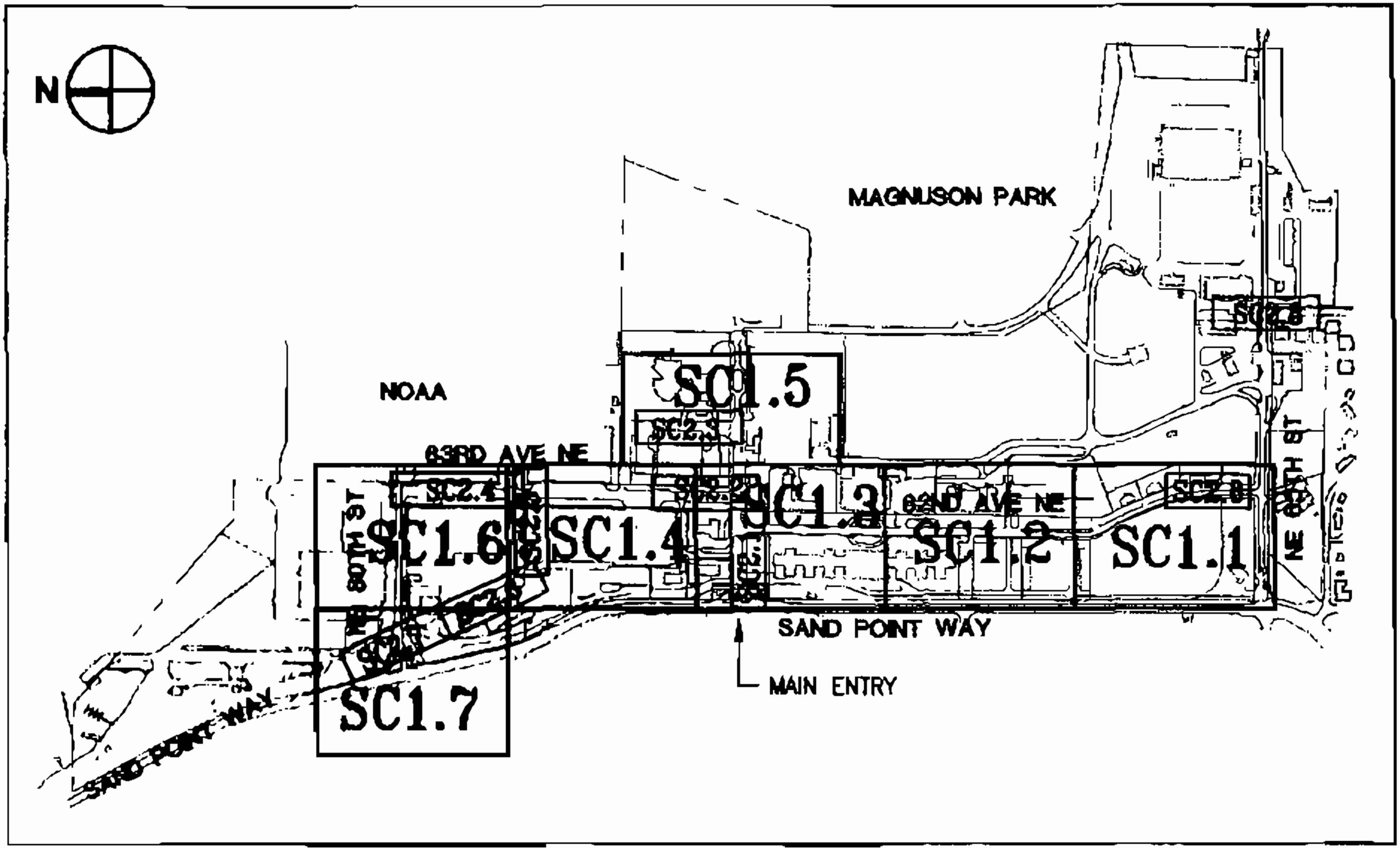
KEY MAPS


N
MAGNUSON PARK
NOAA
SC1.5
SC2.3
63RD AVE NE
SC2.4
NE 80TH ST
SC1.6
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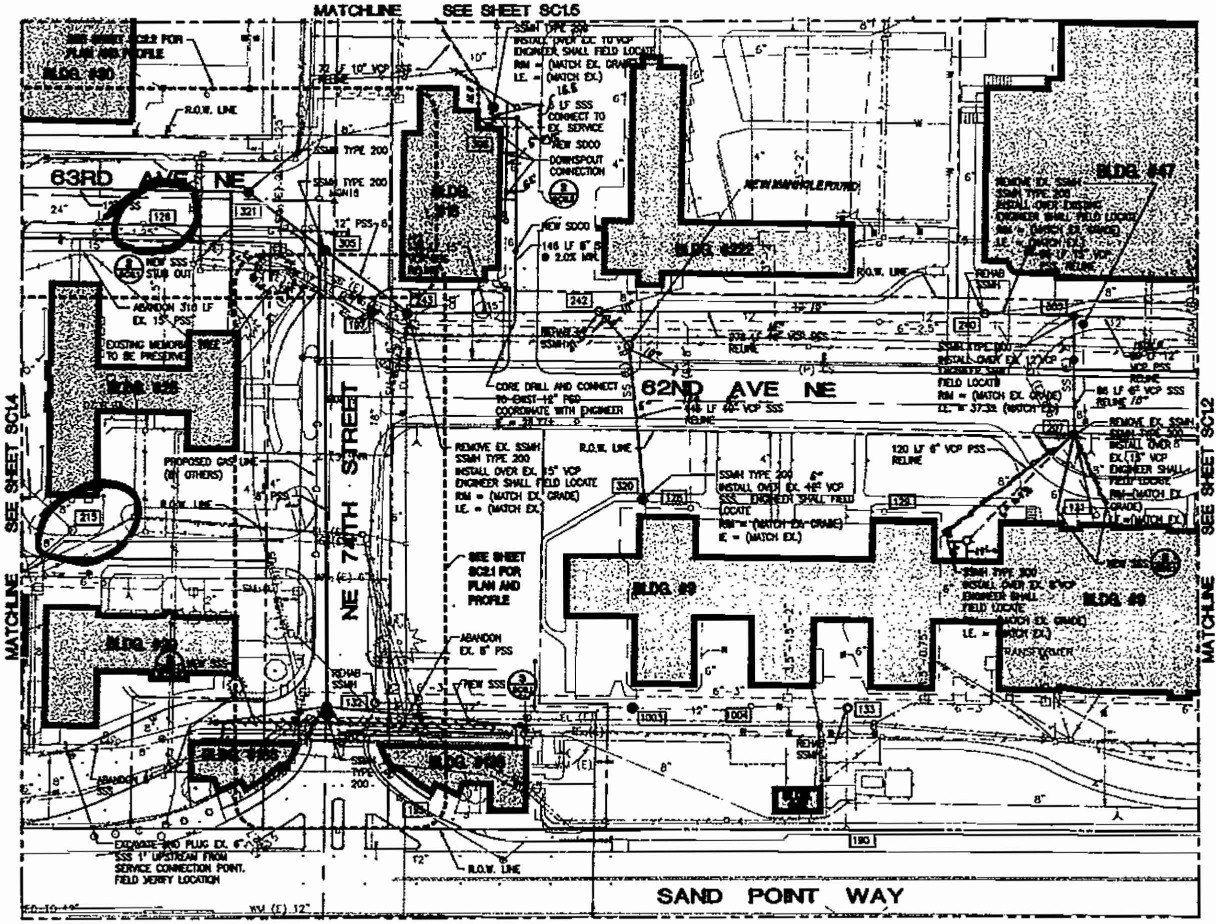
SAND POINT WAY
MAIN ENTRY
SC1.7
SAND POINT WAY



SANITARY SEWER MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
207	54.31	43.30 8" IN (W)	12
		42.80 8" OUT (E)	
		50.81 6" (W)	13
		45.31 6" (W)	
215	48.56	42.15 8" IN (NW)	10
		40.55 8" IN (N)	
		43.40 6" (SW)	
240	52.85	36.20 12" IN (S)	3
		36.00 12" OUT (N)	
		36.30 8" (E)	
		36.20 8" (SE)	
242	49.15	29.95 15" IN (S)	11
		29.82 15" OUT (N)	
		33.15 6" (S)	13
		32.75 10" (W)	
243	43.50	27.80 15" IN (S)	12
		27.80 15" OUT (N)	

NOTES

1. SEE SHEET SC1.1 FOR UTILITY PLAN NOTES AND REHABILITATION NOTES.

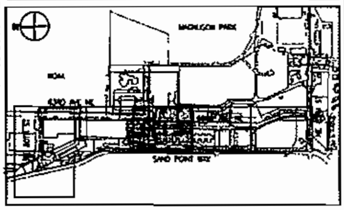
SCALE: 1" = 40'

CITY OF SEATTLE

STORM DRAIN MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
126	39.85	34.30 24" IN (S)	10
		34.20 24" OUT (N)	
		35.17 10"	
		36.37 6"	
127	44.26	39.29 18" IN (W)	7-12-
		39.17 24" OUT (N)	
		39.24 12" IN (S)	
		41.82 6" IN (NE)	
		41.37 6"	
		39.31 4"	
128			10
129	56.16	47.93 6" OUT (S)	10
		47.82 6" OUT (?)	
		47.93 6"	
		47.88 4"	
		48.05 2"	
130	55.98	51.96 8" IN (SW)	10
		45.04 12" OUT (N)	
		45.08 8" IN (W)	
		53.20 6"	
		53.36 6"	
		45.09 6"	
132	57.37	50.06 12" IN (W)	1,7
		49.82 18" OUT (E)	
		49.97 12" IN (S)	
133	57.21	53.35 12" IN (W)	7
		53.27 12" OUT (N)	
		53.27 12"	
190	64.17	60.37 12"	10
		60.69 12"	
195	61.06	56.96 12" IN (W)	10
		54.71 12" OUT (E)	
1003	57.06	51.61 12" IN (S)	12
		51.59 12" OUT (N)	
1004	57.24	52.42 12" IN (S)	10
		52.42 12" OUT (N)	

KEY MAP



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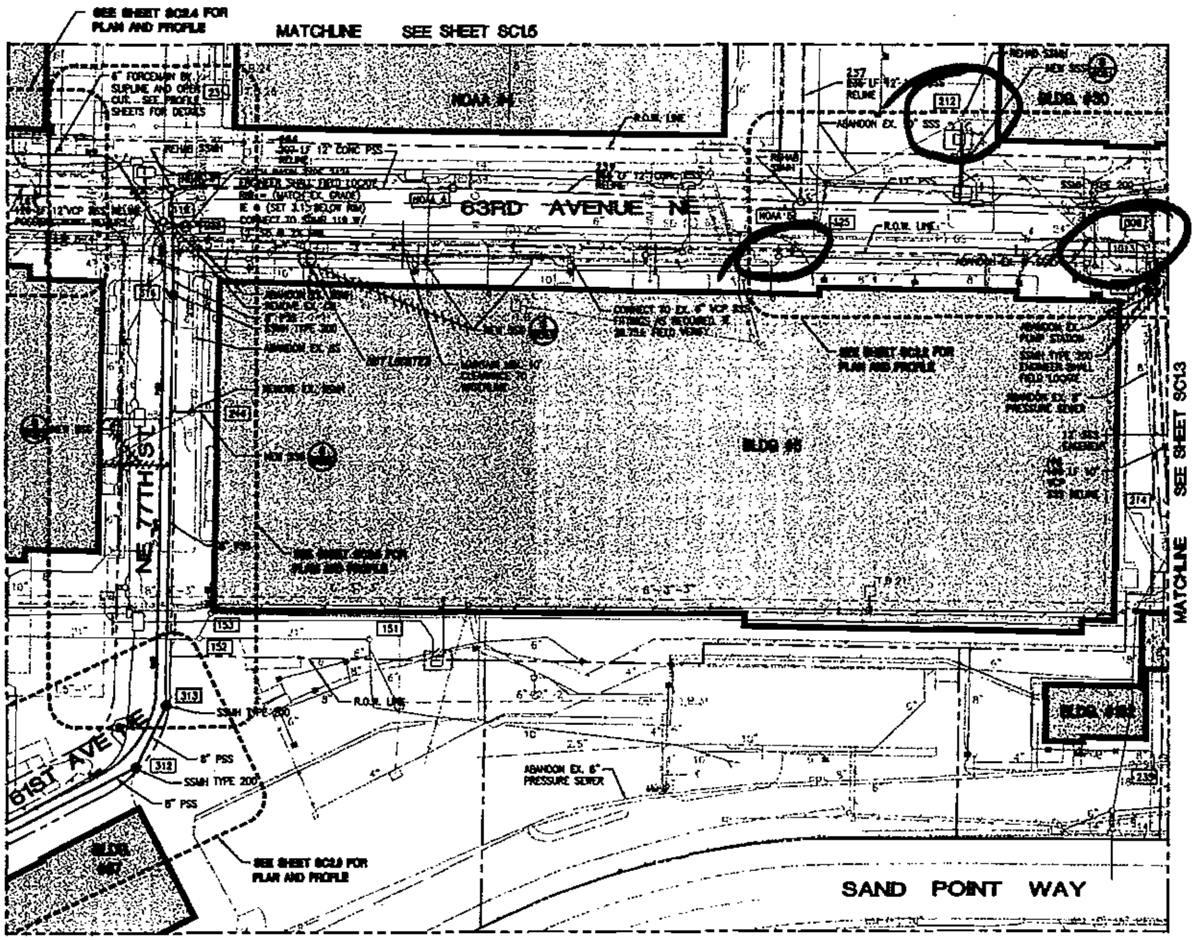


SANITARY SEWER MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
212	35.81	27.77 6" IN (S)	50
		27.41 10" OUT (E)	PLUG
		31.52 6" (W)	PLUG
216	41.66	35.66 8" IN (S)	10
		35.61 10" OUT (E)	
		35.61 6" (S)	
231	31.89	23.34 8" IN (W)	10
		23.29 8" OUT (E)	
		23.89 6" (N)	
		27.79 4" (S)	
232	31.94	25.09 8" IN (S)	10
		25.07 8" OUT (E)	
		25.09 8" (N)	
		26.09 6" (W)	
235			10
NOAA 3	31.45	19.25 12" IN (S)	10
		22.75 8" IN (SW)	
		19.25 8" OUT (N)	
NOAA 4	33.87	20.55 12" IN (S)	10
		20.45 12" OUT (N)	
NOAA 5	38.31	21.95 12" IN (S)	5
		22.35 12" IN (SE)	
		21.95 12" OUT (N)	

STORM DRAIN MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
119	31.47	25.87 12" IN (SW)	3,5,7
		25.87 15" OUT (E)	
		28.57 6" IN (N)	
		28.97 6" IN (S)	
		26.17 8" IN (W)	
		26.87 6" IN (SW)	
125	36.34	30.32 24" IN (S)	10
		30.27 24" OUT (E)	
		33.06 6" IN (SE)	
152	32.96	27.51 21" IN (S)	10
		27.41 21" OUT (N)	
		27.81 21" IN (E)	
153	33.13	32.13 12" IN (S)	10
		27.63 21" OUT (W)	
		28.03 8" IN (E)	
		28.63 6"	
151	32.97	28.39 10" IN (W)	10
		28.34 18" OUT (N)	
1013	38.61	32.80 24" IN (S)	10
		32.76 24" OUT (N)	

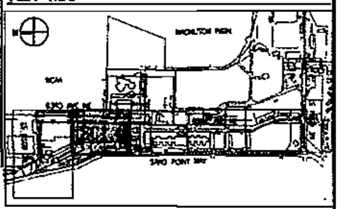
SCALE: 1" = 40'

CITY OF SEATTLE

NOTES:

1. SEE SHEET SC1.1 FOR UTILITY PLAN NOTES AND REHABILITATION NOTES.

KEY MAP



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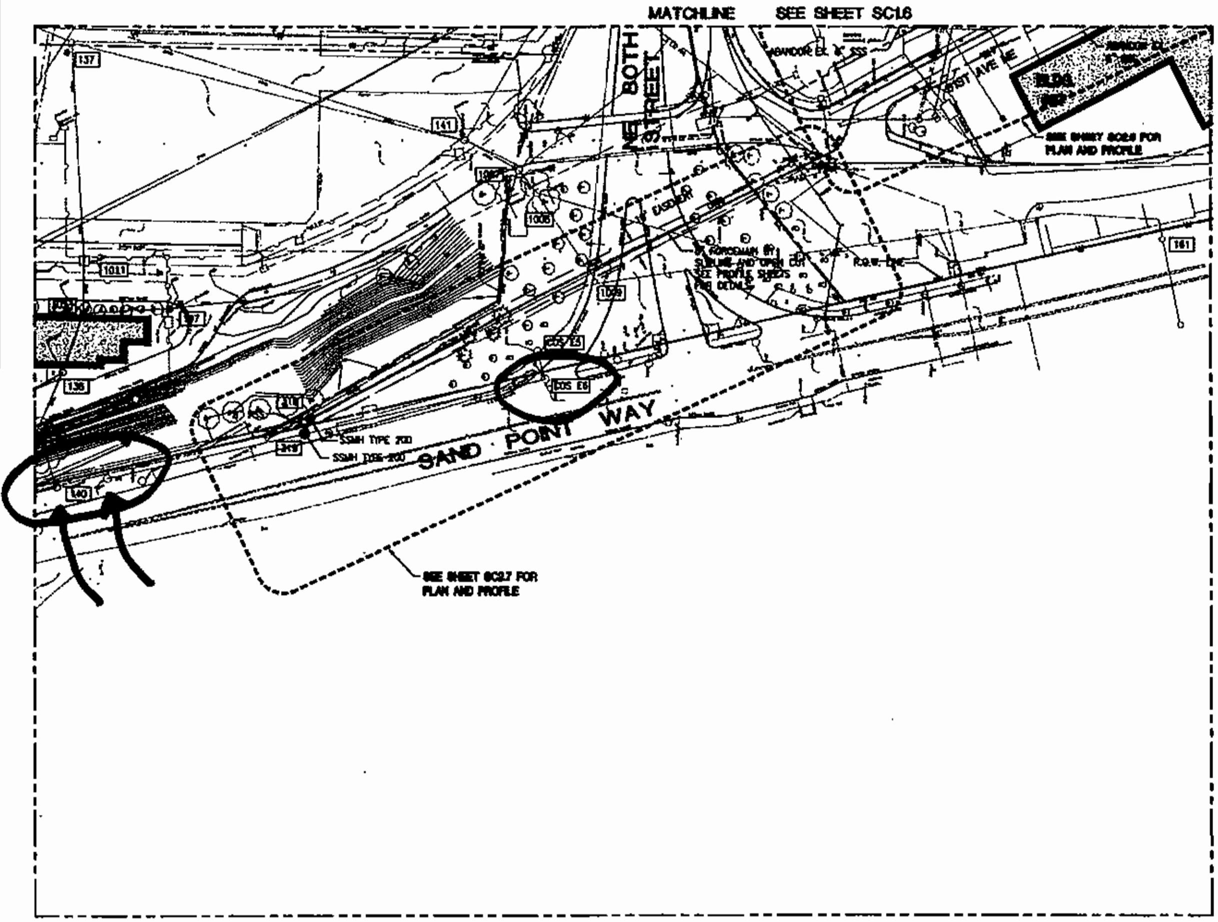
SHEET SC1.4 OF

44031

MATCHLINE SEE SHEET SC1.6



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SANITARY SEWER MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
COS E6	56.00	51.50 12" OUT (N)	10
		51.50 12" IN (E)	
COS E5	56.90	53.10 12" OUT (W)	10
		53.10 8" IN (E)	

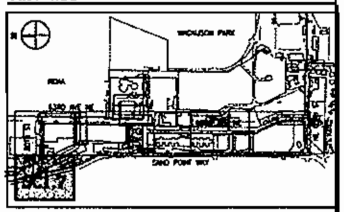
NOTES:

1. SEE SHEET SC1.1 FOR UTILITY PLAN NOTES AND REHABILITATION NOTES.

STORM DRAIN MANHOLE SCHEDULE (EXISTING)

MANHOLE NUMBER	RIM ELEVATION	INVERT ELEVATION	REHABILITATION NOTES
137	22.24	15.55 36" IN (NE)	10
		15.55 36" OUT (SW)	
		17.00 16" IN (E)	
138	28.25	24.91 18" OUT (E)	10
		25.23 18" IN (NE)	
		25.23 6" IN (NNE)	
		26.43 6"	
		25.43 4"	
		25.65 4"	
139	31.70	25.97 18" IN (W)	10
		25.97 18" OUT (E)	
		25.97 18"	
		27.30 4"	
140	51.07	37.78 18" OUT (E)	10
		37.78 18" IN (N)	
141	26.99	19.03 36" IN (S)	10
		18.80 36" OUT (N)	
		18.80 6" IN (SE)	
161	58.80	54.36 24" OUT (E)	10
		54.01 18" IN (W)	
		54.58 12"	
		54.67 3"	
187			10
1007			10
1008			10
1009	44.12	37.38 24" IN (S)	10
		35.50 36" OUT (NE)	
		41.07 6"	
		40.18 8"	
		40.14 4"	
		42.59 3"	
1011			10
1023			10

KEY MAP



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44034

Attachment 2

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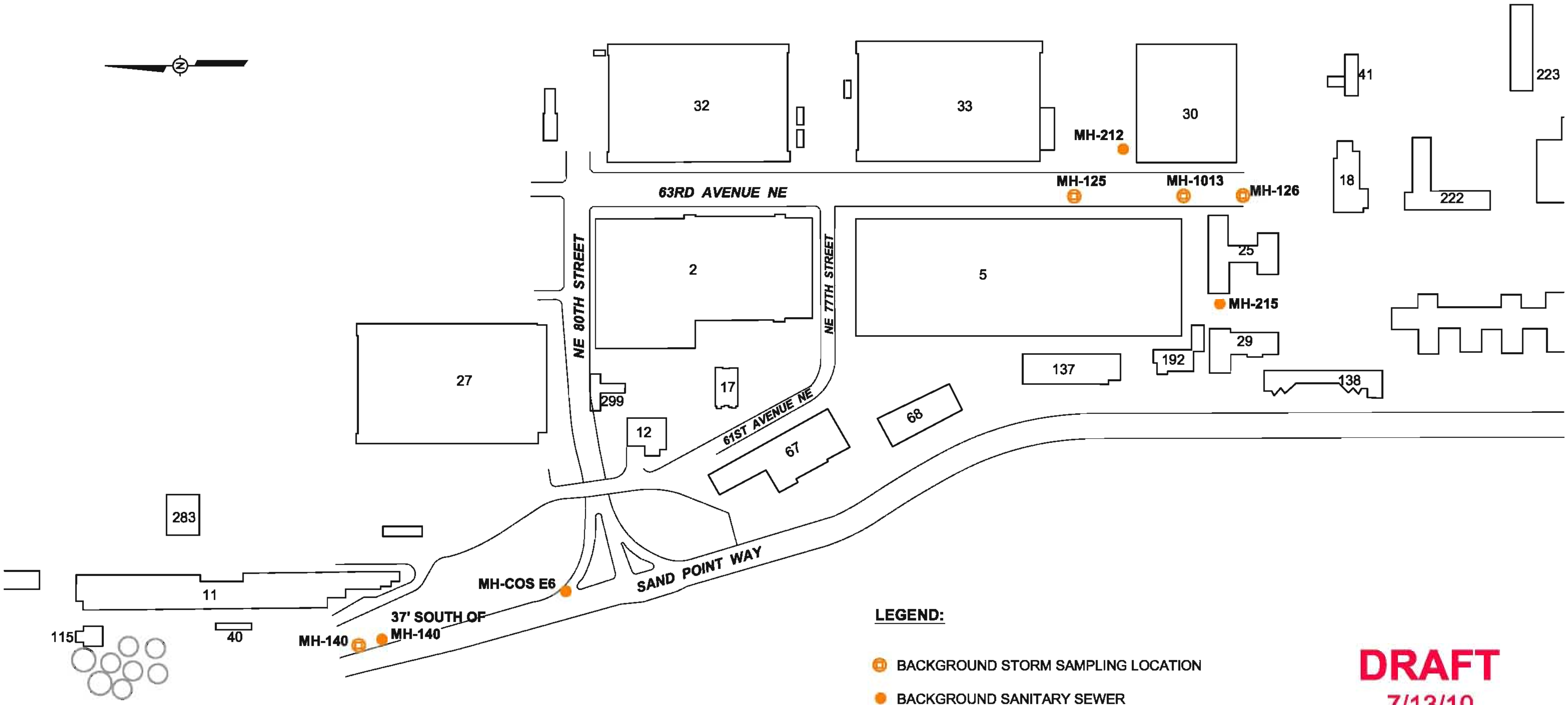
DRAWING NUMBER
BT-137165-B2



LEGEND:

- ⊡ BACKGROUND STORM SAMPLING LOCATION
- ● BACKGROUND SANITARY SEWER SAMPLING LOCATION
- 27 BUILDING NUMBER

DRAFT
7/13/10

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Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766

MANHOLE BACKGROUND
SAMPLE LOCATIONS

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

XREF Files: IMAGE Files: 2835_001_Page_1.jpg
54076.tif BLDG27-1943.jpg ss_Page_2.jpg ss_Page_3.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\Drawings\Manhole Sampling Drawings\BT-137165-B2.dwg Layout: Layout1 User: maria.portacio Jul 13, 2010 - 12:52pm

Attachment 3

Shaw The Shaw Group Inc.™

Shaw Environmental & Infrastructure, Inc.

717 Redwood Lane
Richland, WA 99354
509-375-0982

Memorandum

Date: 27 August 2010

To: Jim Langsted

CC: John Carson, Guy Gallello

From: Robert O'Brien

RE: Statistical Analysis for Creating a "Bright Line" Screening Value to be used in Comparisons to Background Data for NAVSTA PS Sewer Lines

Overview and Summary

A statistical analysis was carried out on the background data from sanitary sewer line and storm drain sediments from the Naval Station Puget Sound (NAVSTA PS) in Seattle, WA. The purpose of this analysis is to produce a "bright line" background screening value, per Navy criteria, with which to compare an unknown number of Radium-226 concentration measurements from down-gradient manholes to determine if the down-gradient measurements were individually within the range of background.

The Navy has defined the comparison criteria as follows:

> "The Contractor shall establish radiological background as appropriate for implementation of the cleanup action. Radiological contamination is expected to contain Radium-226. Should any soil or sediment exceeding the mean statistical background level plus three standard deviations be encountered they will be removed, inventoried, packaged, labeled, and stored in a secure dedicated Radioactive Materials Storage Area in accordance with all appropriate regulations pending disposal by a separate contractor managed by the Navy." (Revised SOW, Section 2.5)

If the data were normally distributed, the "bright line" value defined in the Navy criteria, the mean plus three standard deviations of the background measurements, would be a point estimate of the upper 99.9th percentile of the background distribution.

The statistical analysis presented here estimates this proposed "bright line" value from background data collected from 26 sediment samples collected from 6 manholes up-gradient from the sanitary sewer and storm drain systems of concern. The 26 background measurements when pooled together from the 6 manholes were statistically tested and found not to be normally distributed. However, when the data was statistically tested within manhole it was found to be normally or lognormally distributed. The data also tested to have different means and variances by manhole. Thus, there exists a random effect due to manholes that needs to be modeled to obtain an estimate of the overall variance of the combined background data set. To estimate the mean plus 3 standard deviations of background the data was first transformed into the natural log scale to stabilize the variances. This was necessary as unequal variances by manhole can disturb inferences on variance components in a random effects model Montgomery(1984). After transformation into the natural log scale the random effects model was fit using MARSSIM and NUREG-1505 guidance to estimate the background mean and total variance. The mean plus three standard deviations in the log scale was then transformed back into the original scale to obtain the “bright line” value to be used in future to background.

The result of this analysis was an estimated “bright line” value of 1.61 pCi/g representing a value of the mean plus three standard deviations of background.

This is a rather conservative value to use in a multiple testing situation especially when more than k measurements (k > 1) from down-gradient locations are going to be compared to this “bright line” value. Actually, the significance level of using this “bright value” of 1.61 is 99.7%, not 99.9%, for k=1 future down-gradient measurement. As number of future down-gradient comparisons k increases, the overall significance level using this “bright line” value deceases. The overall significance levels decrease to 99.3%, 98.9%, 98.6%, 98.0%,…, 82.9% for k future measurements in the range of 2 to 50 respectively.

The conclusion section below offers another method, using prediction intervals (UPLs), which may be more appropriate for establishing a fixed significance level for any value of k future measurements. This method requires a different “bright line” value for each number, k, of future down-gradient measurements to be used in each comparison from a down-gradient manhole. The advantage of this method is no matter how many measurement comparisons are made from a down-gradient manhole the significance level remains fixed at a pre-specified significance level of say 95%, 99% or 99.9%.

Statistical Analysis

Background data sediment data was collected at six manholes up-gradient from the areas believed to be affected by possible RA-226 contamination. There were a total of 26 background samples taken from the six manhole locations (Table 2). The raw data from these manhole locations exhibited different mean concentrations and variances based on the non-parametric Kruskal-Wallis and Levene’s test methods respectively. However, there were no differences in mean concentrations due to type of system the manholes were situated (sanitary sewer vs. storm drain) based on both the Kruskal-Wallis test and a mixed effects linear modeling.

Since the data from the manhole locations exhibited different means and variances, the background data was first transformed to the natural log scale in order to stabilize the variances between manhole locations. In the log scale, the mean concentrations still tested to be different based on the Kruskal-Wallis test but the variances tested to be equal based on Levene’s test. The estimate of the total variance of the observations was then made in the log scale using a random effects component of variance model of the background manhole locations based on methods suggested in NUREG-1575 (MARSSIM) and NUREG-1505 (Chap. 13). This total variance estimate was used to estimate the standard deviation of full background data set. Table 4 gives the p-values associated with each of the tests performed in the original and the natural log scales.

As the data tested to be lognormal within manhole, the natural log transformation has no effect on the statistical meaning of the “bright line” value being estimated as percentage points estimated in the log scale are transformed back into the original scale without transformation bias. This is in contrast to procedures like estimates of or upper confidence limits for the mean, which are biased low by simple transformation of the values and back-transformation of the estimates. The random effects linear models procedure given in NUREG-1505 (Section 13.3) was used to calculate the between location variance ($\omega^2 = 0.1604$) and the within-location + error variance ($\sigma^2 = 0.041$) in the log scale. The grand mean ($\overline{y} = -0.869$) in the log scale was also computed. The "bright line" value, BL, was then estimated by inversely transforming the mean plus 3 standard deviations in the log scale back into the original scale as

$$BL = \exp\left(\overline{y} + 3(\omega^2 + \sigma^2)^{1/2}\right) = 1.61$$

Table1 gives the raw background data used in the analysis.

Figure1 gives a dot plot of the raw background concentration data by manhole. In this Figure, concentration values are blue circles and the means are red squares. It can be easily seen in this figure how the mean RA-226 concentrations differ by manhole and how the spread (variance) of the data differs by manhole.

Conclusion

The "bright line" value computed as

$$BL = \exp\left(\overline{y} + 3(\omega^2 + \sigma^2)^{1/2}\right) = 1.61$$

is a conservative value to be using as a screening level in a multiple comparison situation (that is when more than a measurement is going to be compared to background from a specific manhole location). A typical problem in multiple comparisons is the overall significance level of the test can decrease with each comparison. Using the BL above as a fixed screening value Table 2 gives the actual significance levels that will be achieved by using the BL above for k=1:100 comparisons. Note that for k=1 future comparisons the achieved significance level is 99.7% not 99.9% and decreases from there to 67.5% at k=100.

A more statistically defensible method would be to use 99.0% prediction intervals. One sided upper prediction limits (UPLs) would not give a single fixed "bright line" value but would change depending on the number of comparisons, k, being made from a down-gradient location. Prediction intervals are commonly in industry and by EPA(2009) in RCRA ground water monitoring for a screening value when multiple comparisons are going to being made. The value would change depending on the number of comparisons, k, being made from a down-gradient location. The "bright line" values depending on k would be computed following procedures given in EPA(2009) and Hahn and Meeker(1991) as

$$BL(k)_{UPL} = \exp\left(\overline{y} + t_{1-.01/k,25}(1+1/26)^{1/2}(\omega^2 + \sigma^2)^{1/2}\right)$$

These values have a more conservative fixed 99% significance level than the initial assumed 99.9% significance level of the *BL* value computed above. The advantage is that the significance level is fixed at 99% for any number of k comparisons. However, if it is desired to have the significance level fixed at 99.9% this can easily be accomplished. $BL(k)_{\text{UPL}}$ values be larger for higher significance levels and smaller for lower significance levels. Table3 gives the values of the $BL(k)_{\text{UPL}}$ upper prediction intervals that could be used for this project based on the current background data set. Note as the $BL(k)_{UPL}$'s are computed at the 99% level of significance. They are initially smaller than the *BL* value when comparisons are made for k=1 and 2 comparisons, but quickly exceed the *BL* value once $k \geq 3$. If desired $BL(k)_{UPL}$ could easily be generated for any other significance level desired such as 95% or 99.9%.

References

EPA (2009). *Unified Guidance: Statistical Analysis of Groundwater Monitoring DAT at RCRA Facilities***. EPA 530/R-09-007, Washington, DC**

Hahn, G. and W, Meeker (1991). *Statistical Intervals: A Guide for Practitioners.* Wiley, NY, NY

Montgomery, D.C. (1984). *Design and Analysis of Experiments*. Wiley, NY, NY

NRC, 2000. ***MARSSIM:*** *Multi-Agency Radiation Survey and Site Investigation Manual*.
NUREG 1575, Washington, DC

NRC, 1998. *A Non-Parametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys*. NUREG-1505, Washington, DC

.

Table1. Background Sediment Ra-226 Concentrations (pCi/g)

	Sanitary Sewer (SS)		**Storm Drain (SD)**			
	MH212	**MH215**	**MH1013**	**MH125**	**MH126**	**MH140**
1	0.612	0.621	0.200	0.452	0.389	0.665
2	0.527	0.333	0.207	0.612	0.263	0.541
3	0.366	0.538	0.219			0.554
4	0.386	0.578	0.269			0.634
5	0.555	0.491	0.174			0.654
6	0.335					0.583
mean	0.464	0.512	0.214	0.532	0.326	0.605
variance	0.013	0.012	0.001	0.013	0.008	0.003
stand dev	0.115	0.111	0.035	0.113	0.089	0.053

Table2. Achieved Significance Level (SL) of $BL = \exp(y + 3*(\omega^2 + \sigma^2)^{1/2})$ for k=1:100 future comparisons

k	SL	k	SL	k	SL	k	SL
1	0.997	26	0.911	51	0.825	76	0.740
2	0.993	27	0.908	52	0.822	77	0.736
3	0.990	28	0.904	53	0.818	78	0.733
4	0.986	29	0.901	54	0.815	79	0.729
5	0.983	30	0.897	55	0.812	80	0.726
6	0.979	31	0.894	56	0.808	81	0.723
7	0.976	32	0.890	57	0.805	82	0.719
8	0.973	33	0.887	58	0.801	83	0.716
9	0.969	34	0.884	59	0.798	84	0.712
10	0.966	35	0.880	60	0.795	85	0.709
11	0.962	36	0.877	61	0.791	86	0.705
12	0.959	37	0.873	62	0.788	87	0.702
13	0.955	38	0.870	63	0.784	88	0.699
14	0.952	39	0.866	64	0.781	89	0.695
15	0.949	40	0.863	65	0.777	90	0.692
16	0.945	41	0.860	66	0.774	91	0.688
17	0.942	42	0.856	67	0.771	92	0.685
18	0.938	43	0.853	68	0.767	93	0.681
19	0.935	44	0.849	69	0.764	94	0.678
20	0.932	45	0.846	70	0.760	95	0.675
21	0.928	46	0.842	71	0.757	96	0.671
22	0.925	47	0.839	72	0.753	97	0.668
23	0.921	48	0.836	73	0.750	98	0.664
24	0.918	49	0.832	74	0.747	99	0.661
25	0.914	50	0.829	75	0.743	100	0.657

Figure1. Dot plots of the Background RA-226 Concentrations by Manhole

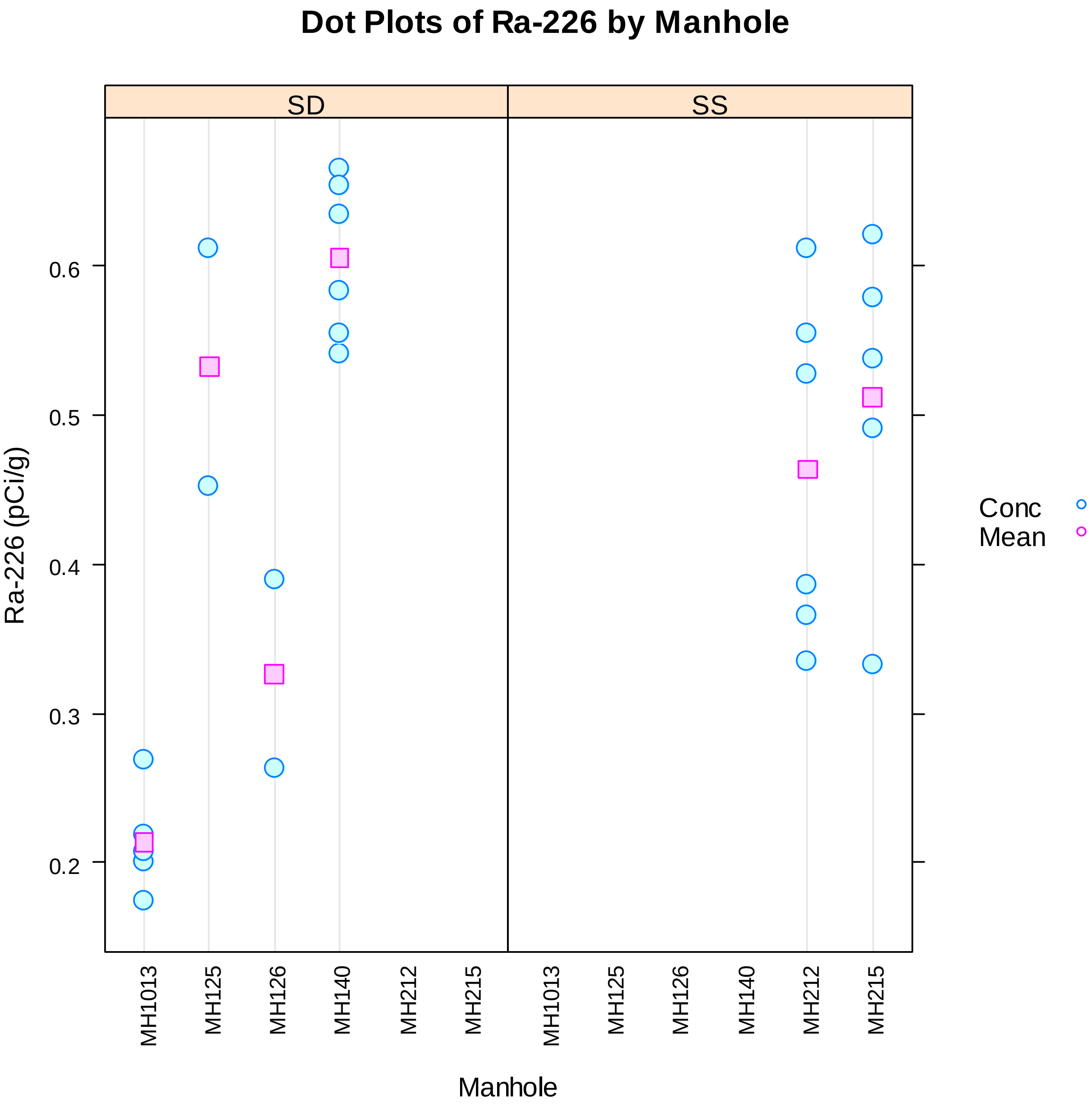


Table3. Upper 99% Prediction Intervals to contain all k future measurements

k	UPL 99%	k	UPL 99%	k	UPL 99%	k	UPL 99%
1	1.306	26	2.414	51	2.722	76	2.922
2	1.500	27	2.430	52	2.732	77	2.928
3	1.622	28	2.446	53	2.741	78	2.935
4	1.713	29	2.462	54	2.750	79	2.942
5	1.787	30	2.477	55	2.759	80	2.948
6	1.848	31	2.491	56	2.768	81	2.955
7	1.902	32	2.505	57	2.776	82	2.961
8	1.949	33	2.519	58	2.785	83	2.967
9	1.992	34	2.533	59	2.793	84	2.974
10	2.031	35	2.546	60	2.802	85	2.980
11	2.067	36	2.559	61	2.810	86	2.986
12	2.100	37	2.571	62	2.818	87	2.992
13	2.130	38	2.583	63	2.826	88	2.998
14	2.159	39	2.595	64	2.834	89	3.004
15	2.186	40	2.607	65	2.842	90	3.010
16	2.212	41	2.619	66	2.849	91	3.016
17	2.236	42	2.630	67	2.857	92	3.022
18	2.260	43	2.641	68	2.865	93	3.028
19	2.282	44	2.652	69	2.872	94	3.033
20	2.303	45	2.662	70	2.879	95	3.039
21	2.323	46	2.673	71	2.887	96	3.045
22	2.343	47	2.683	72	2.894	97	3.050
23	2.362	48	2.693	73	2.901	98	3.056
24	2.380	49	2.703	74	2.908	99	3.061
25	2.397	50	2.713	75	2.915	100	3.067

Table4 p-Values for Statistical Tests

		p-Values	
		Original Scale	**Log Scale**
Kruskal-Wallis Test	**Equality Manhole Means**	0.004	0.004
	Equality of System Means	0.640	0.640
Levene's Test	**Equality Manhole Variances**	0.079	0.250

Attachment 5
Dose-Based Sludge Concentration Derivation

Introduction

An aviation instrument shop was located in the South Shed of Building 27 at the former Naval Station Puget Sound. Historical documentation indicates that radium-226 (Ra-226) was used within the building. Recent radiological surveys confirm the presence of radium within Building 27. Sinks located in Building 27 were presumably used for clean-up and possibly disposal of radium-containing materials. Drain lines from these sinks are connected to both the sanitary sewer system and storm drain lines that service the building. Additional disposal may have been performed at catch basins or manholes outside the building. Sampling and analysis of sludge samples taken from both liquid disposal systems verify that Ra-226 levels exceed background in some locations. The decision to remediate (remove) this contamination depends in part upon the risk to the public that could potentially inhabit or use this area in the future.

To evaluate the risk to the public a dose-based or risk-based sludge concentration guideline has been developed to use as a release criterion for these radiologically contaminated properties. MARSSIM refers to this as a Derived Concentration Guideline Level (DCGL). This radionuclide-specific value is derived through activity/dose relationships by considering various exposure pathway scenarios. This sludge concentration guideline is a concentration above background, consistent with the dose limit discussed below.

The sludge concentration guideline derived here can be applied to the sludge remaining in the sanitary sewer and storm drain systems. The exposure pathway scenarios consider future use scenarios, such as industrial, recreational or residential use. The Residual Radioactivity (RESRAD) model and computer code (RESRAD 6.5) is used to derive a sludge concentration that will result in an annual dose limit set forth in federal or state regulations.

Dose Limit

The U.S. Nuclear Regulatory Commission specifies a dose limit as follows:

> *A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a 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 the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).* 10 CFR 20.1402

TEDE is the acronym for "Total Effective Dose Equivalent," the sum of the dose from external exposure and the 50-year dose resulting from internal deposition of radionuclides. The State of Washington regulations reiterate these dose limits in WAC 246-246-020.

In promulgating CERCLA regulations, the USEPA has specified a dose limit of 15 mrem per year for use on those sites (USEPA Letter). To take a more conservative approach, the dose limit of 15 mrem per year has been adopted for use in this sludge concentration guideline development effort. By using conservative assumptions for the dose limit, the source term, and the exposure pathway scenario, the result is a conservative sludge concentration guideline that is protective of the public at the 15 mrem per year dose limit.

Exposure Scenario

RESRAD was specifically developed to assist in developing cleanup criteria and is commonly used to perform this analysis (RESRAD 6.5, Section 1). RESRAD models radiation exposure to individuals living, working, or recreating in the area that contains residual radioactive contamination in excess of background. It is unlikely that members of the public visiting the site will come in contact with contaminated sludge if it remains in the undisturbed sanitary sewer or storm drain lines. Exposure would be possible if the sludge were to leak out of the pipes through breaches (holes or cracks) or flushed out by flow through the pipes. To model the release of this contamination from the lines, it is conservatively assumed that the soil surrounding the pipes is contaminated to the concentration level of the sludge in the pipe. This contaminated soil is assumed to be available for dispersion and exposure as modeled by RESRAD.

The RESRAD manual identifies four exposure scenarios:

- Resident Farmer scenario
- Suburban Resident scenario
- Industrial Worker scenario
- Recreationist scenario.

The City of Seattle is currently operating the site as Warren G. Magnuson Park. This urban park is available to the public for sports, recreation, and leisure. No residential use currently exists or is planned. Thus, the RESRAD recreationist scenario may be most appropriate to describe future public use of this area.

A more conservative exposure scenario for the future is the Resident Farmer which assumes a family moves onto the site after it has been released, builds a home, and raises crops and livestock for family consumption. Although this scenario seems unlikely in the foreseeable future, in tens or hundreds of years, the sociopolitical nature of the area may change to the point that this scenario becomes possible. By considering this possibility now, the sludge contamination will be left at a level that will not result in these individuals exceeding the selected dose limit. The conservative exposure scenario is consistent with the As Low As Reasonably Achievable (ALARA) requirement.

The exposure pathways considered in this scenario include (see Figure 1):

- Direct radiation from radionuclides in the soil
- Inhalation of resuspended dust (if the contaminated area is exposed at the ground surface)
- Inhalation of radon and its decay products
- Ingestion of food from crops grown in the contaminated soil
- Ingestion of milk from livestock raised in the contaminated area
- Ingestion of meat from livestock raised in the contaminated area

- Ingestion of fish from a nearby pond contaminate by water percolating through the contaminated zone
- Ingestion of water from a well or pond contaminated by water percolating through the contaminated zone ingestion of contaminated soil.

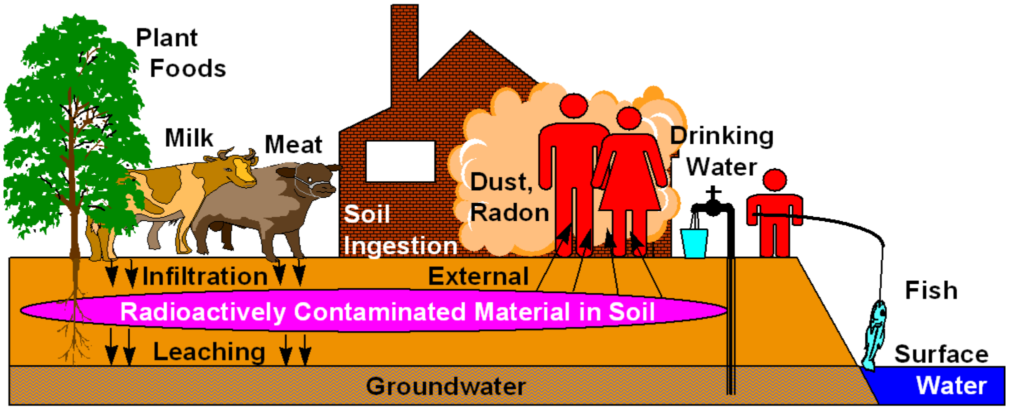


Figure 1. RESRAD Exposure Pathways

RESRAD Analysis

RESRAD contains at least 183 documented parameters that can be changed to model the specific site. Determining site-specific values for each of these parameters is a multi person-year effort. Fortunately RESRAD was published with default values that were carefully selected to be conservatively realistic. The basis for these values are documented in the RESRAD documentation. It is typical to use these default values and to change only those values appropriate to describe the parameters that are well understood at the site. If the analysis must be further refined, a sensitivity analysis can be performed to identify those parameters that can be refined with the collection of additional information.

RESRAD Default Parameters

The RESRAD 6.5 code "out of the box" contains parameters defining a 10,000 square meter contaminated soil mass that is 2 meters thick and has no material cover (clean soil). By specifying a contamination level of 1 pCi/g of Ra-226 uniformly distributed in the contaminated soil mass, the resulting dose rate to the resident farmer is 14.3 mrem per year at 30 years. Adjusted to reflect an annual dose of 15 mrem, this results in a sludge concentration guideline of 1.05 pCi/g for Ra-226.

By default, the radon exposure pathway is suppressed in the model. When this pathway is activated, it models both outdoor and indoor radon exposure. The residence is assumed to be built on the contaminated soil mass. Thus, radon will seep through the floor slab and accumulate in the house. Inhalation of radon results in significant exposure to individuals and has been the focus of USEPA efforts to monitor and reduce elevated radon levels in residences. For this analysis, radon mitigation efforts are assumed to be effective and indoor radon exposure removed from the modeling by modifying the indoor occupancy factor to zero and the onsite outdoor occupancy factor to 100%. With these changes, the remaining default RESRAD parameters result in dose rate to the resident farmer of 18.2 mrem per year after 30 years. Again, adjusted for an annual dose of 15 mrem, this results in a sludge concentration guideline of 0.82 pCi/g for Ra-226.

Sand Point-specific Parameters

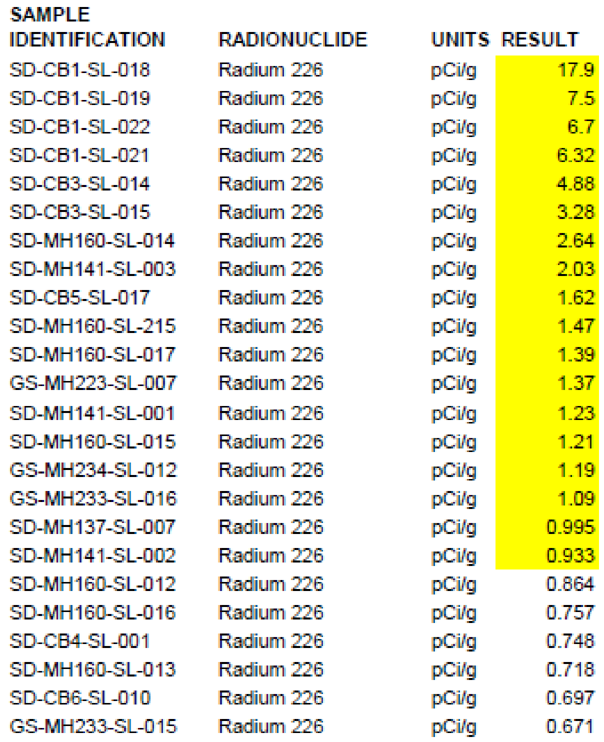
RESRAD modeling has been refined to define a Sand Point-specific source term consistent with the sludge contamination found in the sanitary sewer and storm drain systems.

Sludge Source Term

A contamination level of 0.926 pCi/g Ra-226 was selected to identify those sampling points (catch basins and manholes) above background. This value corresponds to the statistical mean plus three standard deviations, derived from the background sludge sampling results (Shaw, 2011). Review of the sludge samples taken from the down-gradient locations identified 18 non-background samples (shaded results in Table 1). These samples were taken from:

- Catch Basin 1
- Catch Basin 3
- Catch Basin 5
- Manhole 141
- Manhole 160
- Manhole 223
- Manhole 233
- Manhole 234
- Manhole 137.

Table 1 . Non-background Sludge Samples (shaded)



SAMPLE IDENTIFICATION	RADIONUCLIDE	UNITS	RESULT
SD-CB1-SL-018	Radium 226	pCi/g	17.9
SD-CB1-SL-019	Radium 226	pCi/g	7.5
SD-CB1-SL-022	Radium 226	pCi/g	6.7
SD-CB1-SL-021	Radium 226	pCi/g	6.32
SD-CB3-SL-014	Radium 226	pCi/g	4.88
SD-CB3-SL-015	Radium 226	pCi/g	3.28
SD-MH160-SL-014	Radium 226	pCi/g	2.64
SD-MH141-SL-003	Radium 226	pCi/g	2.03
SD-CB5-SL-017	Radium 226	pCi/g	1.62
SD-MH160-SL-215	Radium 226	pCi/g	1.47
SD-MH160-SL-017	Radium 226	pCi/g	1.39
GS-MH223-SL-007	Radium 226	pCi/g	1.37
SD-MH141-SL-001	Radium 226	pCi/g	1.23
SD-MH160-SL-015	Radium 226	pCi/g	1.21
GS-MH234-SL-012	Radium 226	pCi/g	1.19
GS-MH233-SL-016	Radium 226	pCi/g	1.09
SD-MH137-SL-007	Radium 226	pCi/g	0.995
SD-MH141-SL-002	Radium 226	pCi/g	0.933
SD-MH160-SL-012	Radium 226	pCi/g	0.864
SD-MH160-SL-016	Radium 226	pCi/g	0.757
SD-CB4-SL-001	Radium 226	pCi/g	0.748
SD-MH160-SL-013	Radium 226	pCi/g	0.718
SD-CB6-SL-010	Radium 226	pCi/g	0.697
GS-MH233-SL-015	Radium 226	pCi/g	0.671

The sanitary sewer and storm drain lines connecting these locations are shown in Figure 2. Scaling off of the figure (actually the drawing itself), the length of the contaminated line was determined to be 1,460 feet.

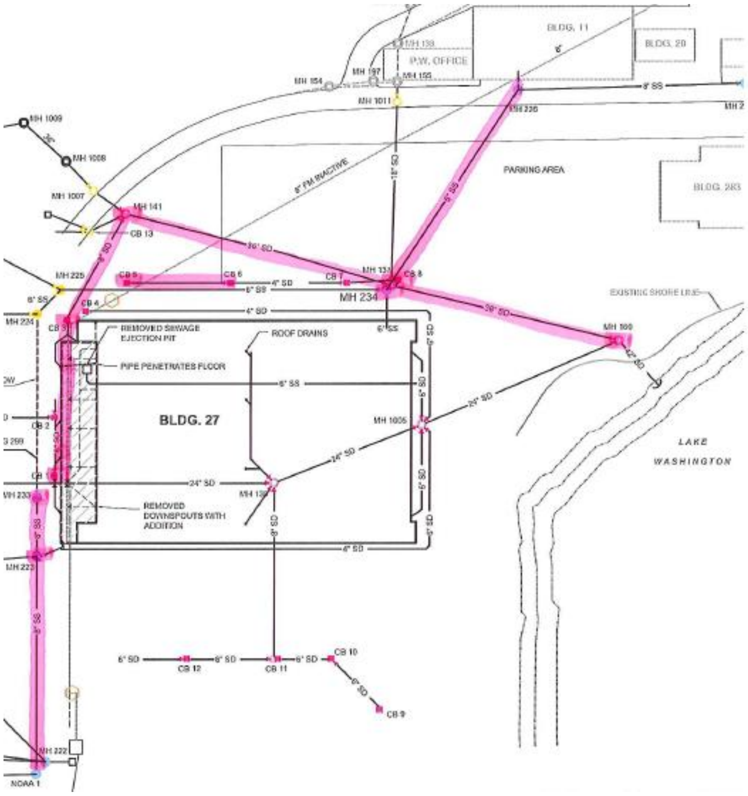


Figure 2. Contaminated Sanitary Sewer and Storm Drain Lines

To model the soil contamination associated with the above-background sanitary sewer and storm sewer lines (Figure 3), it was assumed that a 24-inch diameter 1, 460 foot long drain line containing contaminated sludge has leaked and contaminated the soil out to a distance of 12 inches in each direction. This contamination is buried under 12 inches of clean soil. These assumptions provide a source term of 662 cubic meters of contaminated soil in a 4 foot wide by 4 foot deep by 1, 460 foot long deposit for the Sand Point-specific model.

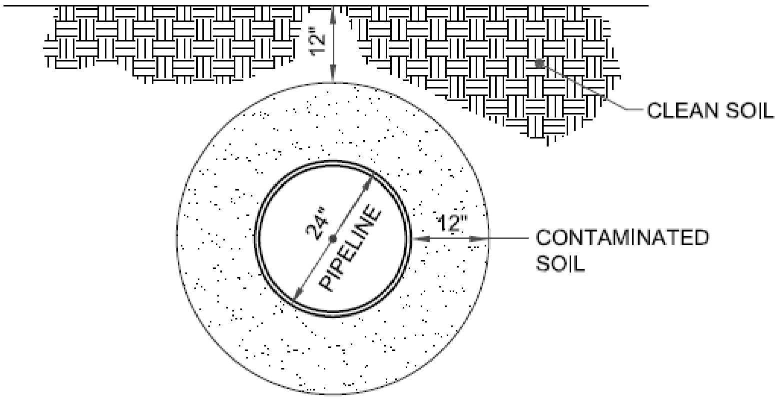


Figure 3. Soil Contamination Surrounding Sanitary Sewer or Storm Drain Line

Sand Point-specific RESRAD Modeling

Using the site-specific source term information identified above defines a 542.5 square meter contaminated soil mass that is 1.22 meters thick and is under 0.3048 meter clean soil cover. By specifying a contamination level of 1 pCi/g of Ra-226 uniformly distributed in the contaminated soil mass, the resulting dose rate to the resident farmer is 4.2 mrem per year at 30 years. Adjusting for a maximum annual dose of 15 mrem, this results in a sludge concentration guideline of 3.6 pCi/g for Ra-226. Including outdoor radon with the Sand Point-specific parameters slightly increases the dose rate to the resident farmer of 4.4 mrem per year after 30 years. Again adjusting for a maximum annual exposure of 15 mrem, this results in a sludge concentration guideline of 3.4 pCi/g Ra-226, resulting in a dose of 15 mrem per year.

Summary

The default RESRAD parameters for the resident framer exposure scenario produce expected dose rate results (exposure) for 1 pCi/g Ra-226 above background (Table 2). The inclusion of outdoor radon produces a slightly higher dose rate. Sand Point-specific parameters (18x less contaminated area under 12 inches of cover) results in a predictably lower dose rate. Adding outdoor radon increases the dose slightly and results in a DCGL (sludge concentration guideline) of 3.4 pCi/g Ra-226 for the sludge left in the sanitary sewer and storm drain lines. This value is recommended as the sludge contamination guideline (above background) for unconditional release that meets the 15 mrem per year dose limit.

Table 2. Sand Point-specific Dose Rates and Sludge Concentration Guidelines

	Default RESRAD Parameters		**Sand Point-specific Parameters**	
1 pCi/g Ra-226	**mrem/yr**[1]	**pC/g**[2]	**mrem/yr**[1]	**pC/g**[2]
without radon	14.3	1.1	4.2	3.6
with outdoor radon	18.2	0.82	4.4	3.4

[1] Dose rate to resident farmer at 30 years

[2] Sludge concentration resulting in 15 mrem/yr

Using the Sludge Concentration Guideline identified in Table 2 and the mean sludge background (Shaw, 2011), the project cleanup criteria for Ra-226 in sludge is 3.85 pCi/g (Table 3).

Table 3. Sand Point-specific Sludge Cleanup Criteria

		Mean background	**Dose-based soil guideline**	**Cleanup Criteria**
Sludge	**Ra-226**	0.453 pCi/g	3.4 pCi/g	3.85 pCi/g

References

MARSSIM, *Multi-Agency Radiation Survey and Site Investigation Manual,* NUREG-1575, Revision 1, Washington, DC, August 2000.

RESRAD 6.5*, Users Manual for RESRAD Version 6,* ANL/EAD-4, Environmental Assessment Division, Argonne National Laboratory, July 2001.

10 CFR 20, Title 10, Code of Federal Regulations, *Part 20 – Standards for Protection Against Radiation*, Nuclear Regulatory Commission, January 2010.

EPA Letter, Memorandum from Stephen D. Luftig to Addressees, *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, OSWER No. 9200.4-18, August 22, 1997.

Shaw, 2011, Draft, *Background Sludge Concentration Determination*, TCRA Former NAVSTA-PS, Shaw Environmental & Infrastructure, Inc., February 2, 2011.

Attachment 6
Dose-Based Soil Concentration Derivation

Introduction

Aviation instrument shops were located in the South Shed of Building 27 and in Building 2 at the former Naval Station Puget Sound. Historical documentation indicates that radium-226 (Ra-226) was used within the building. Recent radiological surveys confirm the presence of radium within the buildings and in some soil areas immediately outside of these facilities. Sinks located in both buildings were presumably used for clean-up and possibly disposal of radium-containing materials. Drain lines from these sinks were removed and sampled for radionuclides. Radium-226 and strontium-90 (Sr-90) were detected in these samples. Strontium-90 has also been used by the Navy in self-luminescent devices.

Disposal may have been performed outside these buildings as evidenced by soil contamination detected by surveys performed in these areas. Soil analysis has identified Ra-226 contamination in excess of background but has not identified Sr-90 at locations other than the pipes. Remediation of contaminated soil depends in part upon the risk to the public that could potentially inhabit or use this area in the future.

To evaluate the risk to the public, dose-based (risk-based) soil concentration guidelines have been developed to use as release criteria for these radiologically contaminated properties. MARSSIM refers to this as a Derived Concentration Guideline Level (DCGL). These radionuclide-specific values are derived through activity/dose relationships, considering an exposure pathway scenario. These soil concentration guidelines are concentrations above background, consistent with the dose limit discussed below.

Several exposure pathway scenarios were evaluated. These scenarios address future use of the site, such as industrial, recreational and residential use. The Residual Radioactivity (RESRAD) model and computer code (RESRAD 6.5) was used to derive soil concentrations that will result in an annual dose consistent with that set forth in federal and state regulations.

Dose Limit

The U.S. Nuclear Regulatory Commission specifies a dose limit as follows:

> *A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a 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 the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).* 10 CFR 20.1402

TEDE is the acronym for "Total Effective Dose Equivalent," the sum of the dose from external exposure and the 50-year dose resulting from internal deposition of radionuclides. The State of Washington regulations reiterate these dose limits in WAC 246-246-020.

In promulgating CERCLA regulations, the USEPA has specified a dose limit of 15 mrem per year for use on those sites (USEPA Letter). To take a more conservative approach, the dose limit of 15 mrem per year has been adopted for use in this soil concentration guidelines development effort. By using conservative assumptions for the dose limit, the source term, and the exposure pathway scenario, the results are conservative soil concentration guidelines that are protective of the public at the 15 mrem per year dose limit exclusive of background sources of radiation.

Exposure Scenario

RESRAD was specifically developed to assist in evaluating cleanup criteria and is commonly used to perform this analysis (RESRAD 6.5, Section 1). RESRAD models radiation exposure to individuals living, working, or recreating in the area that contains residual radioactive contamination in excess of background. It is possible that members of the public visiting the site may come in contact with contaminated soil. To model this contamination, it is conservatively assumed that the soil areas identified as contaminated above background are exposed for potential contact by individuals at the site. This contaminated soil is assumed to be available for dispersion and exposure as modeled by RESRAD.

The RESRAD manual identifies four exposure scenarios:

- Resident Farmer scenario
- Suburban Resident scenario
- Industrial Worker scenario
- Recreationist scenario.

The City of Seattle is currently operating the site as Warren G. Magnuson Park. This urban park is available to the public for sports, recreation, and leisure. No residential use currently exists or is planned. Thus, the RESRAD recreationist scenario may be most appropriate to describe future public use of this area.

A more conservative exposure scenario for the future is the Resident Farmer which assumes a family moves onto the site after it has been released, builds a home, and raises crops and livestock for family consumption. Although this scenario seems unlikely in the foreseeable future, in tens or hundreds of years, the sociopolitical nature of the area may change to the point that this scenario becomes possible. By considering this possibility now, the soil contamination will be left at a level that will not result in these individuals exceeding the selected dose limit. The conservative exposure scenario is consistent with the As Low As Reasonably Achievable (ALARA) requirement.

The exposure pathways considered in this scenario include (see Figure 1):

- Direct radiation from radionuclides in the soil
- Inhalation of resuspended dust (if the contaminated area is exposed at the ground surface)
- Inhalation of radon and its decay products
- Ingestion of food from crops grown in the contaminated soil
- Ingestion of milk from livestock raised in the contaminated area
- Ingestion of meat from livestock raised in the contaminated area

- Ingestion of fish from a nearby pond contaminate by water percolating through the contaminated zone
- Ingestion of water from a well or pond contaminated by water percolating through the contaminated zone.
- Ingestion of contaminated soil.

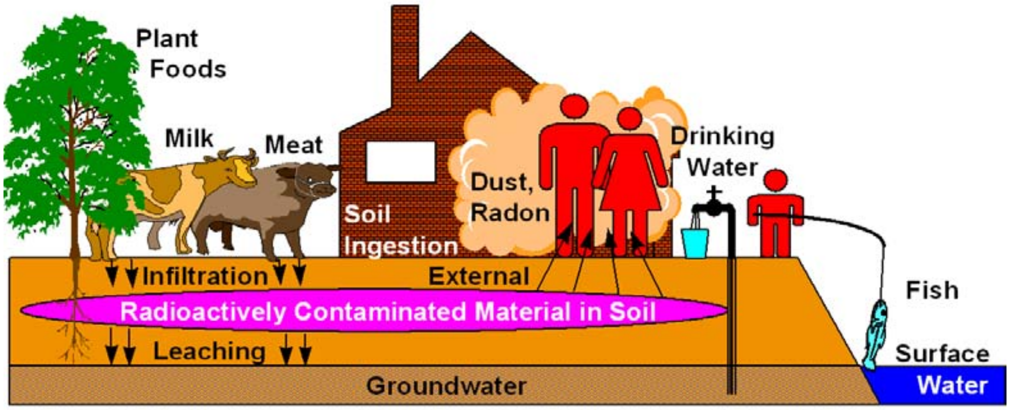


Figure 1. RESRAD Exposure Pathways

RESRAD Analysis

RESRAD contains at least 183 documented parameters that can be changed to model the specific site. Determining site-specific values for each of these parameters is a multi person-year effort. Fortunately RESRAD was published with default values that were carefully selected to be conservatively realistic. The bases for these values are documented in the RESRAD documentation. It is typical to use these default values and to change only those values appropriate to describe the parameters that are well understood at the site. If the analysis must be further refined, a sensitivity analysis can be performed to identify those parameters that can be refined with the collection of additional information.

RESRAD Default Parameters

The RESRAD 6.5 code “out of the box” contains parameters defining a 10,000 square meter contaminated soil mass that is 2 meters thick and has no material cover (clean soil). These results are shown in Table 1.

Table 1. RESRAD Default Parameters

	Resident Farmer Scenario	**Soil Concentration Guideline**
Radionuclide	**1 pCi/g**	**15 mrem/yr**
Ra-226	14.3 mrem/yr	1.05 pCi/g
Ra-226 + outdoor radon	18.2 mrem/yr	0.825 pCi/g
Sr-90	4.98 mrem/yr	3.01 pCi/g

By default, the radon exposure pathway is suppressed in the model. When this pathway is activated, it models both outdoor and indoor radon exposure. The residence is assumed to be built on the contaminated soil mass. Thus, radon will seep through the floor slab and accumulate in the house. Inhalation of radon results in significant exposure to individuals and has been the focus of USEPA efforts to monitor and reduce elevated radon levels in residences. For this analysis, radon mitigation efforts are assumed to be effective and indoor radon exposure removed from the modeling by modifying the indoor occupancy factor to zero and the onsite outdoor occupancy factor to 100%. With these changes, the remaining default RESRAD parameters result in a dose rate and soil concentration guideline shown in Table 1.

Sand Point-specific Parameters

RESRAD modeling has been refined to define a Sand Point-specific source term consistent with the soil contamination found in areas around Buildings 2 and 27.

Soil Source Term

Soil contamination hotspots have been identified by gamma walkover surveys. These hotspots and nearby locations were sampled by hand auguring. Soil samples were field screened and sent for radioanalytical analysis (Shaw, 2010).

The previously determined background concentrations of Ra-226/Sr-90, 0.855 pCi/0.398 pCi, were used to identify soil locations above background. These background concentrations of Ra-226/Sr-90 correspond to the statistical mean plus three standard deviations, derived from the background soil sampling results (Shaw, 2011). Review of the soil samples taken from the down-gradient (impacted) locations identify areas of soil contamination shown in the attached maps (Attachment 1). These maps estimate a total soil contamination area of approximately 1,036 square meters. Review of the depth data indicates that at the hotspot locations, contamination depth varies from one to four feet. One meter depth provides a reasonable approximation for the contaminated soil.

Sand Point-specific RESRAD Modeling

Using the site-specific source term information identified above defines a 1,036 square meter contaminated soil mass that is 1 meter thick with no clean soil cover. By specifying a contamination level of 1 pCi/g of radionuclide uniformly distributed in the contaminated soil mass, the resulting dose rate to the resident farmer is determined. Adjusting for a maximum annual dose of 15 mrem results in a soil concentration guideline. These results are presented in Table 2. Including outdoor radon with the Sand Point-specific parameters slightly increases the dose rate to the resident farmer. Again, adjusting for a maximum annual exposure of 15 mrem, a soil concentration guideline is determined for each radionuclide that would result in a dose of 15 mrem per year.

Table 2. Sand Point-specific Parameters

Radionuclide	Resident Farmer Scenario 1 pCi/g	Soil Concentration Guideline 15 mrem/yr
Ra-226	12.7 mrem/yr	1.18 pCi/g
Ra-226 + outdoor radon	16.1 mrem/yr	0.930 pCi/g
Sr-90	4.05 mrem/yr	3.70 pCi/g

In the case where soil is contaminated with both radionuclides, determination if the soil exceeds the limit is determined using the unity rule (MARSSIM, Section 8.4.5), which is met when the sum of each measurement divided by its limit is less than one:

$$\frac{Conc_{Ra-226}}{DCGL_{Ra-226}} + \frac{Conc_{Sr-90}}{DCGL_{Sr-90}} \leq 1.$$

Summary

The default RESRAD parameters for the resident farmer exposure scenario produce expected dose rate results (exposure) for 1 pCi/g Ra-226 above background and 1 pCi/g Sr-90 (Table 1). The inclusion of outdoor radon produces a slightly higher dose rate from the radium contamination. Sand Point-specific soil contamination parameters results in a predictably lower dose rate (Table 2). Adding outdoor radon increases the dose slightly and results in DCGLs (soil concentration guidelines) of 0.93 pCi/g Ra-226 and 3.7 pCi/g Sr-90 for the soil left onsite. These values (summarized in Table 3) are recommended as the soil contamination guidelines (above background) for unconditional release that meets the 15 mrem per year dose limit.

Table 3. Sand Point-specific Soil Concentration Guidelines

Radionuclide	Sand Point Soil DCGLs[1]
Ra-226	**0.93 pCi/g**
Sr-90	**3.7 pCi/g**

1. Based on 15 mrem/yr to resident farmer

Using the Soil Concentration Guideline identified in Table 3 and the mean soil background (Shaw, 2011), the project cleanup criteria for Ra-226 and Sr-90 in soil are shown in Table 4.

Table 4. Sand Point-specific Soil Cleanup Criteria

		Mean background	Dose-based soil guideline	Cleanup Criteria
Soil	**Ra-226**	0.467 pCi/g	0.93 pCi/g	1.40 pCi/g
	Sr-90	0.055 pCi/g	3.7 pCi/g	3.80 pCi/g

References

MARSSIM, *Multi-Agency Radiation Survey and Site Investigation Manual,* NUREG-1575, Revision 1, Washington, DC, August 2000.

RESRAD 6.5, *Users Manual for RESRAD Version 6*, ANL/EAD-4, Environmental Assessment Division, Argonne National Laboratory, July 2001.

10 CFR 20, Title 10, Code of Federal Regulations, *Part 20 – Standards for Protection Against Radiation*, Nuclear Regulatory Commission, January 2010.

EPA Letter, Memorandum from Stephen D. Luftig to Addressees, *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, OSWER No. 9200.4-18, August 22, 1997.

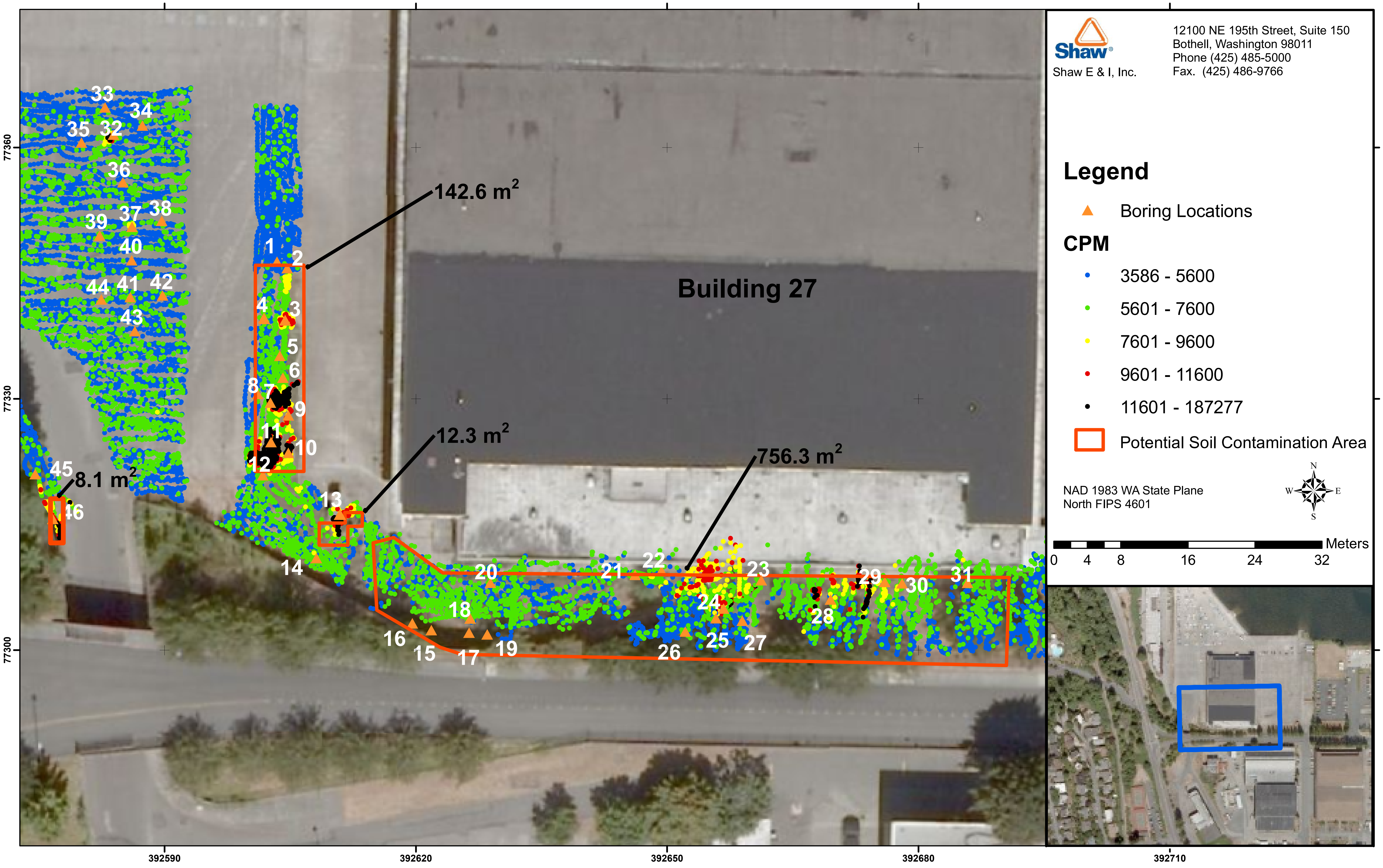
Shaw, 2010, *Final Soil Characterization Sampling Plan for Time Critical Removal Action, Former Naval Station Puget Sound, Seattle Washington*, Shaw Environmental & Infrastructure, Inc., November 2010.

Shaw 2011, *Background Soil Concentration Determination,* Shaw Environmental & Infrastructure, Inc., February 2.

Attachments

1. Soil Contamination Area Estimates

Attachment 1


Shaw®
Shaw E & I, Inc.
12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766
Legend
▲ Boring Locations
CPM
● 3586 - 5600
● 5601 - 7600
● 7601 - 9600
● 9601 - 11600
● 11601 - 187277
☐ Potential Soil Contamination Area
NAD 1983 WA State Plane
North FIPS 4601
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E
S
W
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16
24
32
Meters
Building 27
142.6 m²
12.3 m²
756.3 m²
8.1 m²
1
2
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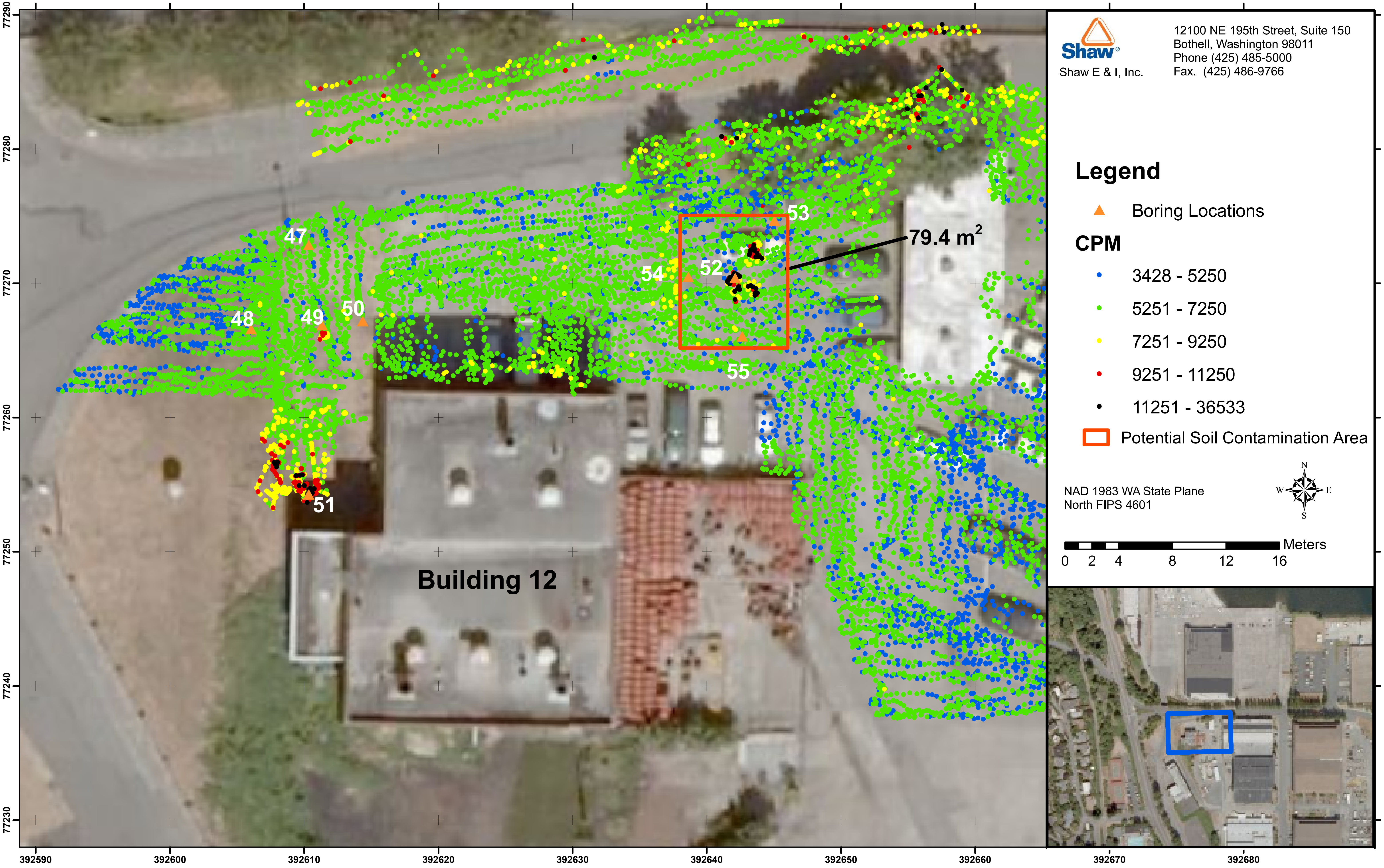
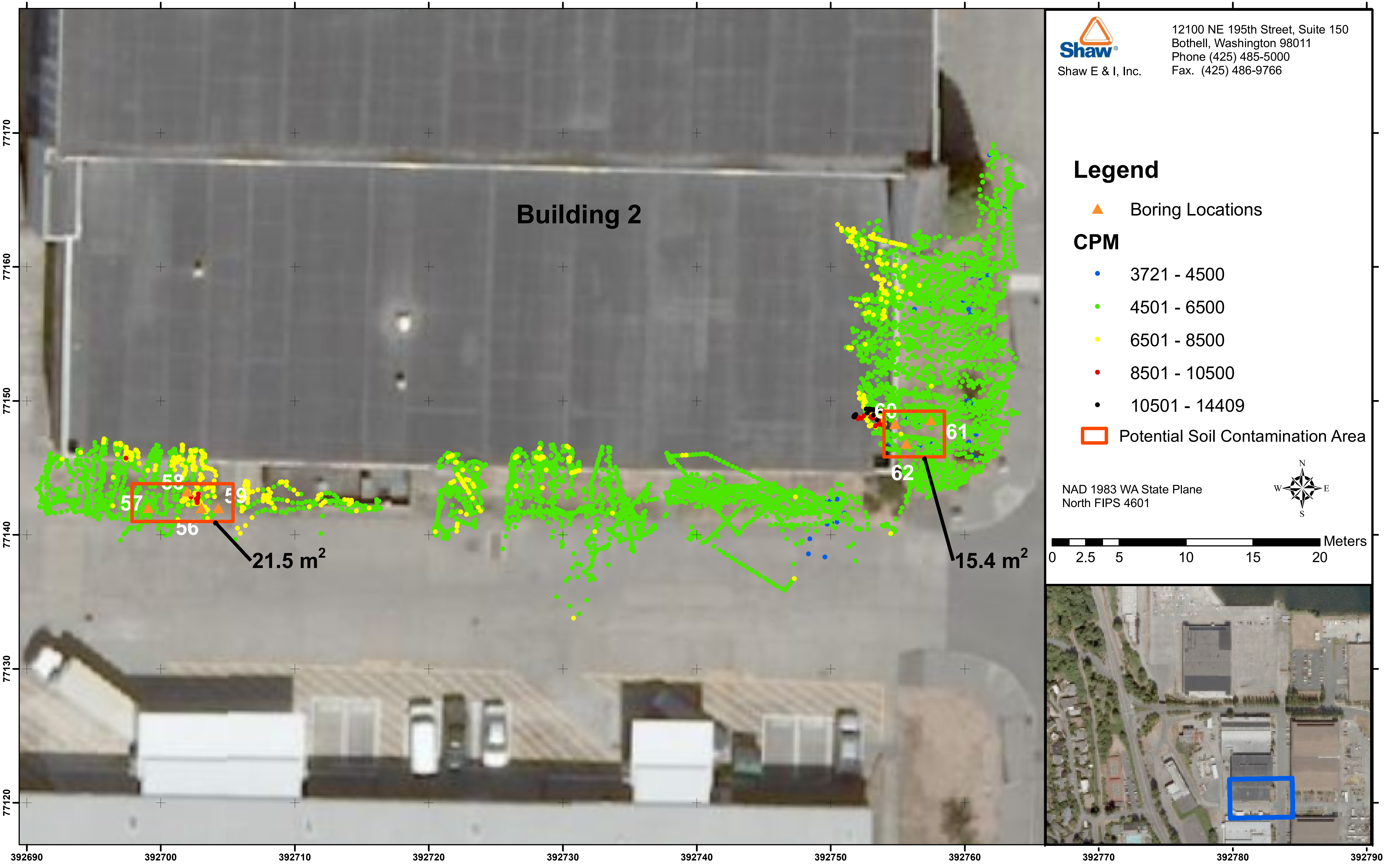
Time Critical Removal Action   Naval Station Puget Sound




Building 2
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58
59
56
21.5 m^2
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15.4 m^2
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Legend
▲ Boring Locations
CPM
● 3721 - 4500
● 4501 - 6500
● 6501 - 8500
● 8501 - 10500
● 10501 - 14409
☐ Potential Soil Contamination Area
NAD 1983 WA State Plane
North FIPS 4601
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5
10
15
20
Meters
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77130
77120
392690
392700
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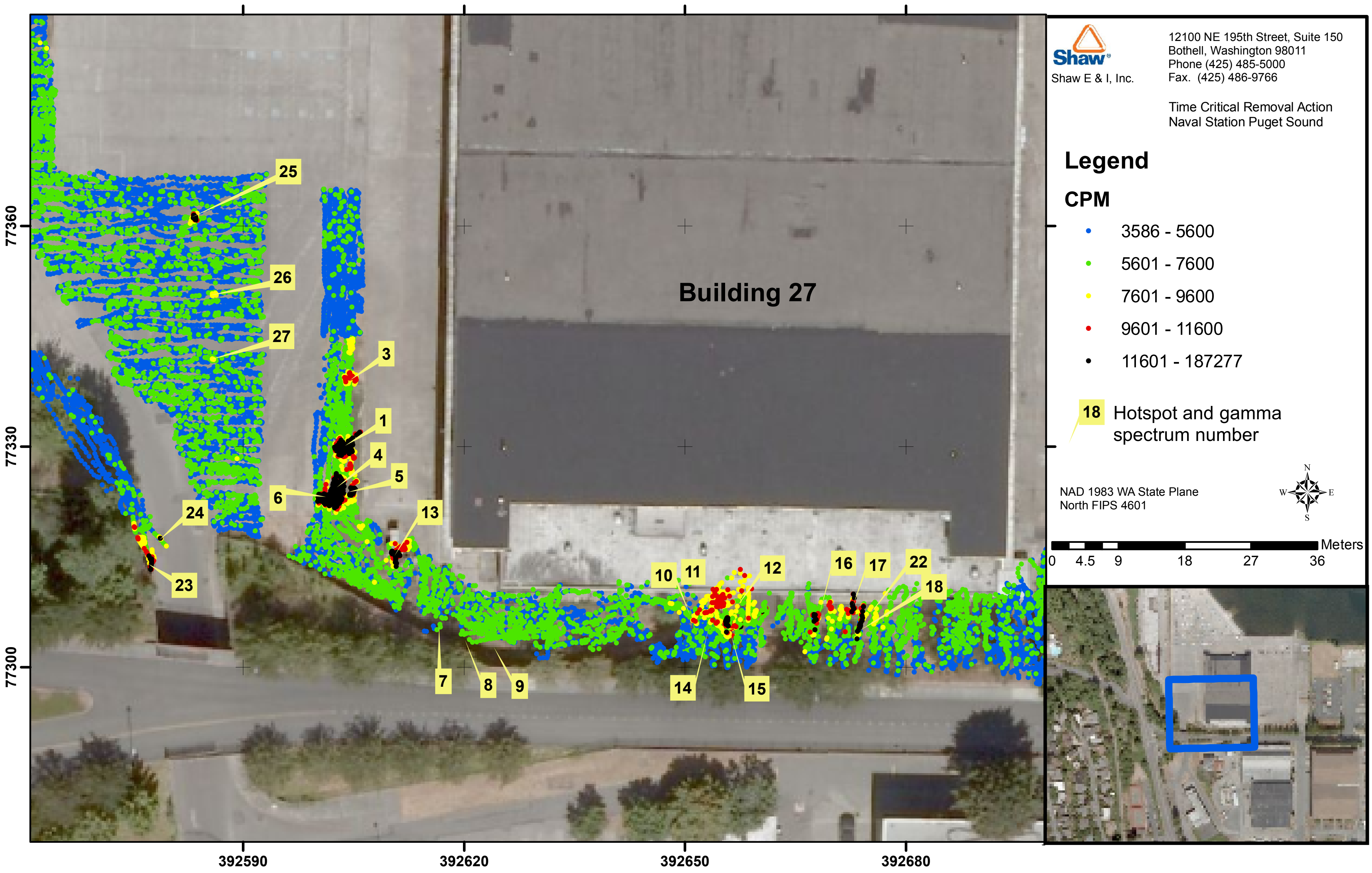
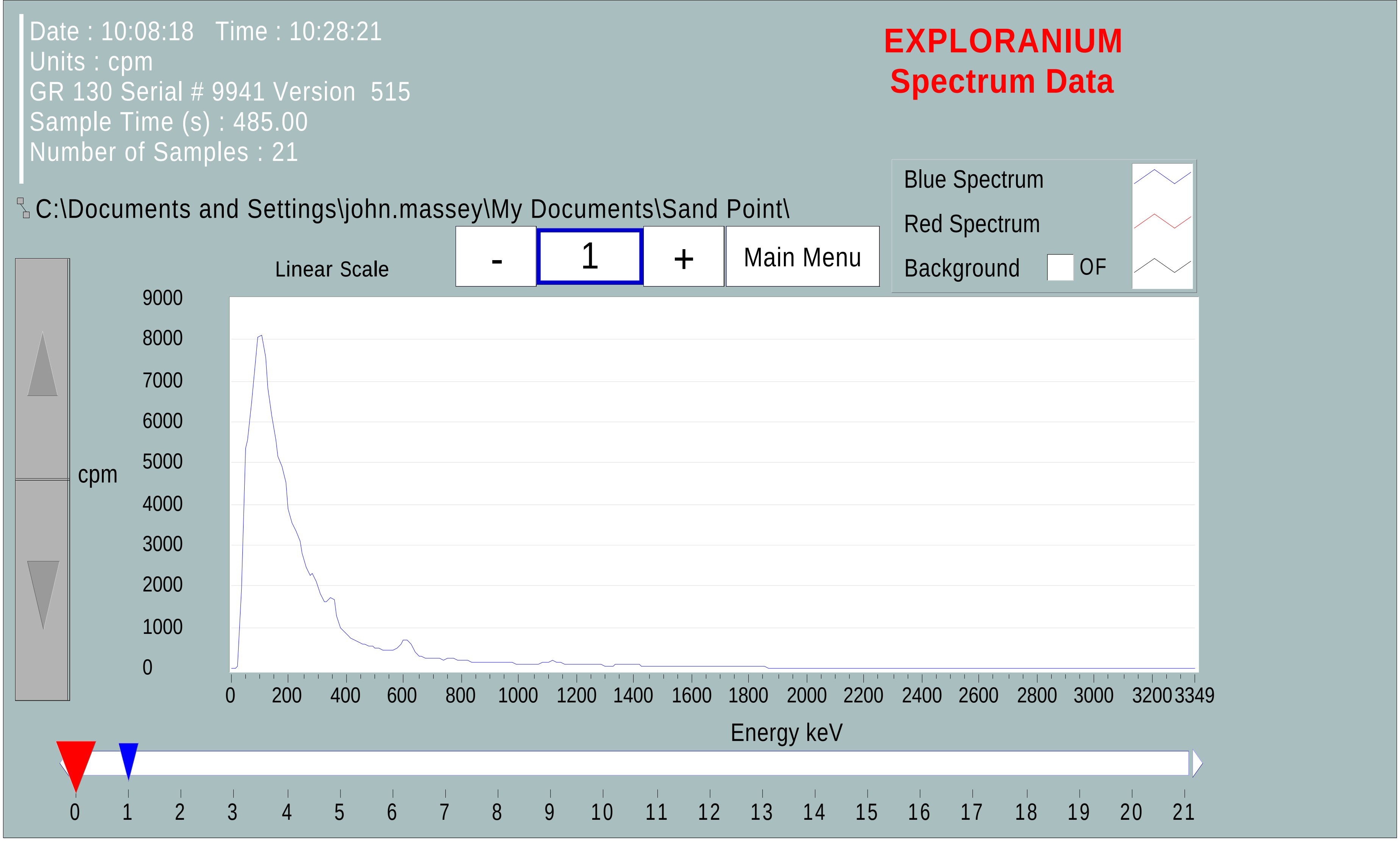
Attachment 7
Exploranium Spectrum Results

Exploranium Gamma Spectrometry Locations





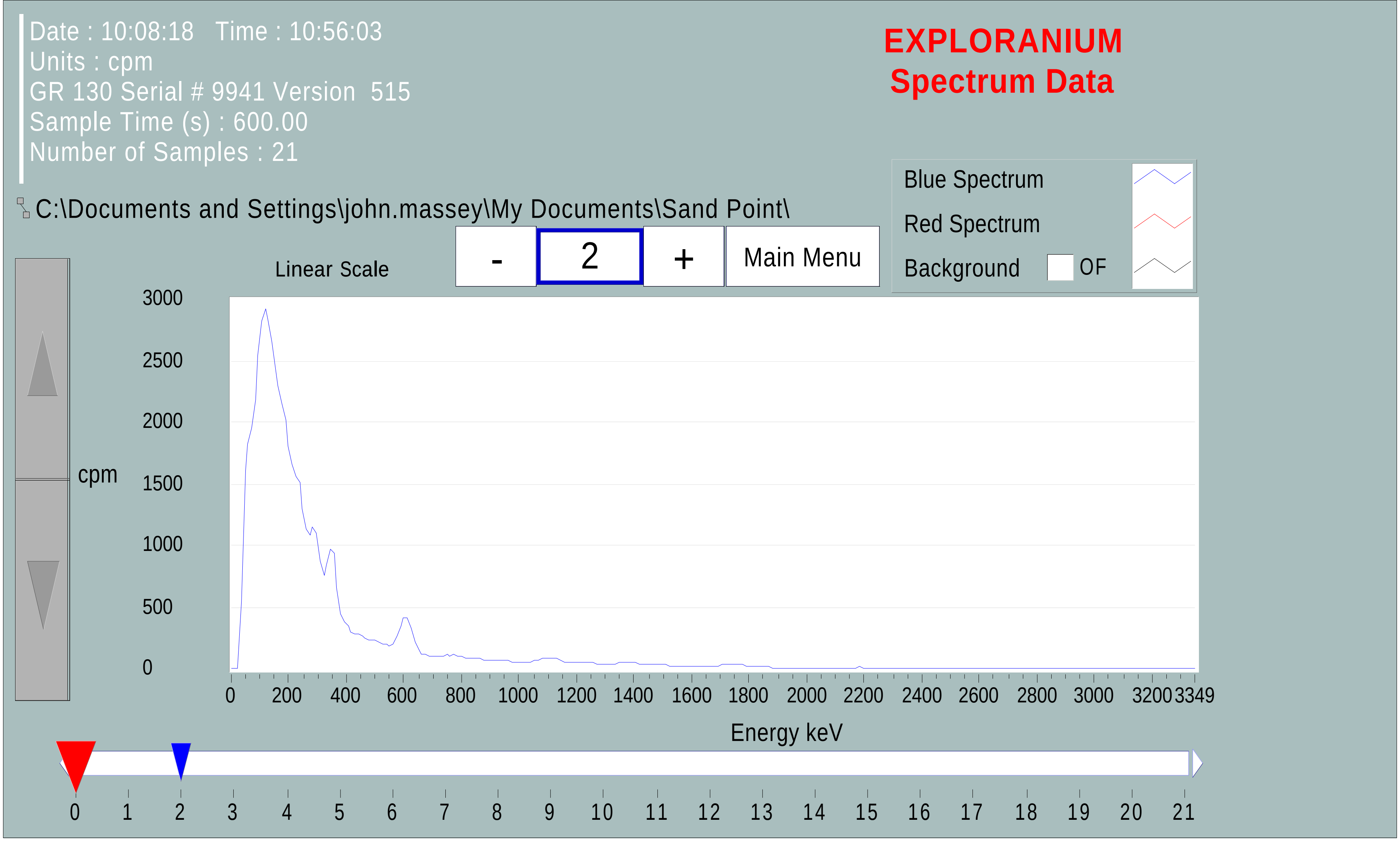
EXPLORANIUM
Spectrum Data

Date : 10:08:18   Time : 10:28:21
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 485.00
Number of Samples : 21

C:\Documents and Settings\john.massey\My Documents\Sand Point\

Building 27 Hotspot # 1.

Unidentified Peaks
all results in keV:
100
604
758
1113
1384
1749
2184



EXPLORANIUM
Spectrum Data

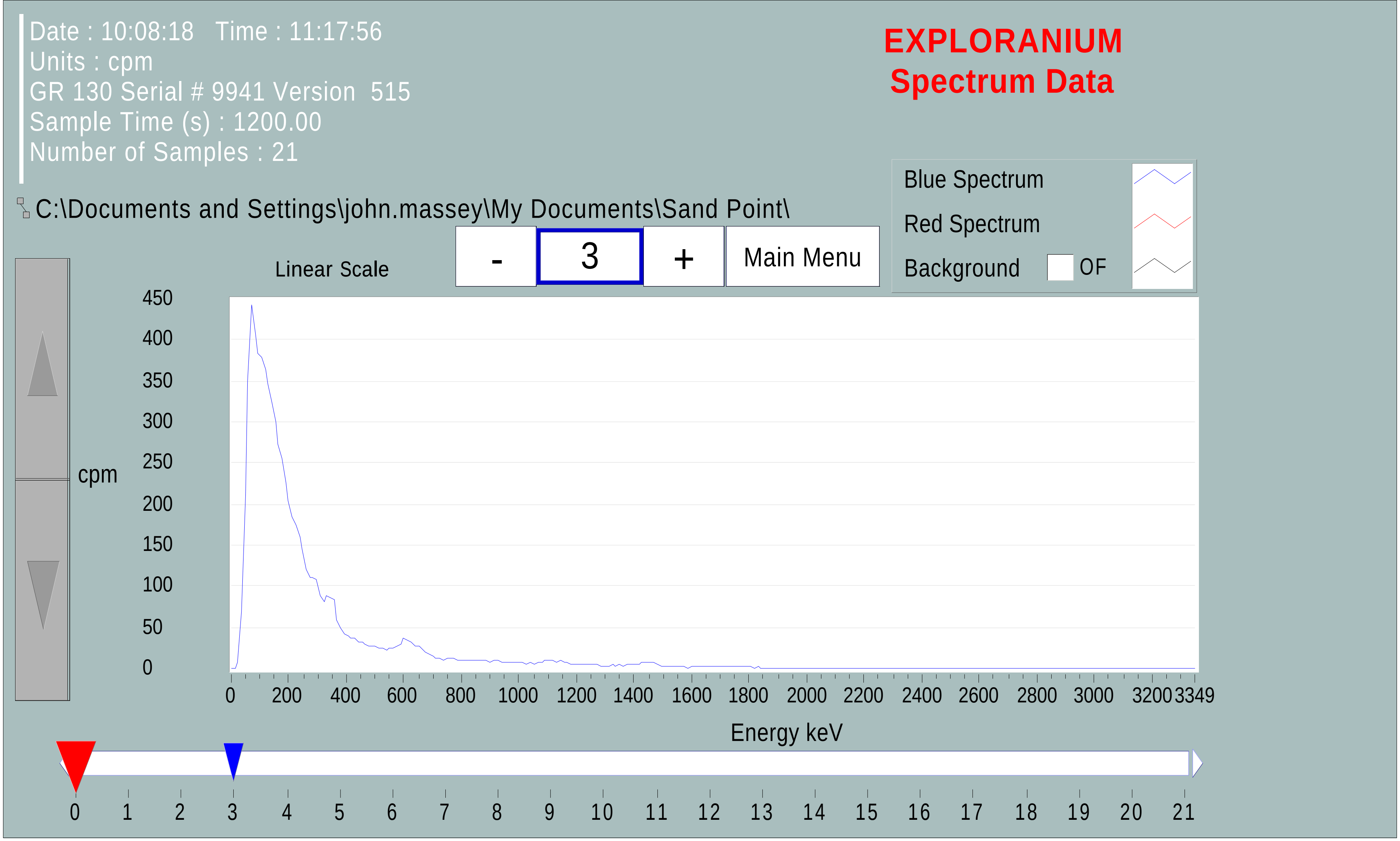
Date : 10:08:18 Time : 10:56:03
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 600.00
Number of Samples : 21

C:\Documents and Settings\john.massey\My Documents\Sand Point\

Blue Spectrum
Red Spectrum
Background ☐ OF

55 gal drum
of rad waste
containing
drain piping
cut out from
Building 27

Unidentified Peaks
all results in keV:
119
604
1109
1740
2176



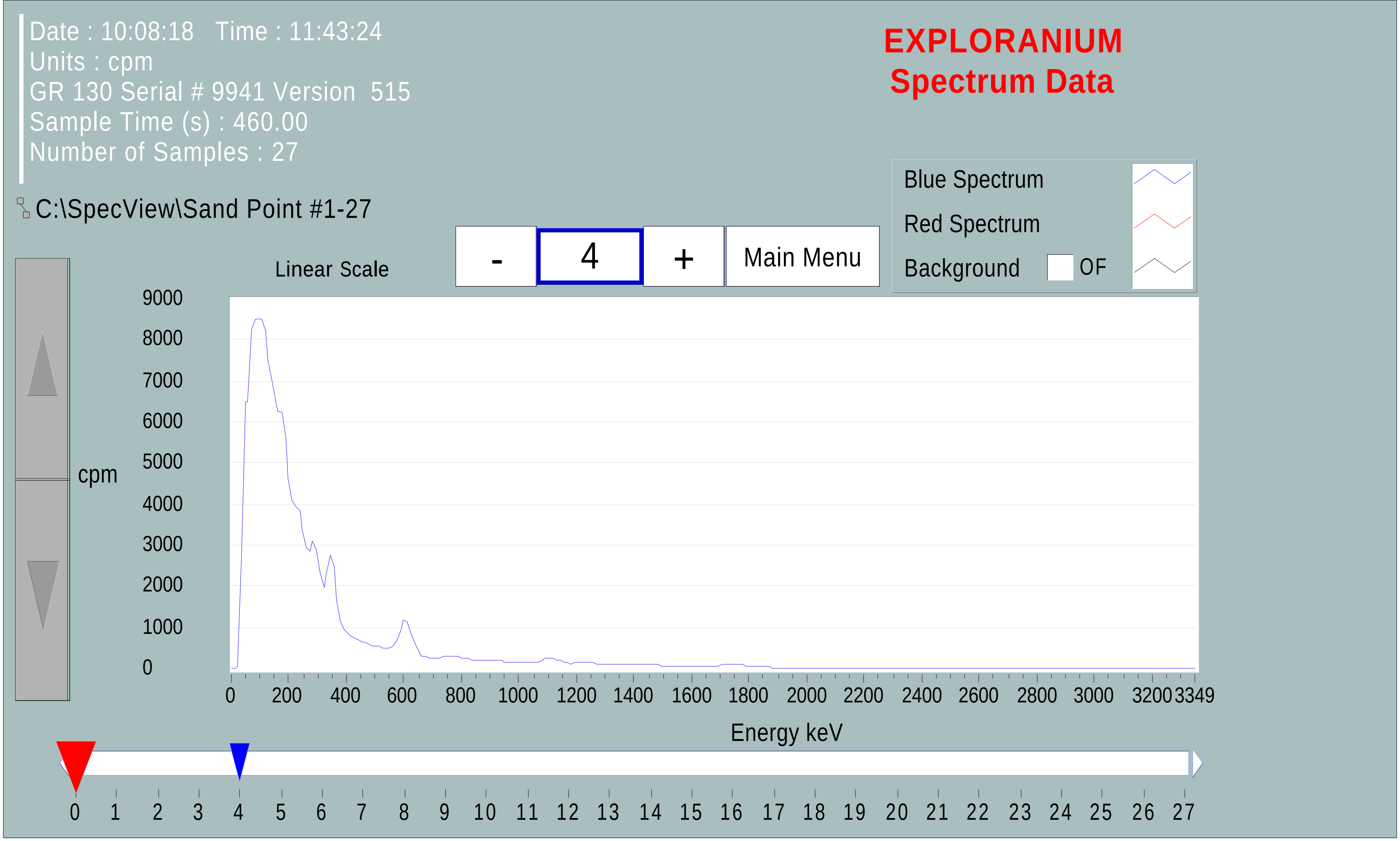
EXPLORANIUM Spectrum Data

Date : 10:08:18 Time : 11:17:56
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 21

C:\Documents and Settings\john.massey\My Documents\Sand Point\

Hotspot #3 located in soil west of Building 27 between Catch Basin # 5 and project field trailer.

Unidentified peaks (keV) at:
81
1,738



Date : 10:08:18   Time : 11:43:24

Units : cpm

GR 130 Serial # 9941 Version 515

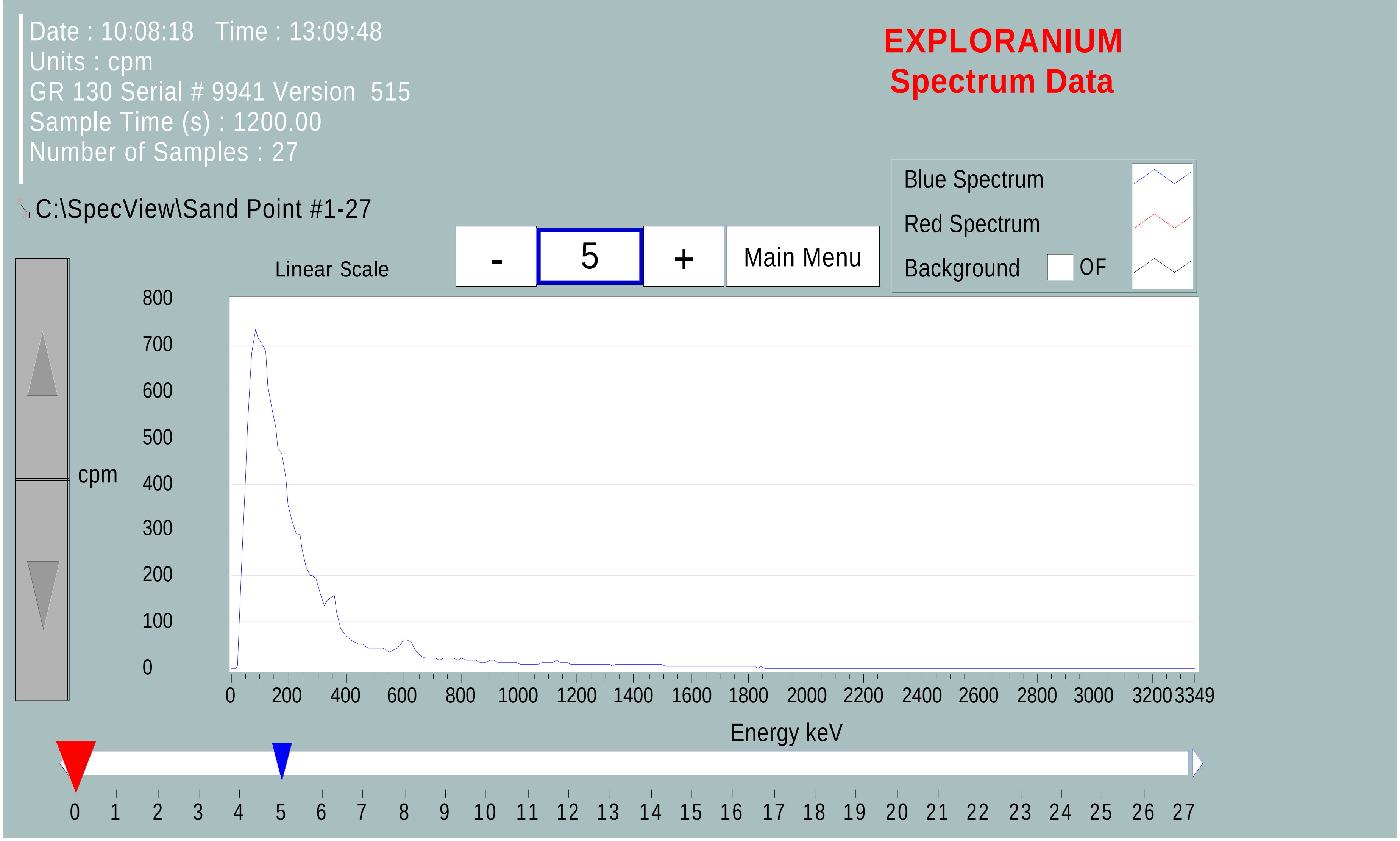
Sample Time (s) : 460.00

Number of Samples : 27

C:\SpecView\Sand Point #1-27

Hotspot #4, in soil area west of Building 27.

Unidentified peaks (keV) at:
92
603
760
1,110
1,220
1,373
1,741
2,171
2,417



Date : 10:08:18 Time : 13:09:48
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

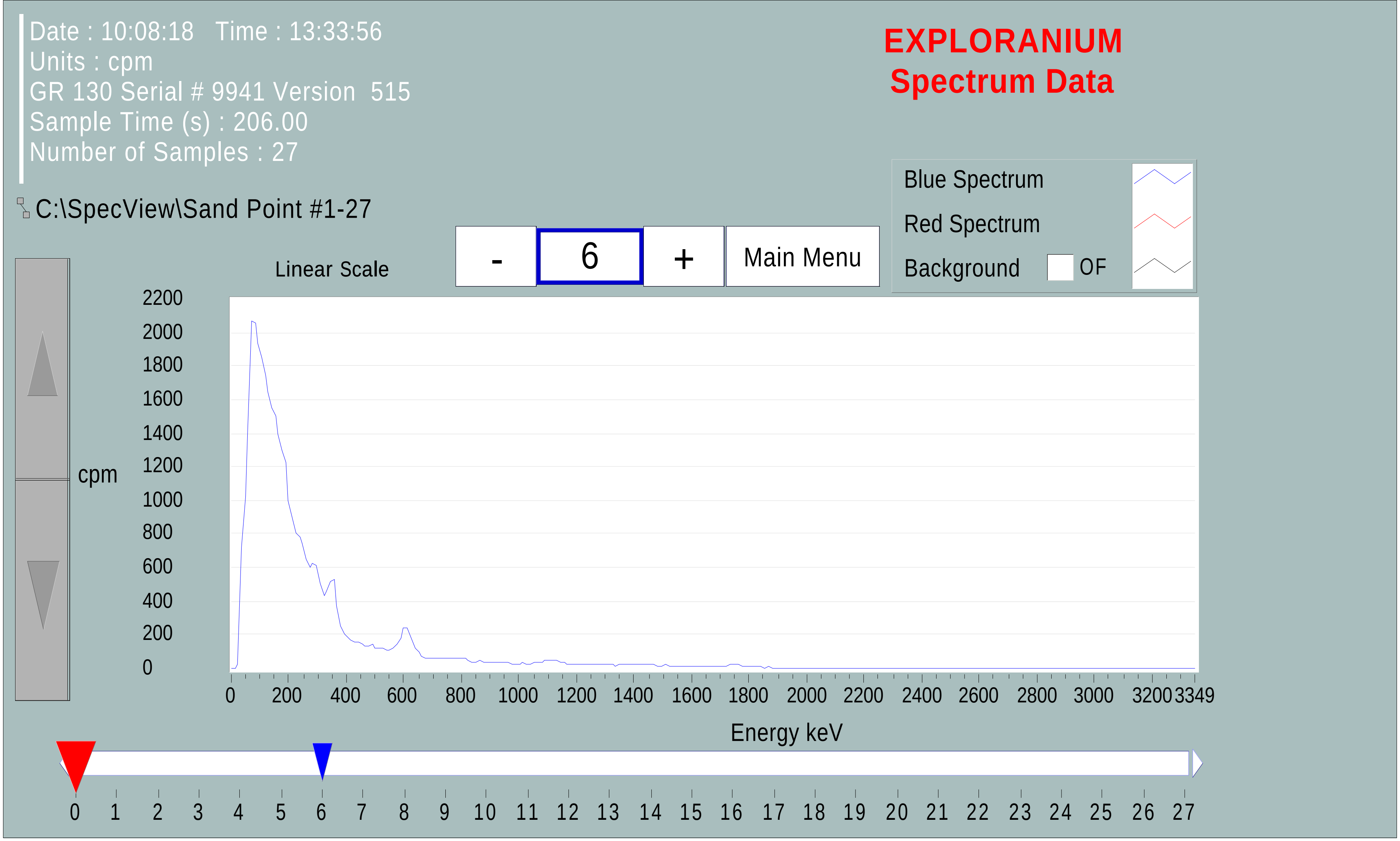
C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Background ☐ OF

Hotspot #5, in soil area west of Building 27.

Unidentified peaks (keV) at:
92
607
760
1,124
1,752

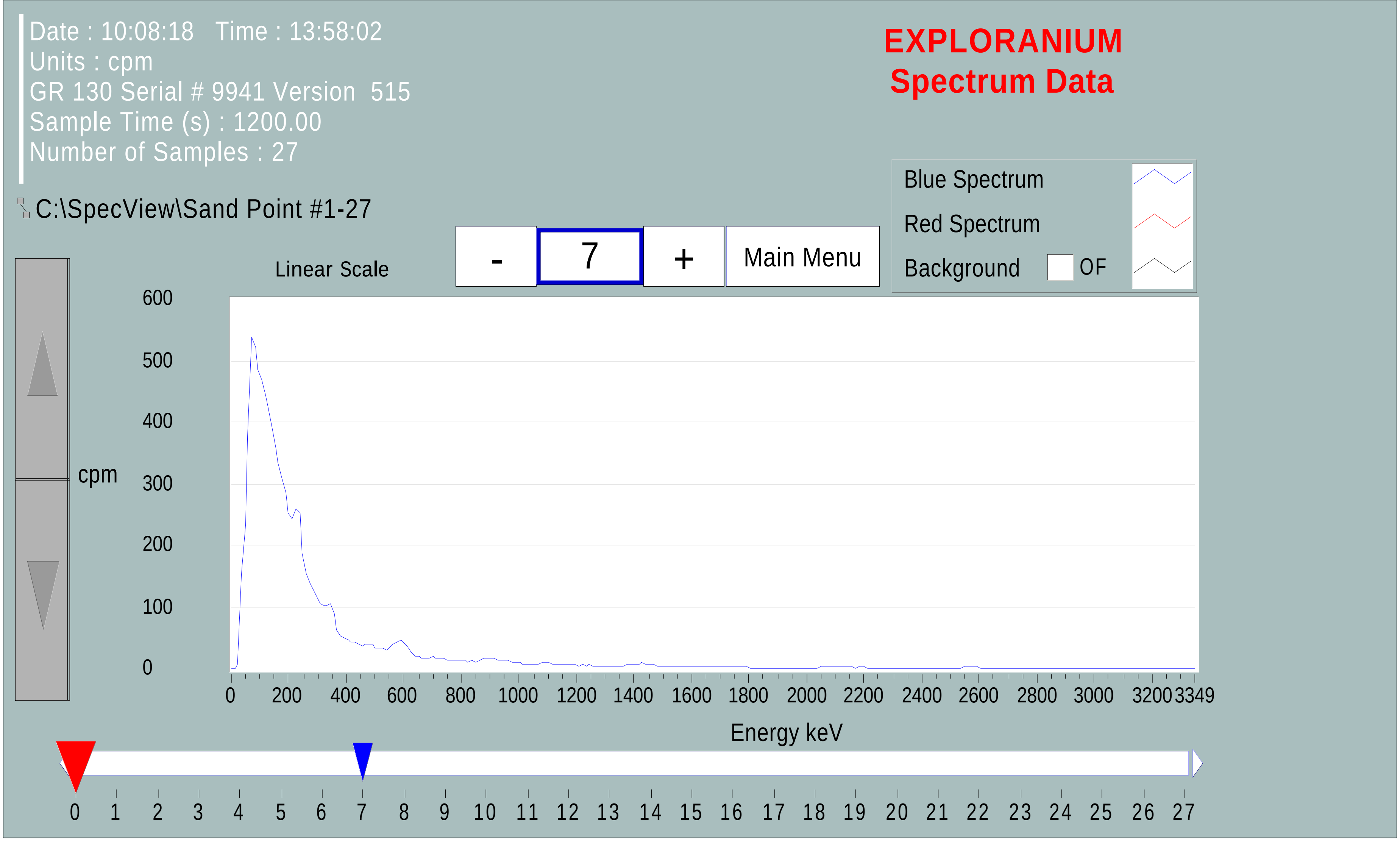


Date : 10:08:18   Time : 13:33:56
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 206.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Hotspot #6, in soil
area west of
Building 27.

Exploranium identified as:
Ra-226
Unidentified peaks (keV) at:
1,737



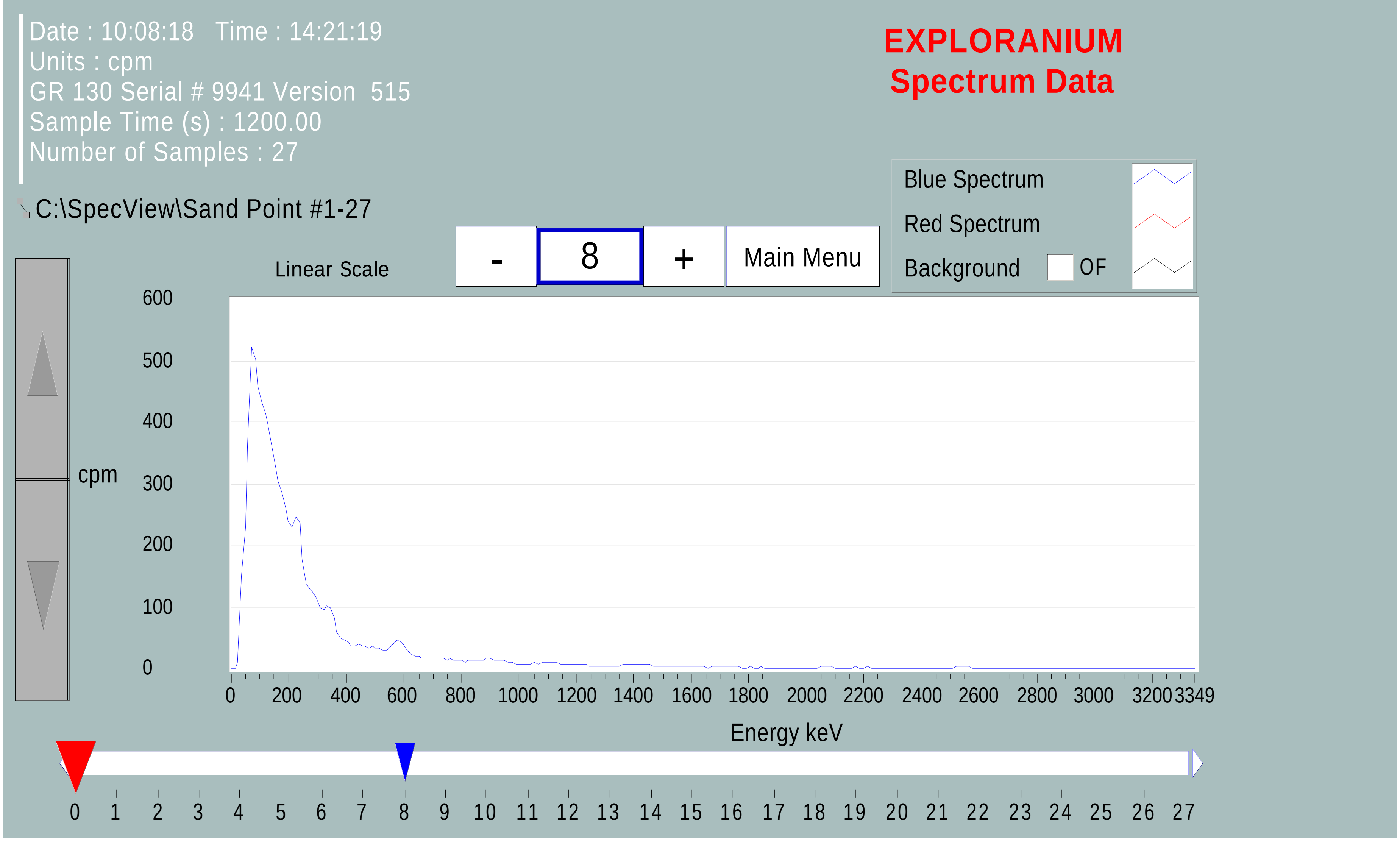
Date : 10:08:18 Time : 13:58:02
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Hotspot # 7, in soil area south of Building 27.

Exploranium identified as:
Th-232
K-40



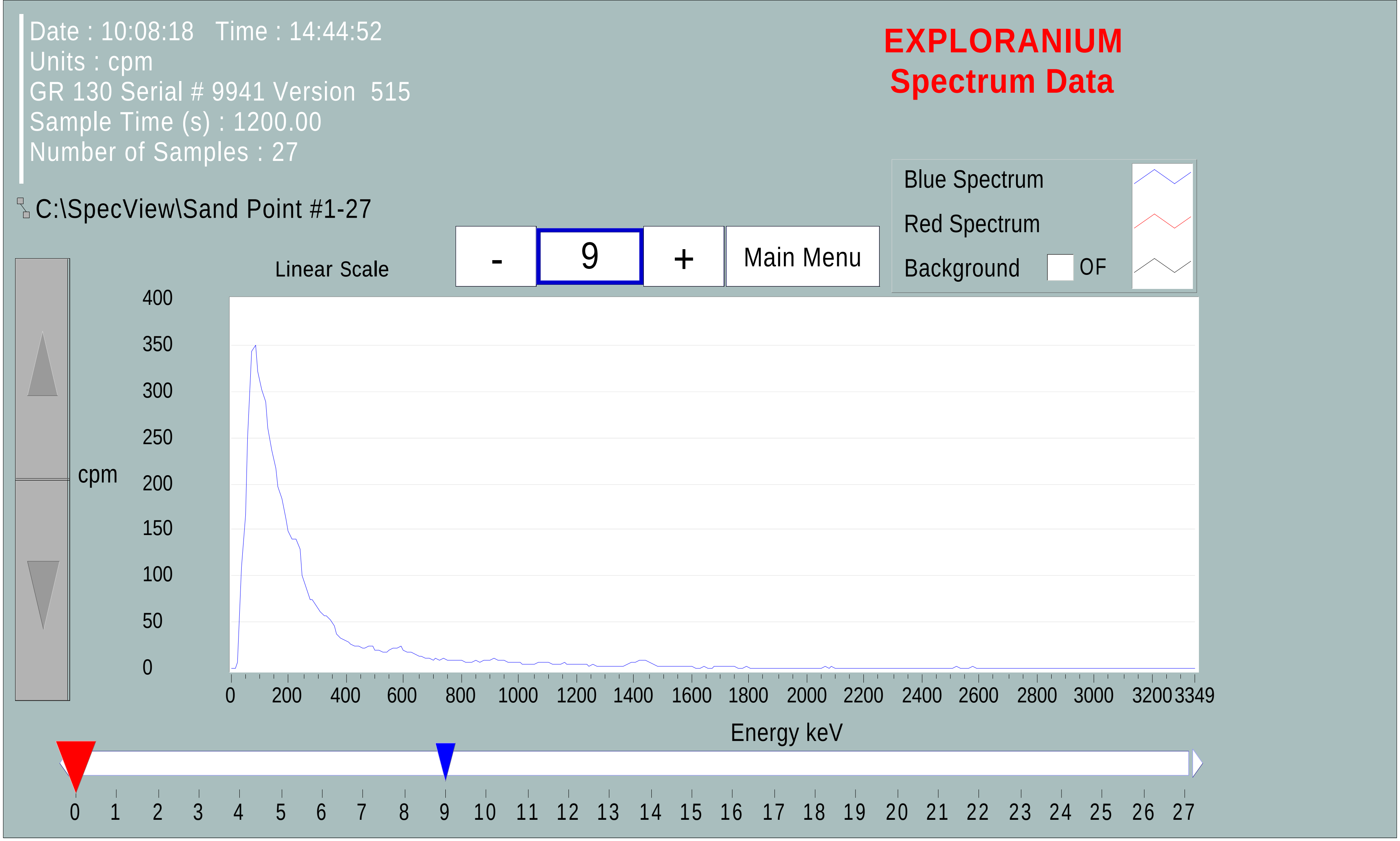
Date : 10:08:18 Time : 14:21:19
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

EXPLORANIUM
Spectrum Data

C:\SpecView\Sand Point #1-27

Hotspot # 8, in soil area south of Building 27.

Exploranium identified as:
Th-230
K-40
Unidentified peak (keV) at:
1,105

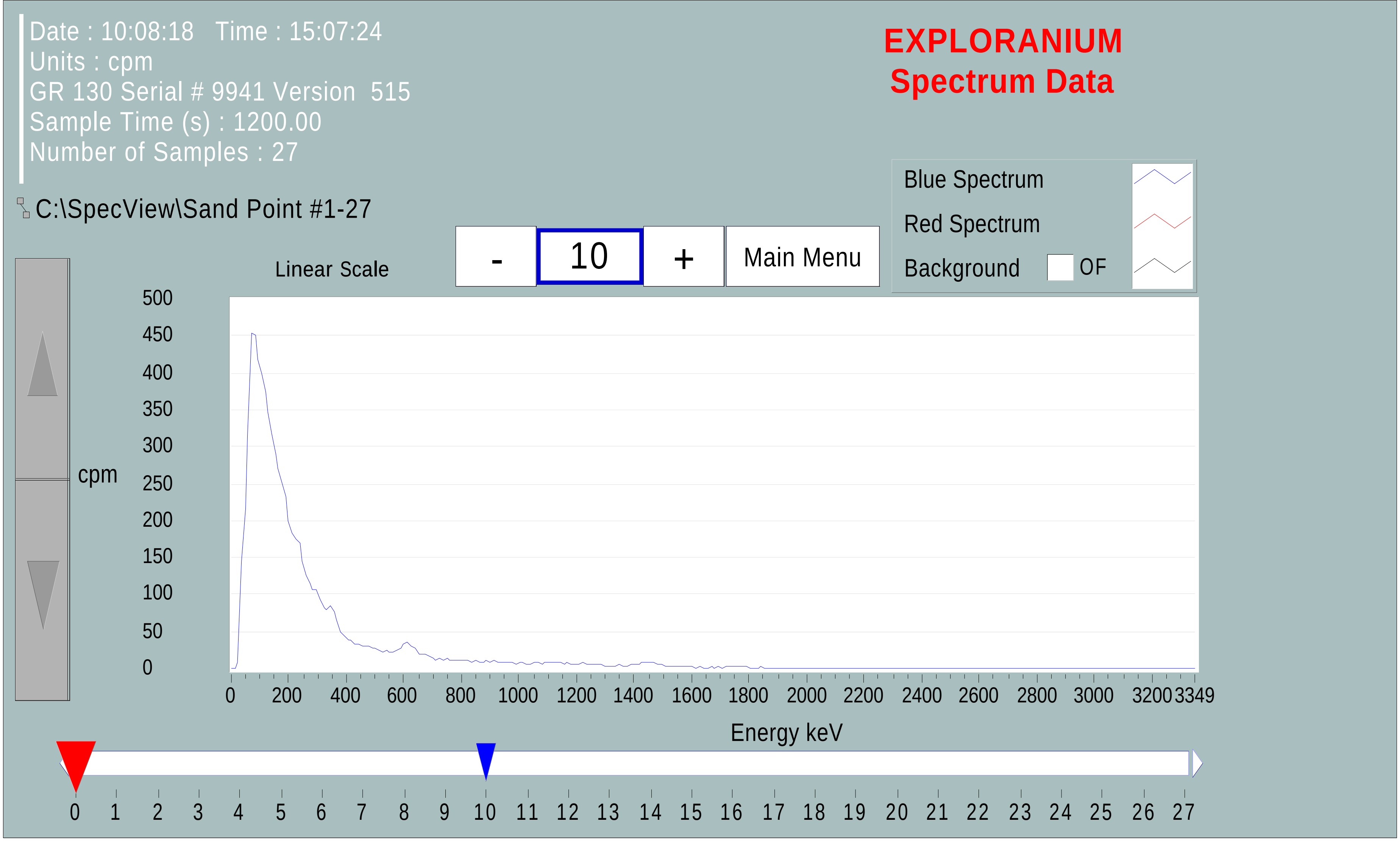


Date : 10:08:18   Time : 14:44:52
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Hotspot # 9, in soil
area south of
Building 27.

Exploranium identified as:
K-40
Th-232



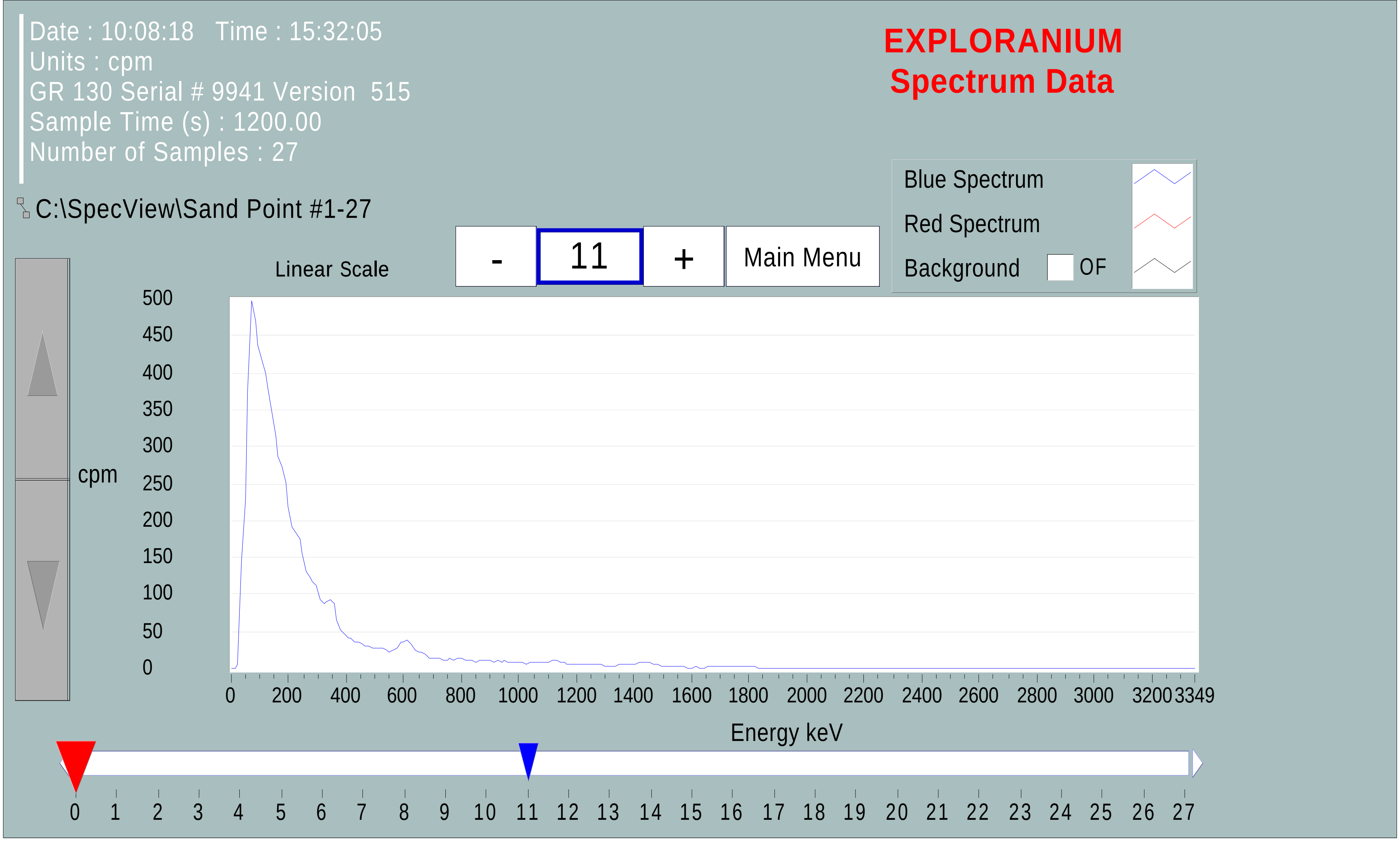
Date : 10:08:18   Time : 15:07:24
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Hotspot # 10, in soil area south of Building 27.

Exploranium identified as:
K-40
Unidentified peaks (keV) at:
85
608

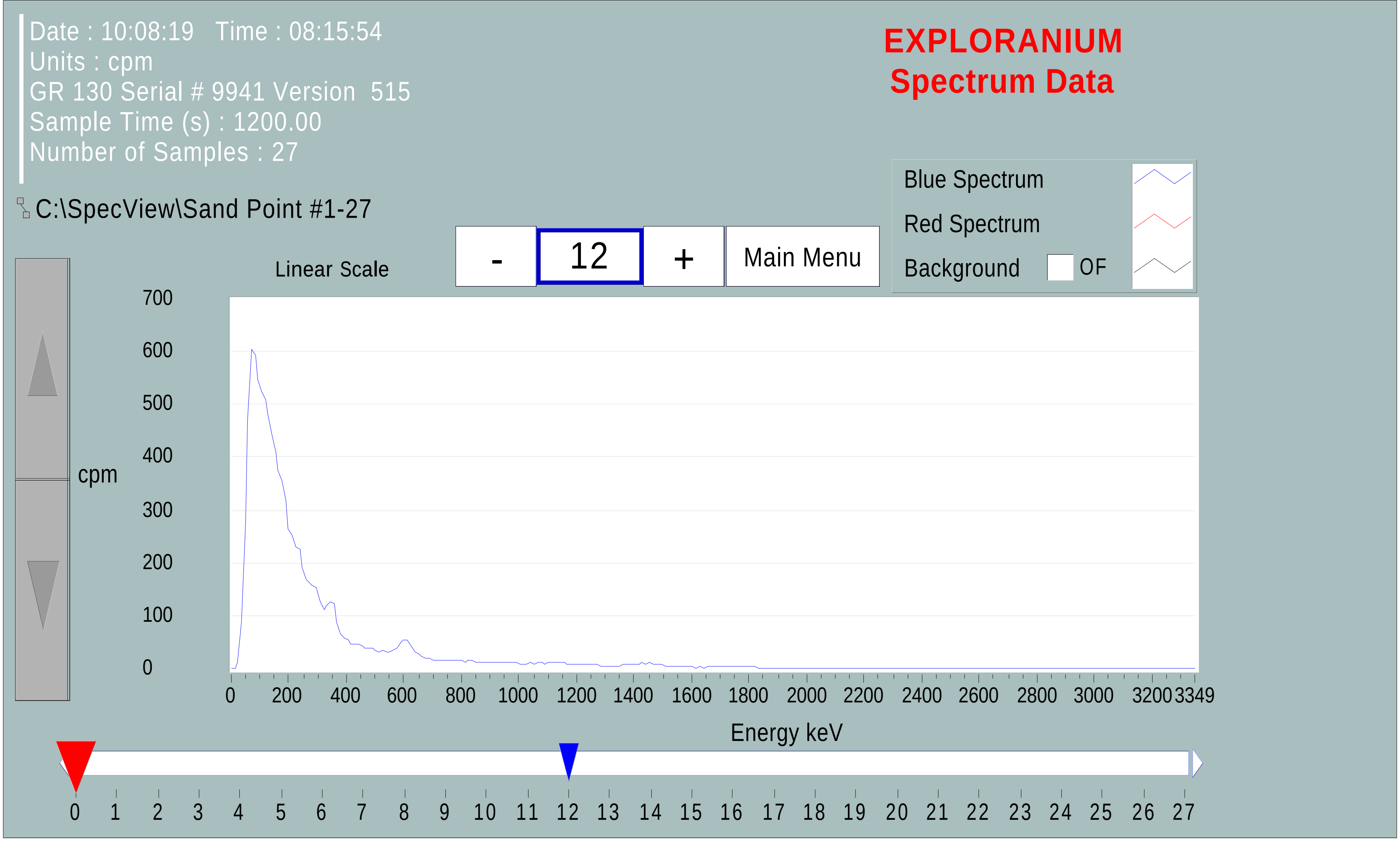


Date : 10:08:18   Time : 15:32:05
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Hotspot # 11, in
soil area south of
Building 27.

Exploranium identified as:
Ra-226
K-40
Unidentified peaks (keV) at:
1,734

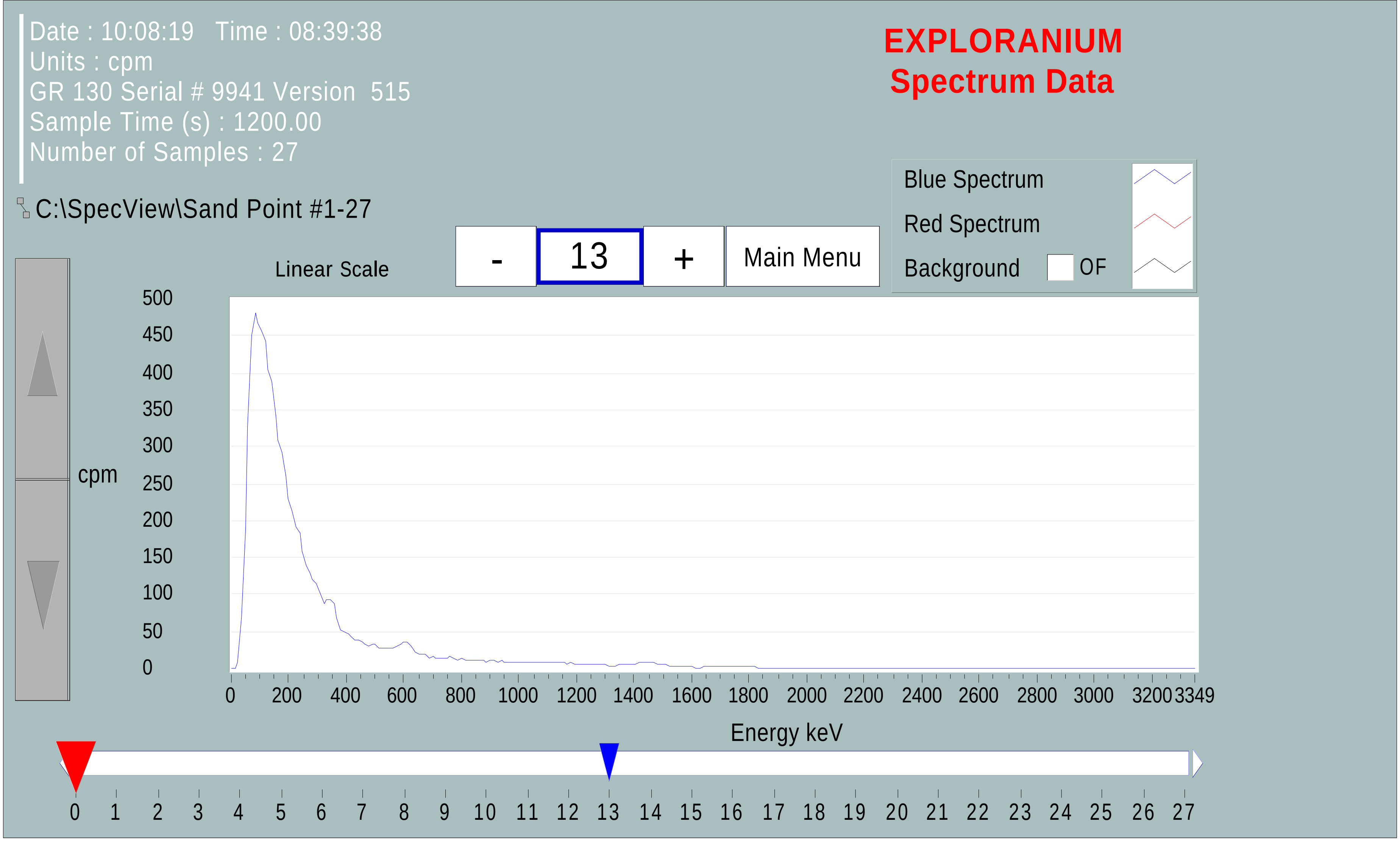


Date : 10:08:19   Time : 08:15:54
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Hotspot # 12, in soil area south of Building 27.

Exploranium identified as:
Ra-226
Unidentified peaks (keV) at:
1,739



Date : 10:08:19 Time : 08:39:38
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

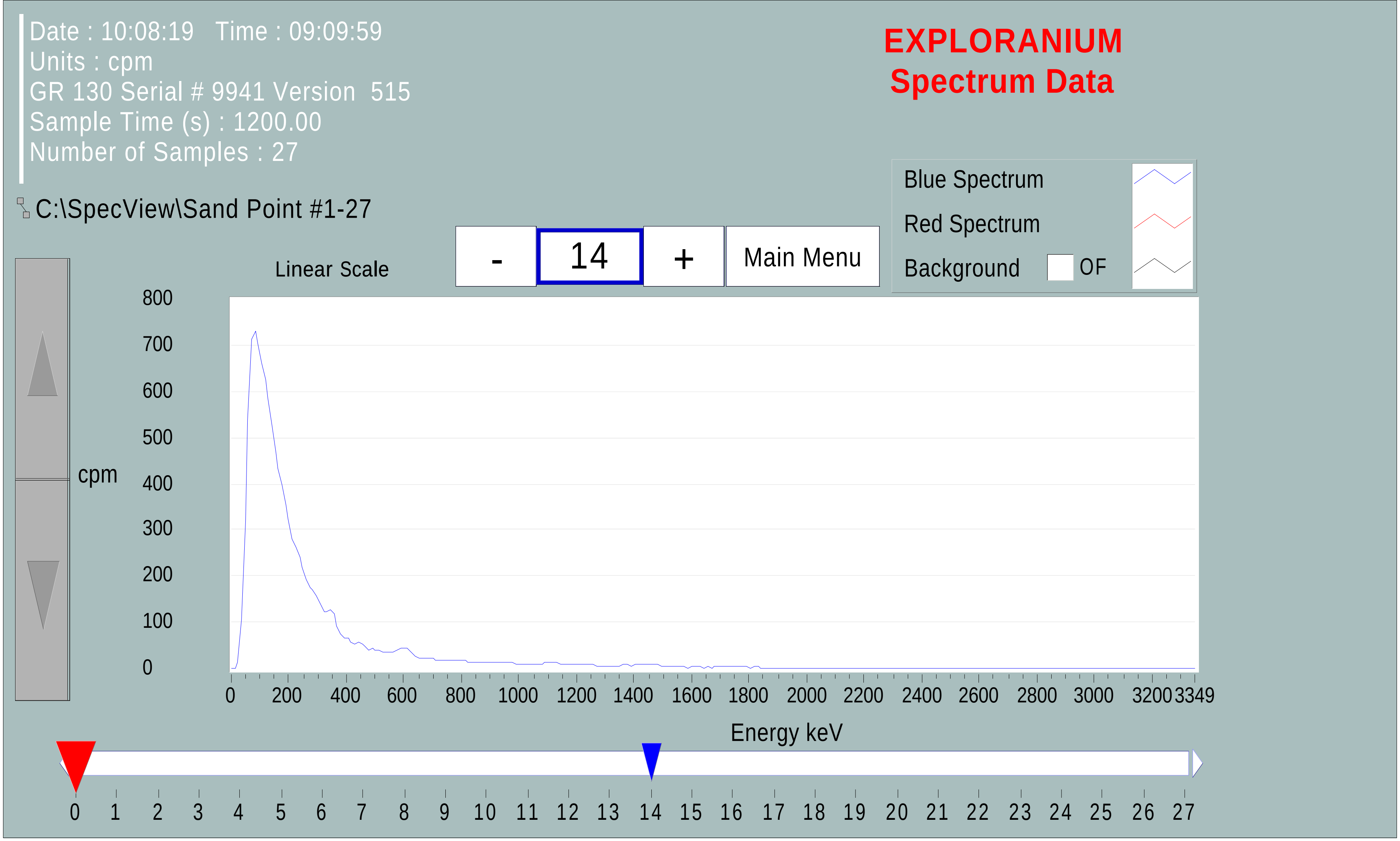
C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Background ☐ OF

Hotspot # 13, in
soil area west of
Building 27.

Unidentified peaks (keV) at:
91
601

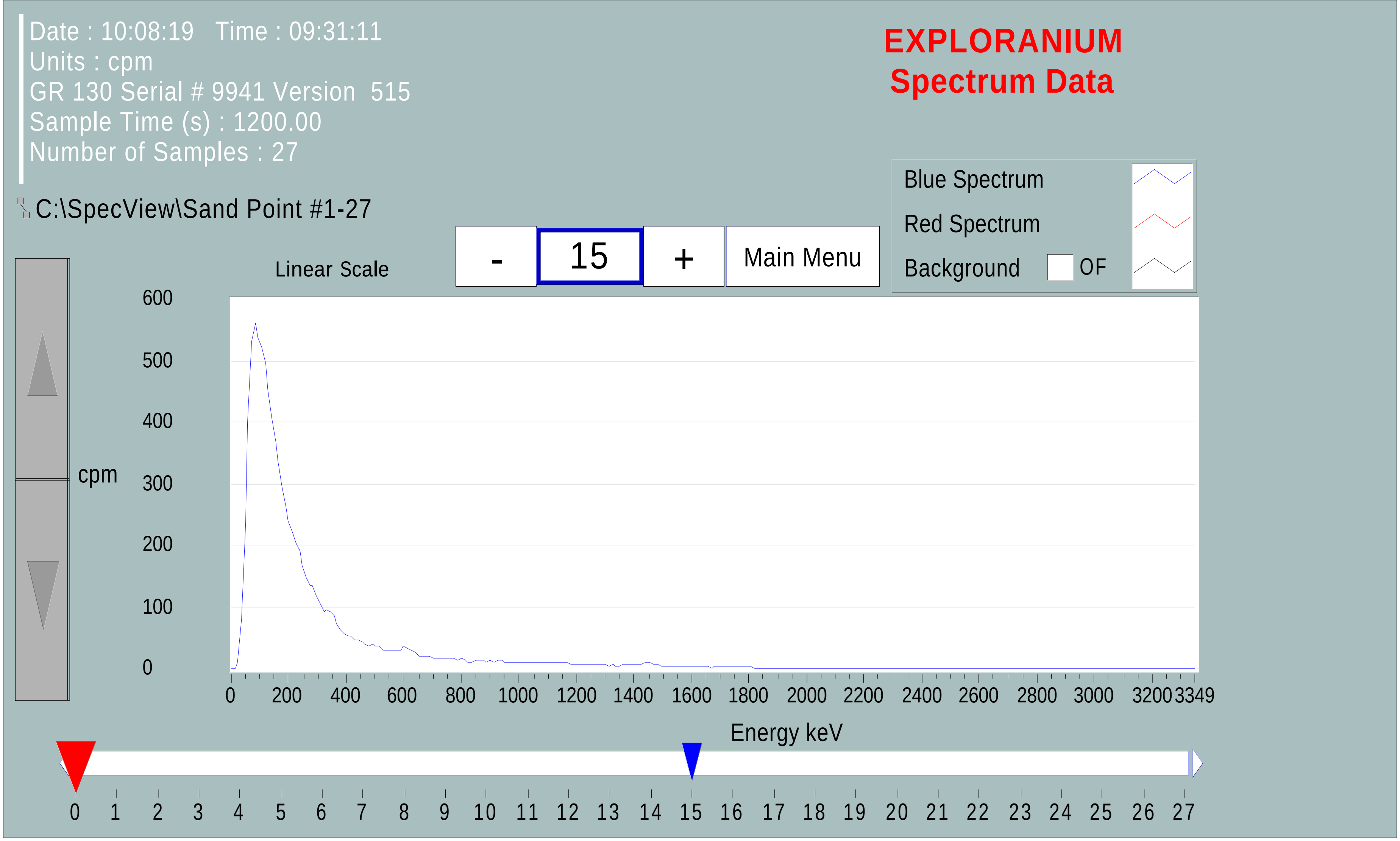


Date : 10:08:19   Time : 09:09:59
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Hotspot # 14, in
soil area south of
Building 27.

Exploranium identified as:
Ra-226
K-40
Unidentified peaks (keV) at:
1,746

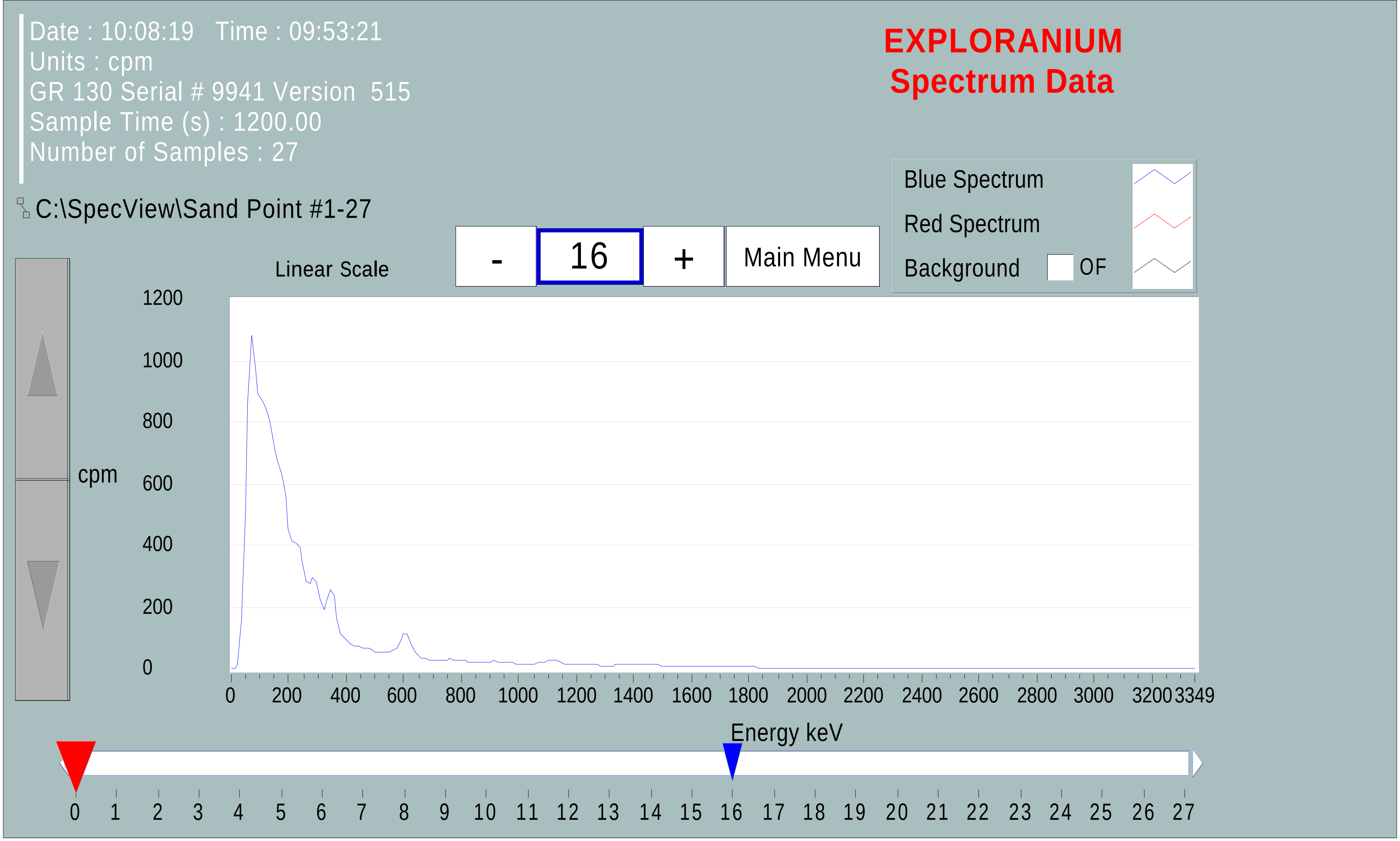


Date : 10:08:19 Time : 09:31:11
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Hotspot # 15, in
soil area south of
Building 27.

Exploranium identified as:
K-40
Unidentified peaks (keV) at:
89
599
1,743



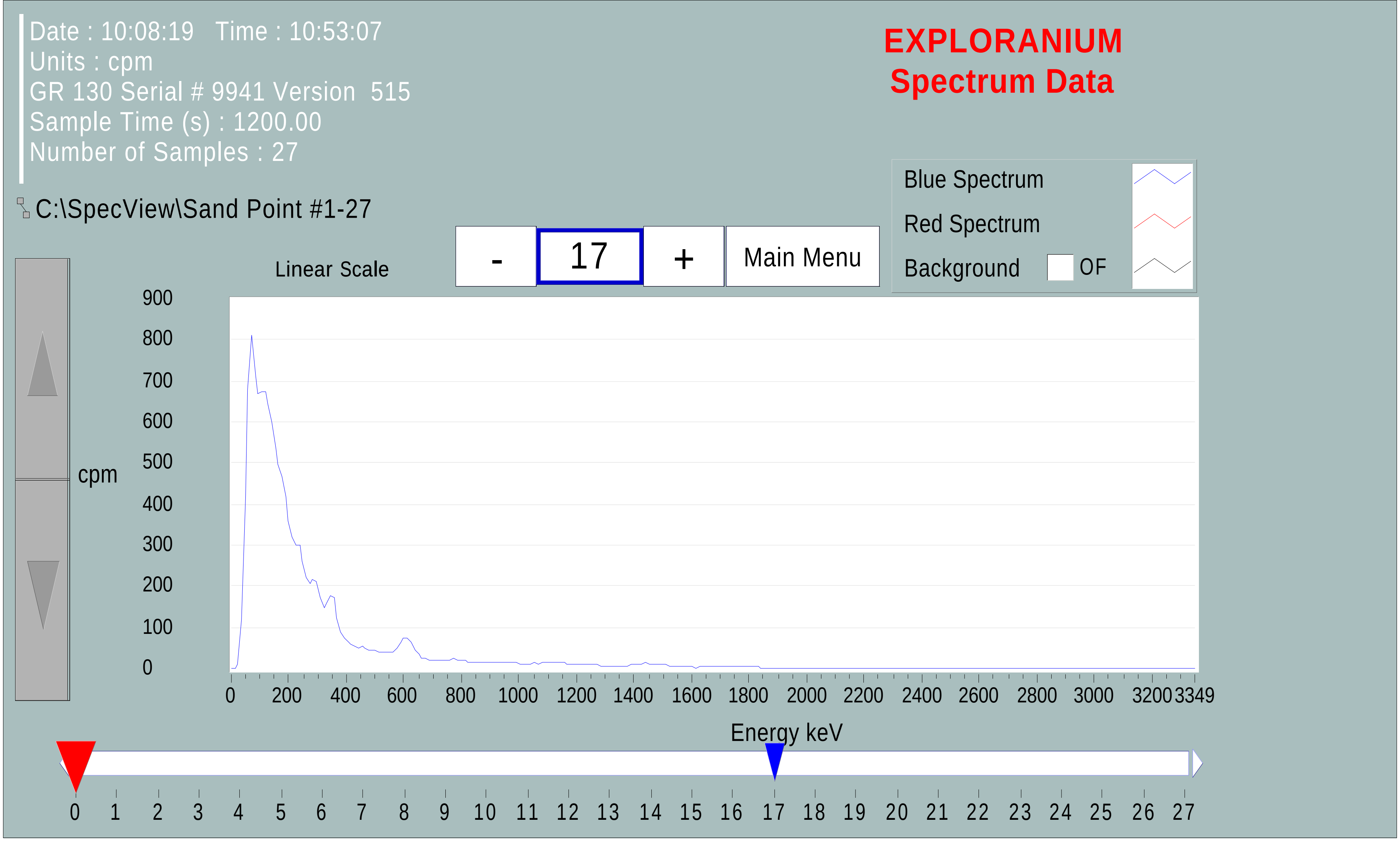
Date : 10:08:19 Time : 09:53:21
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Hotspot # 16, in soil area south of Building 27.

Exploranium identified as:
Ra-226
Unidentified peaks (keV) at:
1,743
2,177



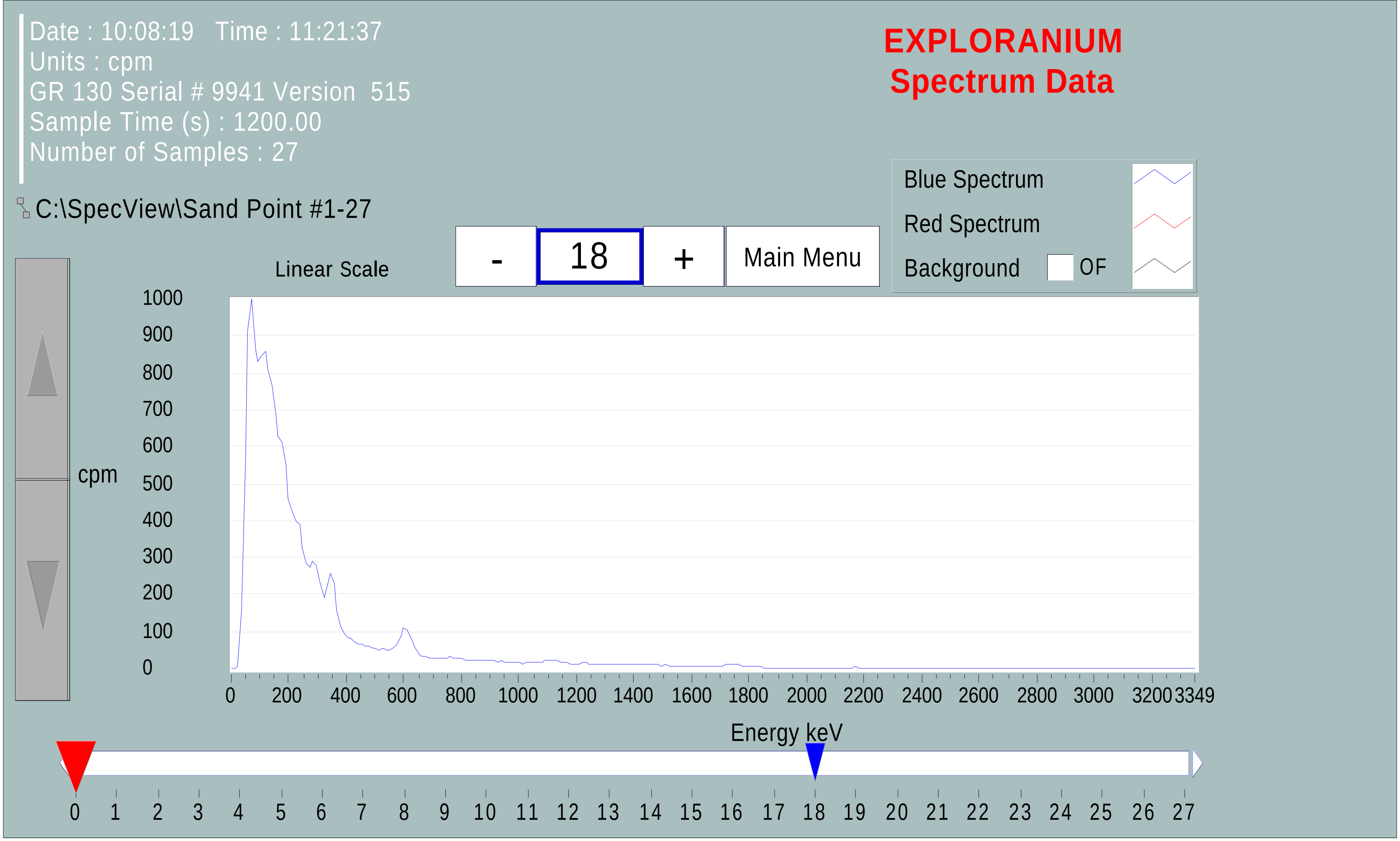
Date : 10:08:19 Time : 10:53:07
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Hotspot # 17, in
soil area south of
Building 27.

Exploranium identified as:
Ra-226
Unidentified peaks (keV) at:
1,750



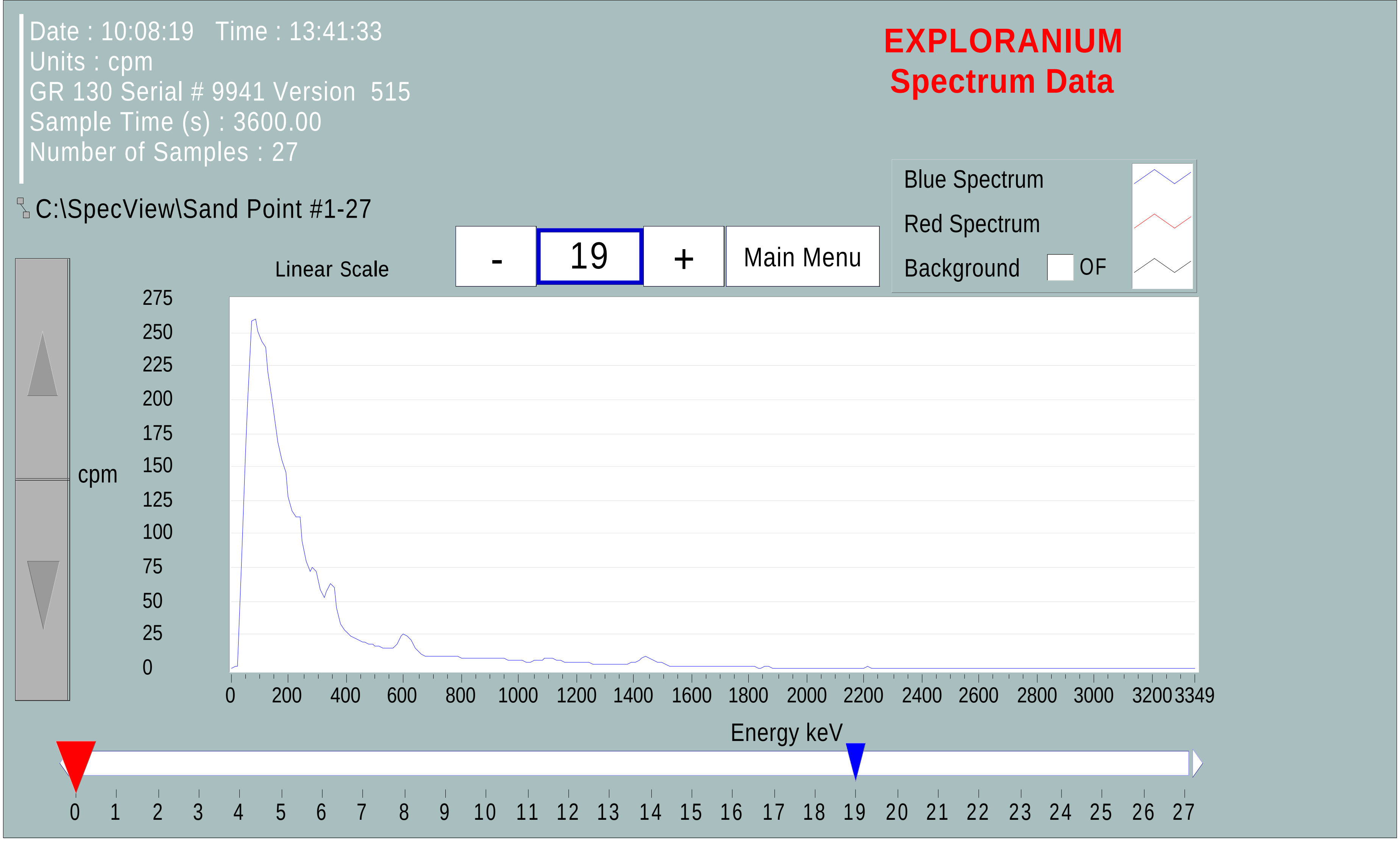
Date : 10:08:19 Time : 11:21:37
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Hotspot # 18, in soil area south of Building 27.

Exploranium identified as:
Ra-226
Unidentified peaks (keV) at:
1,746
2,175

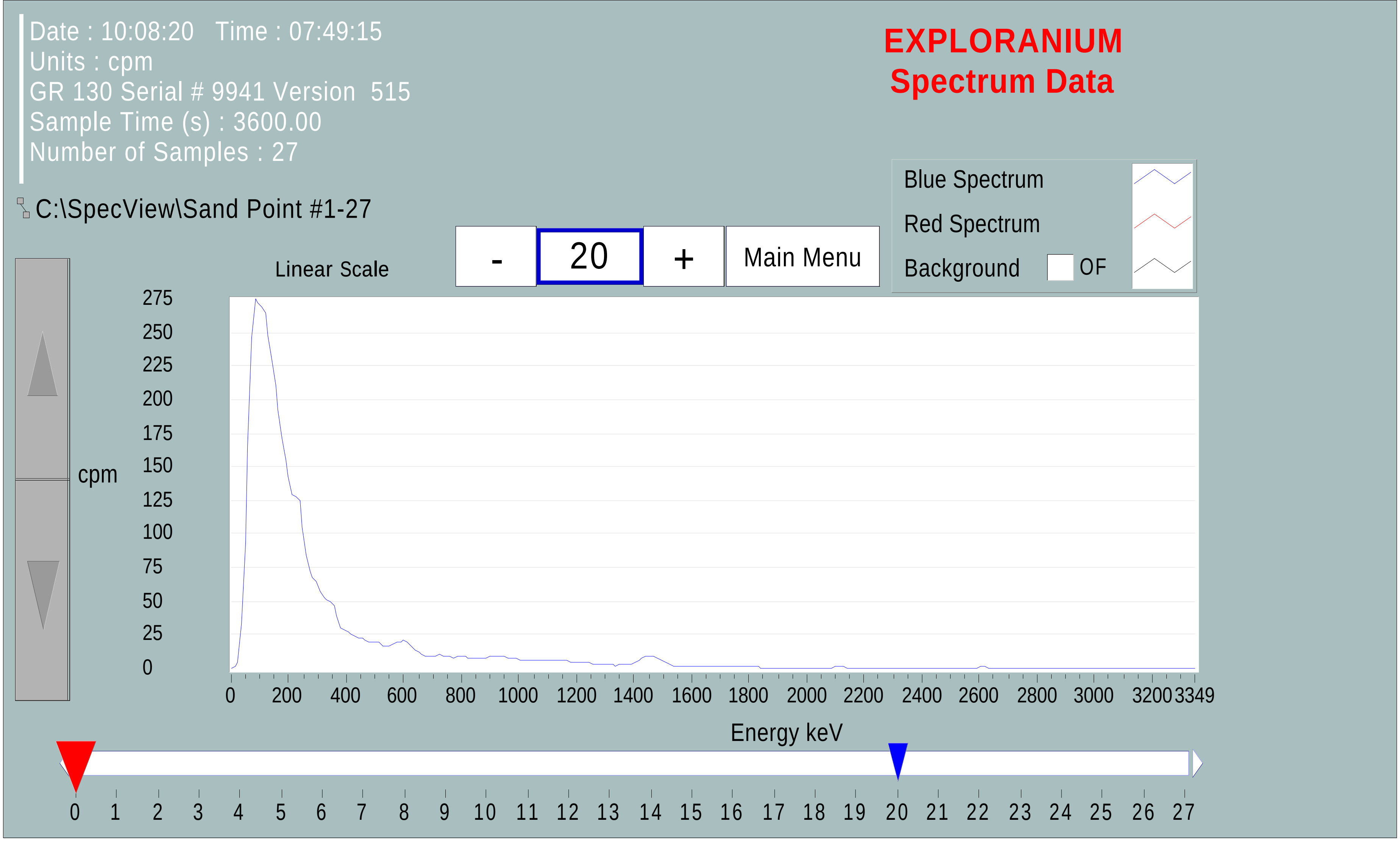


Date : 10:08:19 Time : 13:41:33
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 3600.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Location # 19 located on the brick wall in the Building 2 1939 Former Instrument Shop. This one is not related to the soil excavation plan but is in the same Exploranium file as the others.

Exploranium identified as:
Ra-226
K-40
Unidentified peaks (keV) at:
1,738
2,586



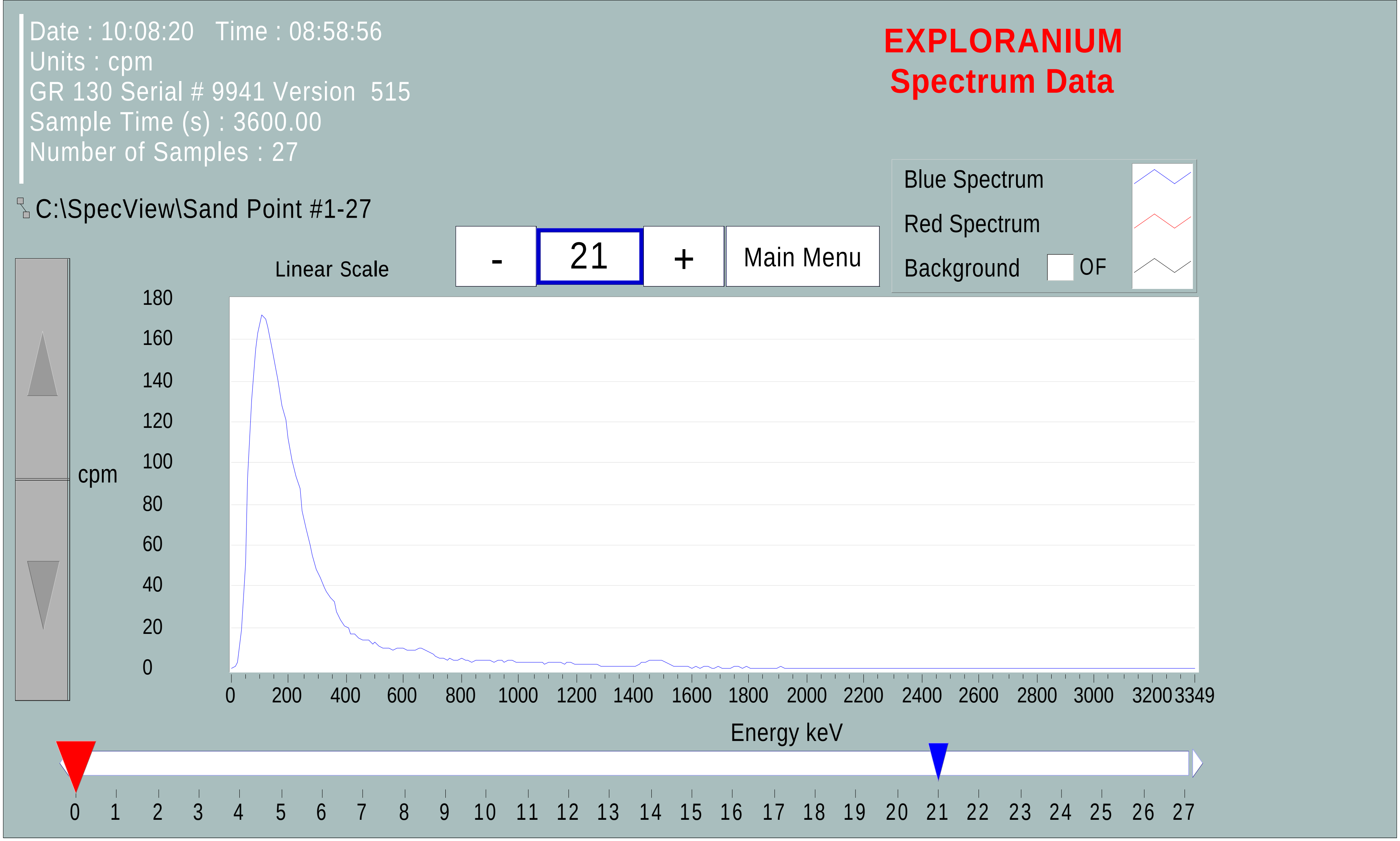
Date : 10:08:20 Time : 07:49:15
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 3600.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Location # 20 is a scan of the Building 27 SE Tower restroom tile floor. This one is not related to the soil excavation plan but is in the same Exploranium file as the others.

Exploranium identified as:
K-40
Unidentified peaks (keV) at:
97
2,615

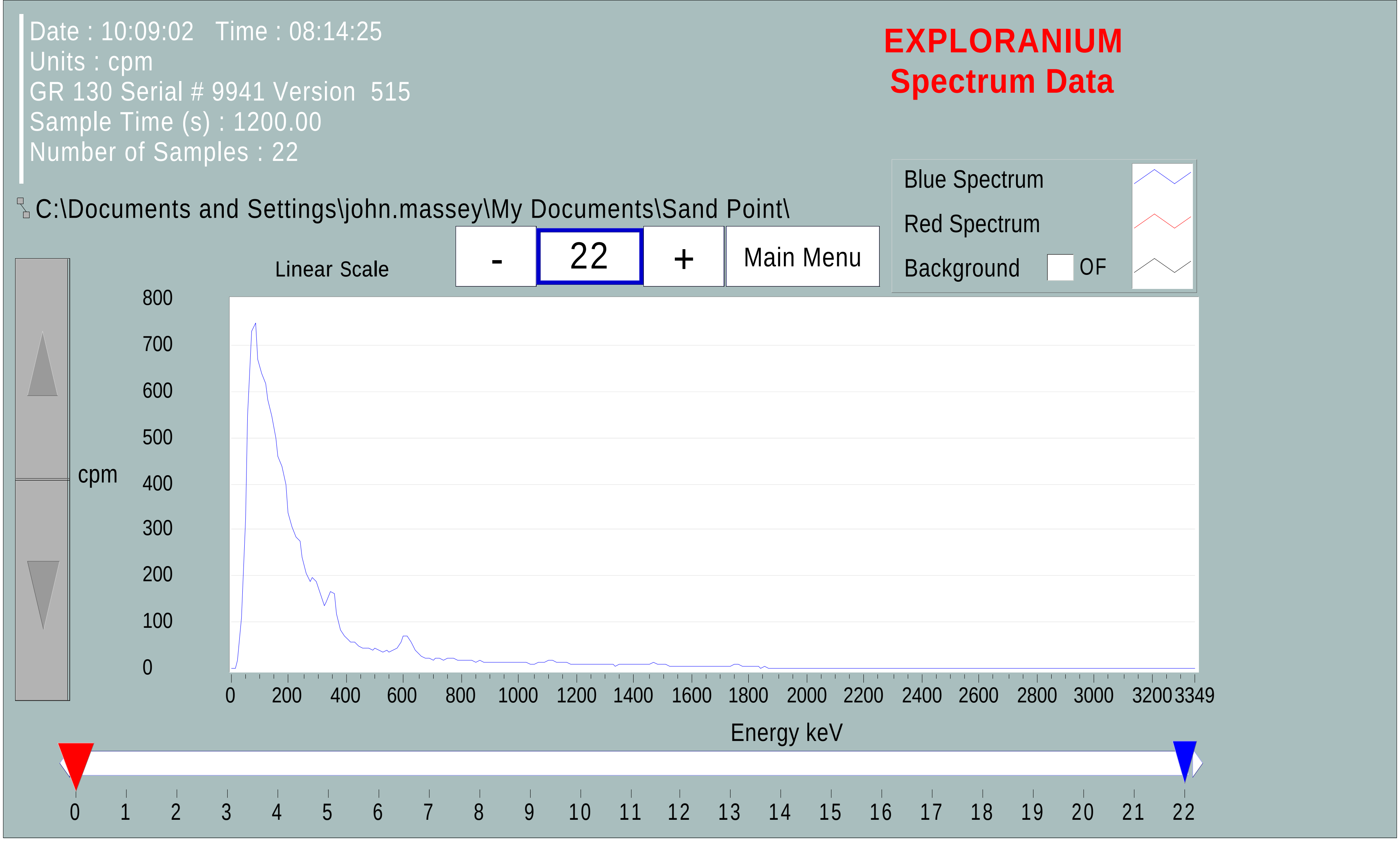


Date : 10:08:20   Time : 08:58:56
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 3600.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Location # 21 taken in a non-impacted area of soil south of Building 11.

Exploranium identified as:
Cs-137
K-40
Unidentified peaks (keV) at:
112
2,633

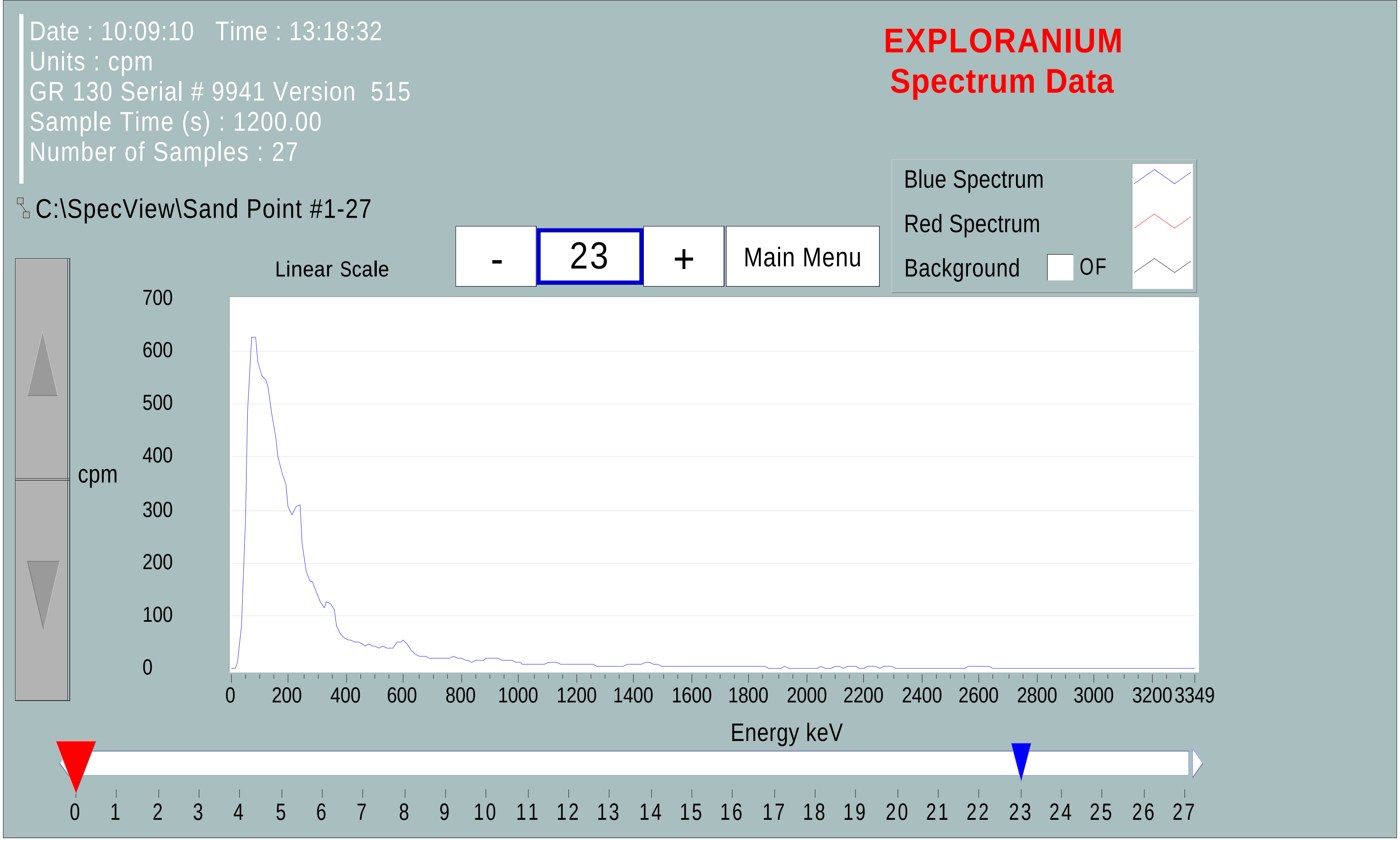


Date : 10:09:02 Time : 08:14:25
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 22

C:\Documents and Settings\john.massey\My Documents\Sand Point\

Hotspot # 22, in soil area south of Building 27.

Ra-226 Identified
Unidentified peak at 1753 keV



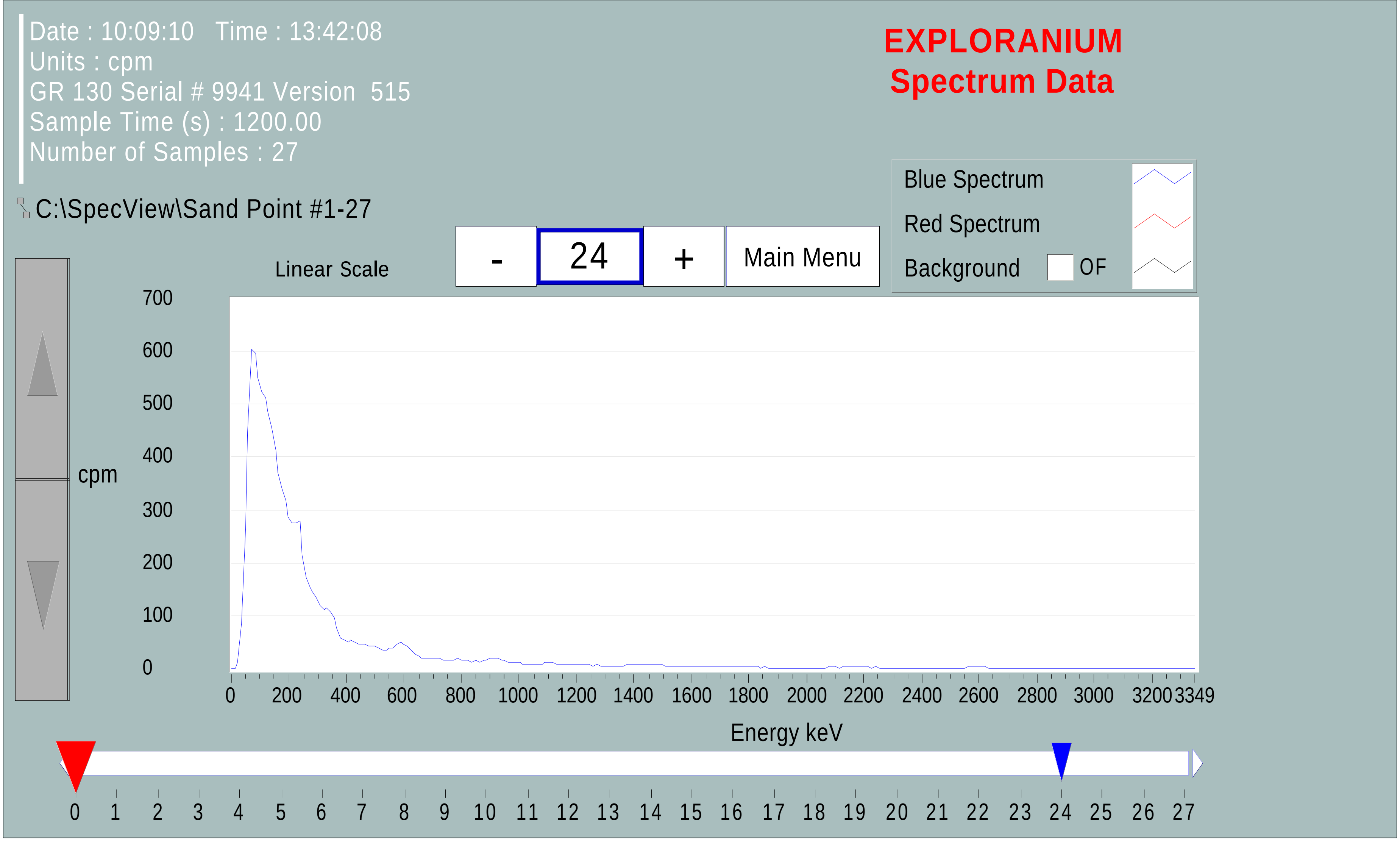
Date : 10:09:10 Time : 13:18:32
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Building 27 soil
west of entrance
road near NOAA
overpass. Hotspot
#23.

Exploranium
identified as:
Th-232
K-40

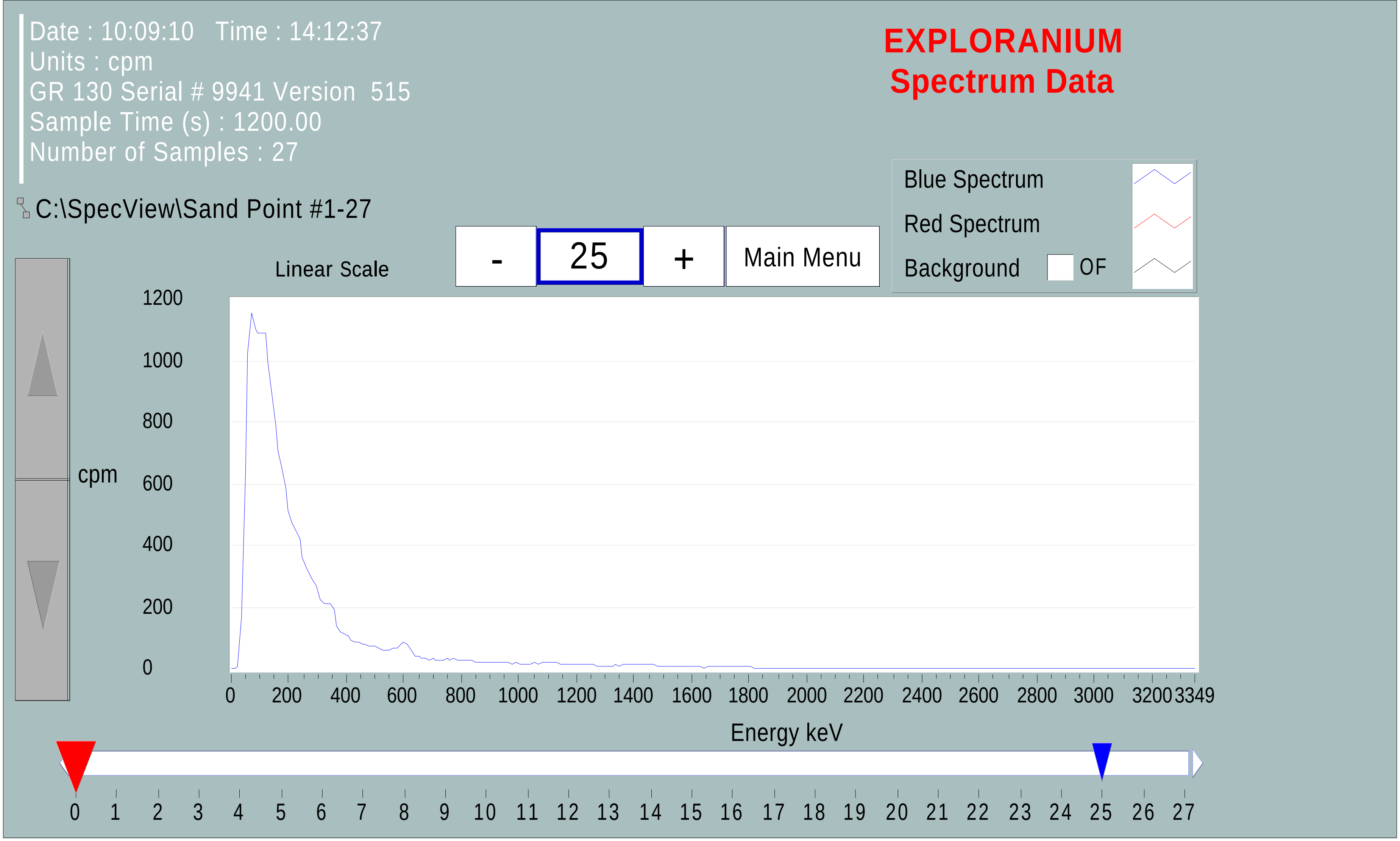


Date : 10:09:10 Time : 13:42:08
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Building 27 soil west of entrance road near NOAA overpass. Hotspot #24.

Exploranium identified as:
Th-232
K-40



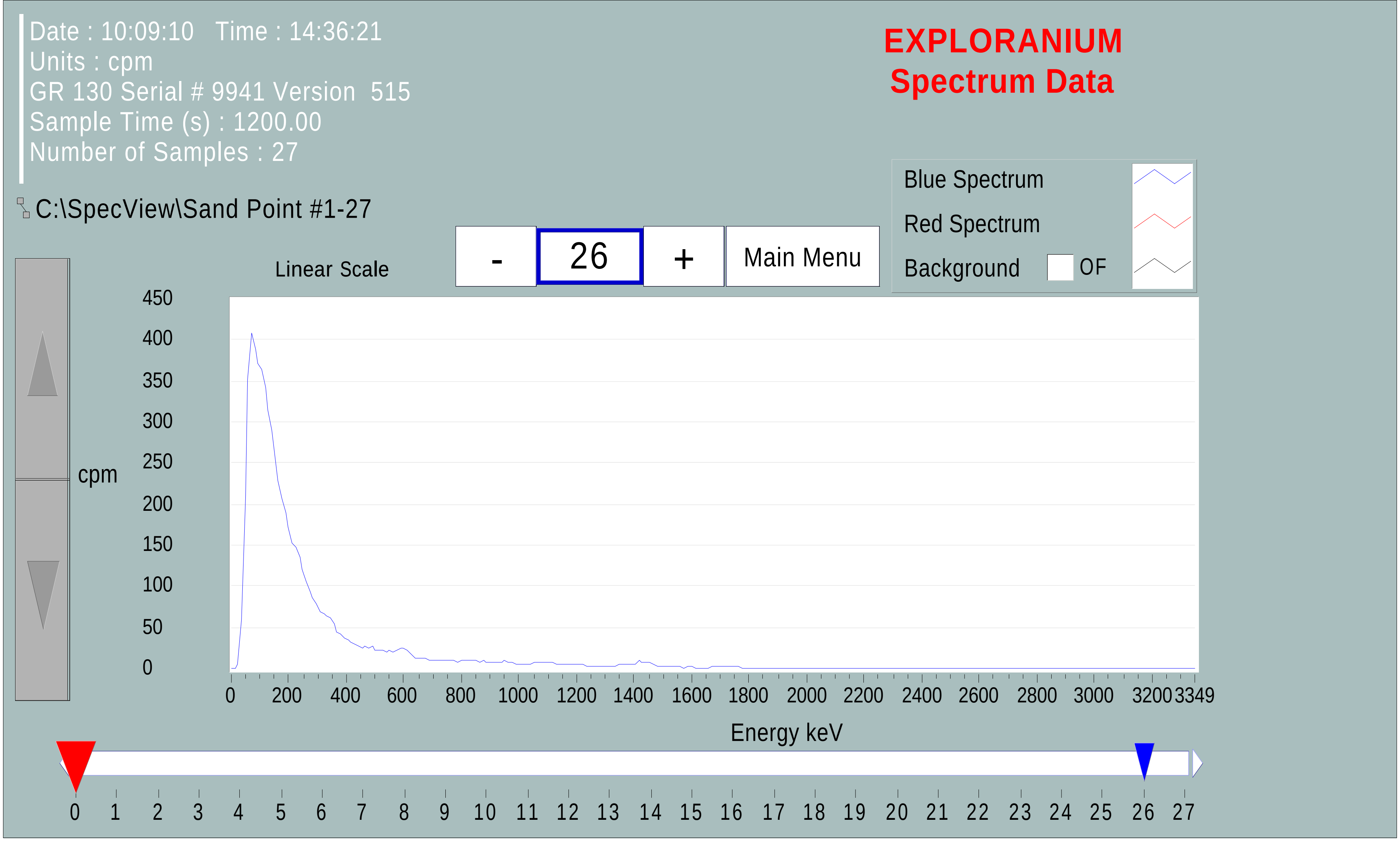
Date : 10:09:10   Time : 14:12:37
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

EXPLORANIUM
Spectrum Data

C:\SpecView\Sand Point #1-27

Hotspot #25, in paved area west of Building 27.

Exploranium identified as:
Ra-226
Unidentified peak:
1,729 keV

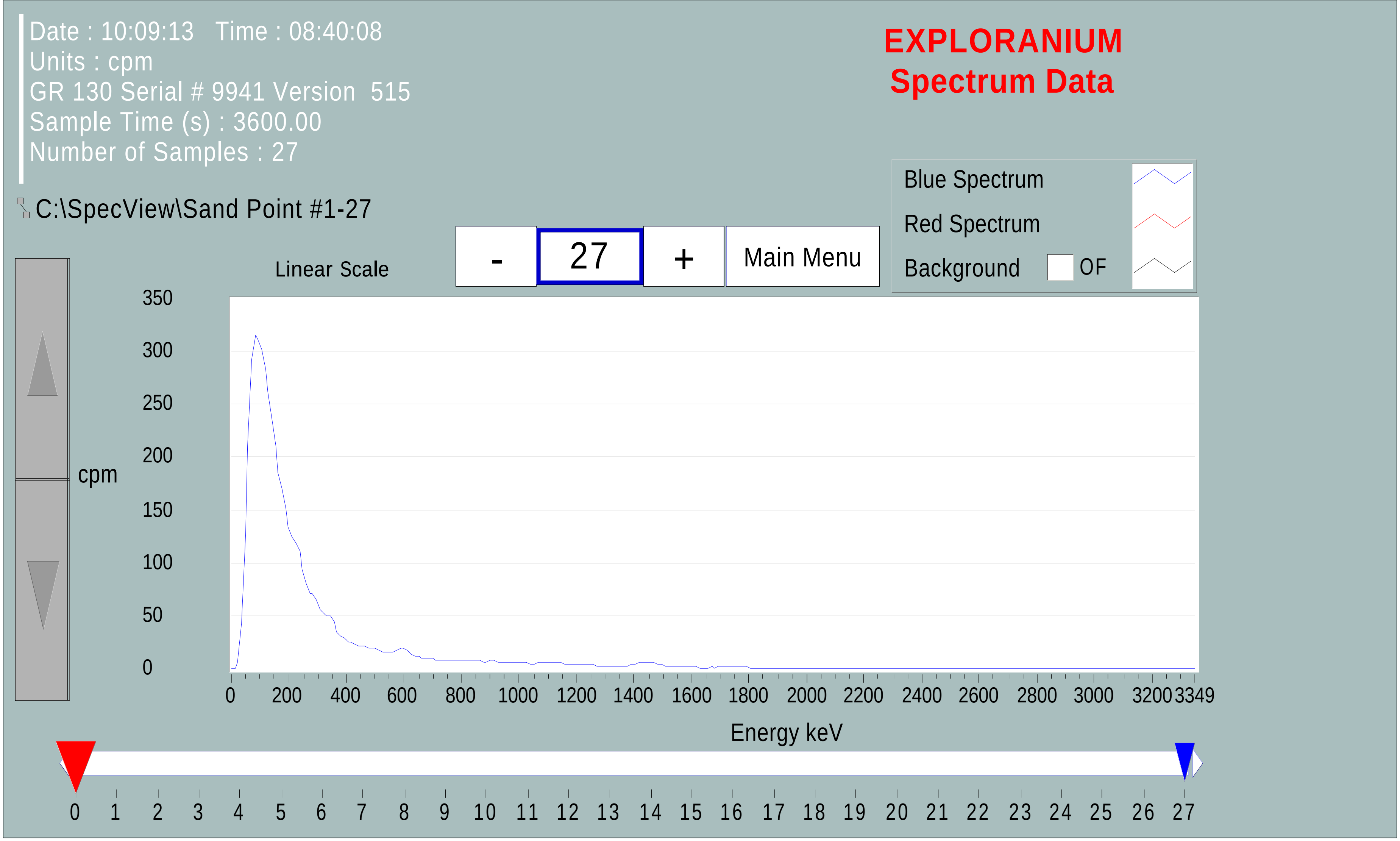


Date : 10:09:10   Time : 14:36:21
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 1200.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

Hotspot #26, in paved area west of Building 27.

Exploranium identified as:
K-40
Unidentified peaks (keV) at:
80
590



Date : 10:09:13   Time : 08:40:08
Units : cpm
GR 130 Serial # 9941 Version 515
Sample Time (s) : 3600.00
Number of Samples : 27

C:\SpecView\Sand Point #1-27

EXPLORANIUM
Spectrum Data

Hotspot #27, in paved area west of Building 27.

Exploranium identified as:
Th-232K-40
Unidentified peaks (keV) at:
1,102
1,740

Attachment 8
Soil Boring Logs

BORING NO. B-1

COORDINATES: __________

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 3 ft. bgs

DATE BEGAN 11/18/10
DATE FINISHED 11/18/10
TOC ELEV. __________
HOLE SIZE __________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5416	800			SM	░	SILTY SAND WITH ORGANICS, moist, dark borwn, moderately dense, roots 0.5'
.5	5365	1000		Hold 1-SL-B-0.5-1.0' 11:05	CH	▨	CLAY, dry, light brown to gray, dense 1.0'
-1.0	5312	1000			SC	▨	Same as above with fine sand 1.5'
-1.5	5500	600		Analyze 1-SC-B-1.5-2.0' 201-SC-B-1.5-2.0'		▨	Same as above 2.0'
-2.0	5403	1000			SM	░	FINE SAND, wet, gray, moderately dense 2.5'
-2.5	5388	1000		Hold 1-SC-B-2.5-3.0' 11:25		░	Same as above, very wet 3.0'
-3.0							
-3.5							

TOTAL DEPTH OF BORING IS 3 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM - Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

Shaw

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B1-B5-B8-B12(2)-B16-B17-B18-B19-B22 User: maria.portacio Feb 02, 2011 - 3:03pm

BORING NO. B66

COORDINATES: __________

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 5 ft. bgs

DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV. __________
HOLE SIZE __________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0 – .5	5529	600		66-SC-R-0-0.5' 2:10	SM		SILTY SAND (SM), Moderate brown, moist, firm, organics, tree roots 0.5'
.5 – 1.0	5575	1000		Hold 66-SC-R-0.5-1.0' 2:15			Same as above 1.0'
1.0 – 1.5	5423	1000		66-SC-R-1.0-1.5' 2:20			Same as above 1.5'
1.5 – 2.0	5458	800		Hold 66-SC-R-1.5-2.0' 2:25			2.0'
2.0 – 2.5	5525	900		66-SC-R-2.0-2.5' 2:30			2.5'
2.5 – 3.0	5505	1000		Hold 6-SC-R-2.5-3.0' 2:35			3.0'
3.0 – 3.5	5422	600		66-SC-R-3.0-3.5' 2:40			3.5'

TOTAL DEPTH OF BORING IS 5 FEET

PAGE 1 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/3/11	APPROVED BY	C. GENEROUS	2/2011	

Shaw®

BORING NO. B-65

COORDINATES:
FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 5 ft. bgs
DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
3.5	5456	800		Hold 65-SC-R-3.5-4.0' 3:25			Same as above 4.0'
4.0	5483	700		Hold 65-SC-R-4.0-4.5' 3:30	SM		Same as above 4.5'
4.5	5514	1200		Hold 65-SC-R-4.5-5.0' 3:35			Same as above 5.0'
5.0					▽		
5.5							
6.0							
6.5							
7.0							

TOTAL DEPTH OF BORING IS 5 FEET

PAGE 2 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/3/11	APPROVED BY	C. GENEROUS	2/2011	

Shaw

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B63-B64-B65-B66 User: maria.portacio Feb 03, 2011 - 8:48am

BORING NO. B65

COORDINATES:

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 5 ft. bgs

DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0 – .5	5607	700		65-SC-R-0-0.5' 2:50	SM		SILTY SAND (SM), Moist, brown 0.5'
.5 – 1.0	5608	900		Hold 65-SC-R-0.5-1.0' 2:55			Same as above 1.0'
1.0 – 1.5	5540	800		65-SC-R-1.0-1.5' 3:00			Same as above 1.5'
1.5 – 2.0	5525	700		Hold 65-SC-R-1.5-2.0' 3:05			Same as above 2.0'
2.0 – 2.5	5673	900		65-SC-R-2.0-2.5' 3:10			Same as above 2.5'
2.5 – 3.0	5419	1000		Hold 65-SC-R-2.5-3.0' 3:15			Same as above 3.0'
3.0 – 3.5	5484	1000		65-SC-R-3.0-3.5' 3:20			Same as above 3.5'

TOTAL DEPTH OF BORING IS 5 FEET

PAGE 1 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

Shaw

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/3/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-64

COORDINATES: ____________

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 3 ft. bgs

DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV. ____________
HOLE SIZE ____________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5378	600		64-SC-R-D-0.5' 2:20	SM		SILTY SAND (SM) WITH GRAVEL, Moist, firm, gravel 0.5'
.5	5554	900		64-SC-R-0.5-1.0' 2:25			Same as above 1.0'
1.0	5515	800		64-SC-R-1.0-1.5' 2:30			Same as above 1.5'
1.5	5445	800		Hold 64-SC-R-1.5-2.0' 2:35			Same as above 2.0'
2.0	5438	1100		64-SC-R-2.0-2.5' 2:40			Same as above 2.5'
2.5	5432	500		Hold 64-SC-R-2.5-3.0' 2:45			Hit groundwater @ 33" 3.0'
3.0							
3.5							

TOTAL DEPTH OF BORING IS 3 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM - Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

Shaw

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B63-B64-B65-B66 User: maria.portacio Feb 03, 2011 - 11:26am

BORING NO. B-63

COORDINATES:

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 3.5 ft. bgs

DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5404	1000		63–SC–R–0–0.5' 2:40			SILTY SAND (SM), Brown, moist, firm, organics
.5	5569	1000		Hold 63–SC–R–0.5–1.0' 2:45			0.5' Same as above
1.0	5455	900		63–SC–R–1.0–1.5' 2:50			1.0' Same as above
1.5	5477	1000		Hold 63–SC–R–1.5–2.0' 2:55	SM		1.5' Same as above
2.0	5389	1100		63–SC–R–2.0–2.5' 3:00			2.0' Rock @ 2'
2.5	5413	1000		Hold 63–SC–R–2.5–3.0' 3:05			2.5'
3.0	5392	600		63–SC–R–3.0–3.5' 3:10			3.0'
3.5							

TOTAL DEPTH OF BORING IS 3.5 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA–PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44–2 (1"X1" NaI)

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT–137165–A1.dwg Layout: B63–B64–B65–B66 User: maria.portacio Feb 03, 2011 – 11:25am

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT–137165–A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

Shaw®

BORING NO. B-61

COORDINATES:
FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 2.5 ft. bgs
DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0 – .5	5332	1000			SM		0–4" SILTY SAND (SM), Brown (LT), Moist, firm
.5 – 1.0	5497	900		Analyze 61–SC–b–0.5–1.0' 10:55			0.5' Same as above
1.0 – 1.5	5402	800					1.0' Same as above
1.5 – 2.0	5407	800		Hold 61–SC–b–1.5–2.0' 11:05			1.5' Same as above
2.0 – 2.5	5468	900					2.0' Same as above
2.5 – 3.5							2.5'

TOTAL DEPTH OF BORING IS 2.5 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA–PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44–2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT–137165–A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-60

COORDINATES: ______

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 2.5 ft. bgs

DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV. ______
HOLE SIZE ______

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0–.5	7367	1100		Analyze 60–SC–H–0–0.5' 10:50	SM		0–4" ROOTS SILTY SAND (SM), Brown, moist, firm, trace gravel, organics 4"–.5" SAND (SW), Brown, moist
.5–1.0	5367	900			SW		0.5' Same as above
1.0–1.5	5465	800		Hold 60–SC–H–1.0–1.5' 10:55			1.0' Same as above
1.5–2.0	5512			1' Below 60–SC–H–1.0–2.0' 11:05			1.5' Same as above
2.0–2.5	5537			Hold 60–SC–H–2.0–2.5' 11:10			2.0' Same as above
2.5–3.5							2.5'

TOTAL DEPTH OF BORING IS 2.5 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA–PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum
2221/44–2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT–137165–A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-56

COORDINATES: ______________

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 0.5 ft. bgs
DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV. ______________
HOLE SIZE ______________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0				Analyze 56-SC-H-0-0.5' 10:30	CL	▨	0-4" SILTY SAND (SM), Moist, brown, firm 4-6" SANDY CLAY (CL), Moist, brown, firm 0.5'
.5							
1.0							
1.5							
2.0							
2.5							
3.0							
3.5							

TOTAL DEPTH OF BORING IS 0.5 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-51

COORDINATES:

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 2.5 ft. bgs

DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0 – .5	5604	500		Analyze 51-SC-H-0-0.5' 9:00	SW	⁙	GRAVELLY SAND (SW), Moist, grayish brown, firm-dense, gravel up to 1" diameter, sub angular, medium grained sand
.5 – 1.0	5317	1100			SW	⁙	0.5' Same as above
1.0 – 1.5	5540	1000		Analyze 51-SC-H-1.0-1.5' 9:10	SW	⁙	1.0' Same as above
1.5 – 2.0	5467	1000		1' Below clean 51-SC-H-1.5-2.0' 9:15	CL	▨	1.5' CLAY (CL), Moist, gray, dense
2.0 – 2.5	5305	800			CL	▨	2.5'
2.5 – 3.5							

TOTAL DEPTH OF BORING IS 2.5 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludium 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-49

COORDINATES: ______
FIELD GEOLOGIST T. O'Connor
DATE BEGAN 11/19/10
CHECKED BY C. Generous
DATE FINISHED 11/19/10
APPROVED BY C. Generous
TOC ELEV. ______
TOTAL DEPTH 2 ft. bgs
HOLE SIZE ______

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5593	500		Analyze 49-SC-H-0-0.5' 9:00			SAND (SW), Brownish gray, moist, firm, trace gravel, trace organics, medium grained sand
.5	5349	800			SW		0.5' Same as above
1.0	5418	800		HOLD 49-SC-H-1.0-1.5' 9:10			1.0' ROCK @ 1' CLAY (CL), Gray, moist, firm, 10% trace gravel, gravel up to 1-1/2" diameter, trace sand
1.5	5449	700		1' Below Background 49-SC-H-1.5-2.0' 9:15			
2.0							2.0'
2.5							
3.0							3.0'
3.5							

TOTAL DEPTH OF BORING IS 2 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM - Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B23-B24-B26-B29-B30-B49-B51-B56-B60-B61 User: maria.portacio Feb 03, 2011 - 11:18am

BORING NO. B-30

COORDINATES: __________

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 3 ft. bgs

DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV. __________
HOLE SIZE __________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	DESCRIPTION
0 – .5	5347	750			SM CL	0.9" SILTY SAND (SM), Moist, dark brown, moderately dense, well rounded trace rocks up to 3/4" diameter, roots CLAY, Moist, light brown to gray, dense, boundary sample 0.5'
.5 – 1.0	5486	1000		30-SC-B-0.5-1.0' 10:40	CL	Same as above 1.0'
1.0 – 1.5	5396	1000			CL	Same as above 1.5'
1.5 – 2.0	5240	800		Hold 30-SC-B-1.5-2.0' 10:45	CL	Same as above with increasing fine sand 2.0'
2.0 – 2.5	5414	1000			SW	SAND, Medium to fine grain sand, moist, gray 2.5'
2.5 – 3.0	5352	900		Hold 30-SC-B-2.5-3.0' 10:50	SW	Same as above, very moist 3.0'
3.0 – 3.5						

TOTAL DEPTH OF BORING IS 3 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-29

COORDINATES: ____________

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 3 ft. bgs

DATE BEGAN 11/16/10
DATE FINISHED 11/16/10
TOC ELEV. ____________
HOLE SIZE ____________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	2221 with 44-10 5635	750		29-SC-H-0-0.5'	SM	░	0.1" 0-1" LOAM WITH ORGANIC, Moss, roots SILTY SAND (SM), Moderately brown, subrounded, trace gravel up to 3/4" diameter
.5	5570	1000			SM	░	0.5' SILTY SAND (SM), Moderately brown, moist, medium density, trace roots
1.0	5355	1000		Hold 29-SC-H-1.0-1.5'	CL	▨	1.0' SAND (CL), Clay, moderately brown to tan, moist, dense
1.5	5452	1000			CL	▨	1.5' CLAY 100%, Light gray to tan, moist, very dense
2.0	5481	1000		29-SC-H-2-2.5'	CL	▨	2.0' Same as above
2.5	5992	800			CL	▨	2.5' Same as above
3.0							3.0'
3.5							

TOTAL DEPTH OF BORING IS 3 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM - Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" Nal)

NOTES: Move angle iron from over location 29. Use control to

Shaw

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-28

COORDINATES: ____________

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 4.5 ft. bgs

DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
3.5						▨	Same as above
	5379	2000		Hold 28-SC-B-3.5-4.0' 10:50	CL	▨	
4.0						▨	4.0'
	5483	2000				▨	
4.5						▨	Red brick @ bottom 4.5'
							TD = 4.5'
5.0							
5.5							
6.0							
6.5							
7.0							

TOTAL DEPTH OF BORING IS 4.5 FEET

PAGE 2 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint\CRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B23-B24-B28-B29-B30-B49-B51-B56-B60-B61 User: maria.portacio Feb 03, 2011 - 9:06am

BORING NO. B-28

COORDINATES: ____________

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 4.5 ft. bgs

DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV. ____________
HOLE SIZE ____________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5538	600		Hold 28-sc-b-0.5-1.0' 10:15			SANDY GRAVEL (GW), Brown, moist, firm, trace silt, organics trace gravel 0.5'
.5	5551	1500			GW		Same as above 1.2'
1.0	5458	2000		Hold 28-5C-B-1.5-2.0' 10:30	CL		CLAY (CL), Gray, moist, firm, dense 1.5'
1.5	5534	1500					SILTY SAND (SM), Grayish, brown, moist, firm, trace gravel up to 2" diameter, sub angular 2.0'
2.0	5489	2500			SM		Same as above, Trace broken brick 2.5'
2.5	5615	2000		Analyze – Run 28-SC-B-2.5-3' 11:00			Same as above 3.0'
3.0	5433	2500			CL		CLAYEY SAND/SANDY CLAY, Moist, brown, firm, trace roots 3.5'
3.5							

TOTAL DEPTH OF BORING IS 4.5 FEET

PAGE 1 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

Shaw®

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-24

COORDINATES: ____________

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 5 ft. bgs
DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV. ____________
HOLE SIZE ____________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
3.5	5586	1500					Same as above 4.0'
4.0	5487	1500		Hold 24–SC–H–4.0–5.0' 9:10	SM		SILTY SAND (SM), Moist, grayish, brown, firm Trace black gravel, 1.5" subray 4.5'
4.5	5435	1500		Run 24–SC–H–4.5–5.0' 9:15			Same as above 5.0'
5.0							
5.5							
6.0							
6.5							
7.0							

TOTAL DEPTH OF BORING IS 5 FEET

PAGE 2 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA–PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44–2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT–137165–A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-24

COORDINATES:

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 5 ft. bgs

DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5949	750		Hold 24-SC-H-0-0.5' 8:30	SM		0-1 LOAM, Brown, moist, firm SILTY SAND (SM), Moist, mod brown
.5	6349	1000		Analyze 24-SC-H-1.0-1.5' 8:35			SANDY GRAVEL (GW), Moist, brown, firm-dense
1.0							1.3'
	16,891	1000			GW		@16" CLAYEY GRAVEL (GW), Moist, dark brown, dense
1.5							1.6'
	10,443	1500					@20" SANDY GRAVEL (GW), Moist, brown, medium dense, trace white clay
2.0	7983	1500					
2.5							2.25'
	6881	1500		Hold 24-SC-H-2-2.5' 8:40	SM		@27" SILTY SAND (SM), Light brown, moist, medium dense, iron oxide 1" too far
3.0							3.0'
	6640	2500		Hold 24-SC-H-3-3.5' 9:00	CL		CLAY (CL), Moist, grayish, brown, firm 1" too far
3.5							3.5'

TOTAL DEPTH OF BORING IS 5 FEET

PAGE 1 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM - Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

Shaw

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint\CRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B23-B24-B28-B29-B30-B49-B51-B56-B60-B61 User: maria.portacio Feb 03, 2011 - 9:03pm

BORING NO. B-23

COORDINATES:

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 2.5 ft. bgs

DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5894	1000			SM		SILTY SAND (SM) WITH ORGANIC, Roots, rounded racks up to 1/4", dry, well graded, dark brown
.5	5902	1000		Analyze 23-SC-H-0.5-1.0' 8:20			0.5' Same as above, slightly moist
1.0	5626	1000			CL		1.0' LIGHT BROWN, Sandy clay, brown, moderately dense, moist, trace organics
1.5	5599	600		Hold 23-SC-H-1.5-2.0'			1.5' Same as above with less sand, gray
2.0	5552	750		1"-BK 23-SC-H-2.0-2.2'			2.0' Found piece of electrical condut tape Terminate boring at 2.2' due to red tape
2.5							2.5'
3.0							
3.5							

TOTAL DEPTH OF BORING IS 2.5 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludium 2221/44-2 (1"X1" NaI)

Shaw

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/2/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-22

COORDINATES: ____________

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 3 ft. bgs
DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV. ____________
HOLE SIZE ____________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5983	600		Analyze 22–SC–B–0.5–1.0' 1:25	SM	░	SILTY SAND WITH ORGANICS, Moist, dark brown, loose 0.5'
.5	5637	750			SC	▨	SILTY SAND, Moist, brown, loose, subangular, gravel up to 1" diameter, dense 1.0'
1.0	5488	1000				▨	Same as above 1.5'
1.5	5394	1000		Hold 22–SC–B–1.5–2.0' 1:40	CL	▨	Same as above, Clay, moist, light brown to gray, dense 2.0'
2.0	5506	700				▨	Same as above 2.5'
2.5	5383	900		Hold 22–SC–B–2.5–3.0' 1:50		▨	Same as above 3.0'
3.0							
3.5							

TOTAL DEPTH OF BORING IS 3 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA–PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44–2 (1"X1" NaI)

Shaw®

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT–137165–A1
DATE	01/25/11	APPROVED BY	C. GENEROUS	2/2011	

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT–137165–A1.dwg Layout: B1–B5–B8–B12(2)–B16–B17–B18–B19–B22 User: maria.portacio Feb 03, 2011 – 9:00am

BORING NO. B-19

COORDINATES:

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 2 ft. bgs
DATE BEGAN 11/18/10
DATE FINISHED 11/18/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0 – .5	5448	800		Analyze 19-SC-B-0-0.5' 8:25	SM		SILTY SAND WITH ORGANICS, Moist, dork brown, loose 0.5'
.5 – 1.0	5409	700					SILTY SAND, Moist, brown, loose 1.0'
1.0 – 1.5	5379	700		Hold 19-SC-B-1.0-1.5' 8:35			Same as above 1.5'
1.5 – 2.0	5394	1100					Same as above 2.0'
2.0 – 3.5							

TOTAL DEPTH OF BORING IS 2 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT-137165-A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

Shaw

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B1-B5-B8-B12(2)-B16-B17-B18-B19-B22 User: maria.portacio Feb 03, 2011 - 8:58am

BORING NO. B-18

COORDINATES: ______

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 2 ft. bgs
DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV. ______
HOLE SIZE ______

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5578	500		Analyze 18-SC-B-0.0-0.5' 3:00			SILTY SAND (SM), Moist, brown, firm, organics-grass, trace silt
.5	5346	1500			SM		0.5' Same as above, without silt
1.0	5427	2000					1.0' CLAY (CL), Moist-dry, gray, dense
1.5	5386	2500			CL		1.5' Same as above
2.0							2.0'
2.5							
3.0							
3.5							

TOTAL DEPTH OF BORING IS 2 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

Shaw®

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint\CRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg   Layout: B1-B5-B8-B12(2)-B16-B17-B18-B19-B22   User: maria.portacio   Feb 02, 2011 – 3:06pm

BORING NO. B-17

COORDINATES:

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 3 ft. bgs

DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5573	600		Against Wall Analyze 17 SC-H-0-0.5' 2:55	SM		SILTY SAND WITH ORGANICS, Moist, dark brown, loose 0.5'
.5	5496	1000		Fill Dirt along Base of Wall Hold 17 SC-H-0-0.5' 2:30			Same as above 1.0'
1.0	5378	800		Hold 17 SC-H-1.0-1.5' 2:40			Same as above 1.5'
1.5	5364	800		1.0' Below Clean Analyze 17 SC-H-1.5-2.0' 2:45			Same as above 2.0'
2.0	5392	600		Hold 17 SC-H-2.0-2.5' 2:50			Same as above 2.5'
2.5	5464	800					Same as above 3.0'
3.0							
3.5							

TOTAL DEPTH OF BORING IS 3 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM - Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

Shaw

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B1-B5-B8-B12(2)-B16-B17-B18-B19-B22 User maria.portacio Feb 03, 2011 - 8:56am

BORING NO. B-16

COORDINATES:

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 2 ft. bgs

DATE BEGAN 11/18/10
DATE FINISHED 11/18/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	DESCRIPTION
0					SM	0–4" SILTY SAND (SM), Brown, moist, firm, organics 4" SAND (SW), Moist, mud brown, firm
0–.5	5373	1500				
.5						0.5'
.5–1.0	5505	1500		Analyze 16–SC–B–0.5–1.0' 8:30 216–SC–B–0.5–1.0' DUPLICATE	SW	TRACE GRAVEL, Up to 1" diameter, sub–angular
1.0–1.5	5382	1500				
1.5–2.0	5315	2000		16–SC–B–1.5–2.0' 8:40		SOMETHING HARD
2.0						2.0'
2.5						
3.0						
3.5						

TOTAL DEPTH OF BORING IS 2 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA–PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44–2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT–137165–A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT–137165–A1.dwg Layout: B1–B5–B8–B12(2)–B16–B17–B18–B19–B22 User: maria.portacio Feb 02, 2011 – 3:05pm

BORING NO. B-12

COORDINATES:

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 5.5 ft. bgs

DATE BEGAN 11/18/10
DATE FINISHED 11/18/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
3.5	5281	2000		Hold 12-SC-B-9.5-4.0' 9:58	SP	░	SAND (SP), Redish brown, moist, firm, dense, very fine, grained
4	5334	2200				░	4.2'
					CL	▨	CLAY (CL), Redish brown, moist, dense
							4.5'
4.5	5397	2200		Hold 12-SC-B-4.5-5.0' 10:05		▨	Same as above, gray
							5.0'
5	5263	2200				▨	Same as above
							5.5'
5.5							
6							
6.5							
7							3.5'

TOTAL DEPTH OF BORING IS 5.5 FEET

PAGE 2 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludium 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

Shaw

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint\TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B1-B5-B8-B12(2)-B16-B17-B18-B19-B22 User: maria portacio Feb 02, 2011 – 3:05pm

BORING NO. B-12

COORDINATES: ____________

FIELD GEOLOGIST T. Wentz

CHECKED BY C. Generous

APPROVED BY C. Generous

TOTAL DEPTH 5.5 ft. bgs

DATE BEGAN 11/18/10

DATE FINISHED 11/18/10

TOC ELEV. ____________

HOLE SIZE ____________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	DESCRIPTION
0	5428	750			SM	SILTY SAND (SM), Moist, brown dark, trace gravel, organics 0.5'
.5	5567	1000		Analyze 12-SC-B-9.5-1.0' 9:40		SAND (SW), Mod brown (fill), moist, firm-dense, 10% gravel, up to 1" diameter, sub angular 1.0'
-1.0	5329	1200				Same as above 1.5'
-1.5	5339	1200		Hold 12-SC-B-1.5-2.0' 9:45	SW	Same as above 2.0'
-2.0	5486	1000				COLOR CHANGE @ 2.2'
-2.5	5336	1500		Hold 12-SC-B-2.5-3.0' 9:50		2.75' CLAY AS ABOVE
-3.0	5379	1500			CL	3.5'
-3.5						

TOTAL DEPTH OF BORING IS 5.5 FEET

PAGE 1 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

XREF Files: IMAGE Files: Bothell_e&s.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B1-B5-B8-B12(2)-B16-B17-B18-B19-B22 User: maria.portacio Feb 02, 2011 - 3:04pm

BORING NO. B-8

COORDINATES: ______________

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 2 ft. bgs
DATE BEGAN 11/18/10
DATE FINISHED 11/18/10
TOC ELEV. ______________
HOLE SIZE ______________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0	5370	1000		Analyze 8-SC-B-0.5-1.0' 9:30	SM		SILTY SAND WITH ORGANICS, Moist, dark brown, loose, well rounded, cobbles up to 2", roots 0.5'
.5	5563	800					SILTY SAND With well rounded cobbles up to 3', brown, loose 1.0'
1.0	5489	7QTS		Hold 8-SC-B-1.5-2.0' 10:00	GM		Same as above, post hole 1.5'
1.5	5496	8QTS					Same as above, post hole 2.0'
2.0							REFUSAL At 2'
2.5							
3.0							
3.5							

TOTAL DEPTH OF BORING IS 2 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger / Post Hole Digger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

BORING NO. B-5

COORDINATES:

FIELD GEOLOGIST T. Wentz
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 3 ft. bgs

DATE BEGAN 11/17/10
DATE FINISHED 11/17/10
TOC ELEV.
HOLE SIZE

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
0 – .5	5300	1000		Hold 5-SC-B-0.0-0.5' 10:45	CL	▨	DARK GRAY, Moist, wet, organics-roots 0.5'
.5 – 1.0	5402	1000				▨	COBBLE @ .5' Same as above 1.0'
1.0 – 1.5	5590	2000		Analyze 5-SC-B-1.0-1.5' 10:55	CL	▨	Same as above with fine sand, trace gravel 1.5'
1.5 – 2.0	5322	1500			SP	░	SAND (SP), Gray, wet, firm 2.0'
2.0 – 2.5	5260	2000		Hold 1-SC-B-2-2.5' 11:20	∇ SP	░	CLAY Layer @ 2.1' @ 2.2' (11:28) SAND (SP), Gray, wet firm 2.5'
2.5 – 3.0	5461	2000			CL	▨	CLAY (CL), Gray, wet, firm 3.0'
3.0 – 3.5							

TOTAL DEPTH OF BORING IS 3 FEET

PAGE 1 OF 1

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludium 2221/44-2 (1"X1" NaI)

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO.: BT-137165-A1
DATE	01/24/11	APPROVED BY	C. GENEROUS	2/2011	

Shaw

XREF Files: IMAGE Files: Bothell site.jpg
File: N:\Project\draft\USNavy\Sandpoint TCRA\137165\Summary Report\Boring Logs\BT-137165-A1.dwg Layout: B1-B5-B8-B12(2)-B16-B17-B18-B19-B22 User: maria.portacio Feb 02, 2011 - 3:03pm

BORING NO. B-66

COORDINATES: ______________

FIELD GEOLOGIST T. O'Connor
CHECKED BY C. Generous
APPROVED BY C. Generous
TOTAL DEPTH 5 ft. bgs

DATE BEGAN 11/19/10
DATE FINISHED 11/19/10
TOC ELEV. ______________
HOLE SIZE ______________

DEPTH IN FEET	CPM	RECOVERY VOLUME (ML)	PID (ppm)	REMARKS	USCS	PROFILE	DESCRIPTION
3.5	5398	900		Hold 65-SC-R-3.5-4.0' 2:45		▨	CLAY (CL), Gray, moist, dense
4.0	5439	700		Hold 66-SC-R-4.0-4.5' 2:50	CL	▨	4.0' Same as above
4.5	5514	500		Hold 66-SC-R-4.5-5.0' 2:55		▨	4.5' Same as above
5.0					▽		● 61" 5.0'
5.5							
6.0							
6.5							
7.0							

TOTAL DEPTH OF BORING IS 5 FEET

PAGE 2 OF 2

DRILLER : N/A
DRILLING CO. :
DRILLING METHOD : Hand Auger
SAMPLING METHOD :
PROJECT : USN NAVSTA-PS
LOCATION : Seattle, Washington
PROJECT NO. : 137165

CPM – Counts Per Minute Using a Ludlum 2221/44-2 (1"X1" NaI)

Shaw®

DRAWN BY	MPORTACIO	CHECKED BY	T. O'CONNOR	2/2011	DRAWING NO. : BT-137165-A1
DATE	02/3/11	APPROVED BY	C. GENEROUS	2/2011	

Attachment 9
Soil Characterization Boring Data

Attachment 9 Soil Characterization Boring Data

BORING NUMBER	START DEPTH (FEET)	END DEPTH (FEET)	DOWNHOLE GAMMA LOGGING (CPM)(1)	BOWL SCREENING (CPM)	SAMPLE ID	ANALYSIS(2)	HOLD(3)	RA-226 (PCI/G)(4)	LAB QUALIFIER	SR-90 (PCI/G)	LAB QUALIFIER
1	0.0	0.5	1231	5416							
1	0.5	1.0	1601	5365	1-SC-B-0.5-1.0		X				
1	1.0	1.5	1875	5312							
1	1.5	2.0	1914	5500	1-SC-B-1.5-2.0	X		0.46		0.12	U(5)
1	2.0	2.5	1802	5403							
1	2.5	3.0	1897	5388	1-SC-B-2.5-3.0		X				
5	0.0	0.5	1855	5300	5-SC-B-0.0-0.5		X				
5	0.5	1.0	2212	5402							
5	1.0	1.5	2113	5598	5-SC-B-1.0-1.5	X		1.05		-0.04	U
5	1.5	2.0	1931	5322							
5	2.0	2.5	1885	5260	5-SC-B-2.0-2.5		X				
5	2.5	3.0	no data(6)	5461							
8	0.0	0.5	1322	5370							
8	0.5	1.0	1618	5563	8-SC-B-0.5-1.0	X		0.50		0.34	
8	1.0	1.5	1788	5489							
8	1.5	2.0	1816	5496	8-SC-B-1.5-2.0		X				
12	0.0	0.5	1685	5428							
12	0.5	1.0	2012	5567	12-SC-B-0.5-1.0	X		0.41		-0.01	U
12	1.0	1.5	2118	5324							
12	1.5	2.0	2034	5339	12-SC-B-1.5-2.0		X				
12	2.0	2.5	1891	5486							
12	2.5	3.0	1852	5336	12-SC-B-2.5-3.0		X				
12	3.0	3.5	1817	5379							
12	3.5	4.0	1826	5281	12-SC-B-3.5-4.0		X				
12	4.0	4.5	1873	5334							
12	4.5	5.0	2001	5397	12-SC-B-4.5-5.0		X				

Attachment 9 Soil Characterization Boring Data

12	5.0	5.5	1988	5263							
16	0.0	0.5	1511	5373							
16	0.5	1.0	1630	5505	16-SC-B-0.5-1.0	X		0.87		0.10	U
16	1.0	1.5	1618	5382							
16	1.5	2.0	1632	5375	16-SC-B-1.5-2.0		X				
17	0.0	0.5	1850	5573	17-SC-H0-0-0.5	X		2.17		0.08	U
17	0.5	1.0	1744	5496							
17	1.0	1.5	1675	5378	17-SC-H-1.0-1.5		X				
17	1.5	2.0	1692	5384	17-SC-H-1.5-2.0	X		0.37		0.29	
17	2.0	2.5	1617	5392	17-SC-H-2.0-2.5		X				
17	2.5	3.0	1738	5464							
18	0.0	0.5	1562	5578	18-SC-B-0-0.5	X		0.65		0.13	U
18	0.5	1.0	2025	5346							
18	1.0	1.5	2056	5427							
18	1.5	2.0	1938	5386							
19	0.0	0.5	1509	5448	19-SC-B-0-0.5	X		0.36		0.38	
19	0.5	1.0	1645	5409							
19	1.0	1.5	1708	5379	19-SC-B-1.0-1.5		X				
19	1.5	2.0	1807	5394							
22	0.0	0.5	1715	5583							
22	0.5	1.0	2132	5637	22-SC-B-0.5-1.0	X		0.89		0.04	U
22	1.0	1.5	1994	5488							
22	1.5	2.0	1922	5394	22-SC-B-1.5-2.0		X				
22	2.0	2.5	1909	5506							
22	2.5	3.0	1831	5383	22-SC-B-2.5-3.0		X				
23	0.0	0.5	4726	5894							
23	0.5	1.0	3527	5902	23-SC-H-0.5-1.0	X		5.88		0.14	U
23	1.0	1.5	2380	5626							
23	1.5	2.0	2179	5599	23-SC-H-1.5-2.0		X				
23	2.0	2.2	no data	5552	23-SC-H-2.0-2.2	X		1.54		0.17	U

24	0.0	0.5	19679	5949	24-SC-H-0-0.5		X				
24	0.5	1.0	54509	6349							
24	1.0	1.5	155343	16891	24-SC-H-1.0-1.5	X		420.00		0.16	U
24	1.5	2.0	63730	10443							
24	2.0	2.5	20019	7983	24-SC-H-2-2.5		X				
24	2.5	3.0	8465	6881							
24	3.0	3.5	4712	6640	24-SC-H-3.0-3.5		X				
24	3.5	4.0	3569	5586							
24	4.0	4.5	2964	5487	24-SC-H-4.0-4.5		X				
24	4.5	5.0	2532	5435	24-SC-H-4.5-5.0	X		3.20		0.02	U
25-2	0.0	0.5	1392	5209							
25-2	0.5	1.0	1520	5296							
25-2	1.0	1.5	1699	5440							
25-2	1.5	2.0	1732	5293							
25-2	2.0	2.5	1785	5362							
25-2	2.5	3.0	no data	5521							
28	0.0	0.5	1695	5338							
28	0.5	1.0	1938	5551	28-SC-B-.5-1.0		X				
28	1.0	1.5	1926	5458							
28	1.5	2.0	1901	5534	28-SC-B-1.5-2.0		X				
28	2.0	2.5	1924	5489							
28	2.5	3.0	1842	5615	28-SC-B-2.5-3.0	X		0.56		0.00	U
28	3.0	3.5	1863	5433							
28	3.5	4.0	1752	5379	28-SC-B-3.5-4.0		X				
28	4.0	4.5	1896	5483							
29	0.0	0.5	6154	5635	29-SC-H-0-0.5	X		34.10		0.08	U
29	0.5	1.0	3889	5570							
29	1.0	1.5	2375	5355	29-SC-H-1-1.5		X				
29	1.5	2.0	2018	5452							
29	2.0	2.5	2064	5481	29-SC-H-2-2.5	X		0.79		0.12	U

29	2.5	3.0	1987	5442							
30	0.0	0.5	1950	5347							
30	0.5	1.0	2296	5486	30-SC-B-0.5-1.0	X		1.21		-0.18	U
30	1.0	1.5	1968	5396							
30	1.5	2.0	1815	5240	30-SC-B-1.5-2.0		X				
30	2.0	2.5	1688	5414							
30	2.5	3.0	1608	5352	30-SC-B-2.5-3.0		X				
49	0.0	0.5	1942	5593	49-SC-H-0-0.5	X		1.86		0.13	U
49	0.5	1.0	1959	5349							
49	1.0	1.5	2109	5418	49-SC-H-1.0-1.5		X				
49	1.5	2.0	2092	5449	49-SC-H-1.5-2.0	X		0.61		0.16	U
51	0.0	0.5	2738	5604	51-SC-H-0-0.5	X		0.82		0.12	U
51	0.5	1.0	2022	5317							
51	1.0	1.5	1833	5540	51-SC-H-1.0-1.5		X				
51	1.5	2.0	1866	5467	51-SC-H-1.5-2.0	X		0.62		0.18	
51	2.0	2.5	1819	5305							
56	0.0	0.5	2235	6130	56-SC-H-0-0.5	X		1.47		0.07	U
60	0.0	0.5	1930	7367	60-SC-H-0-0.5	X		64.60		0.14	U
60	0.5	1.0	1912	5367							
60	1.0	1.5	1759	5465	60-SC-H-1.0-1.5		X				
60	1.5	2.0	1839	5512	60-SC-H-1.5-2.0	X		0.56		-0.09	U
60	2.0	2.5	no data	5537	60-SC-H-2.0-2.5		X				
61	0.0	0.5	1585	5332							
61	0.5	1.0	1957	5497	61-SC-B-0.5-1.0	X		0.62		0.00	U
61	1.0	1.5	1949	5402							
61	1.5	2.0	1886	5407	61-SC-B-1.5-2.0		X				
61	2.0	2.5	1819	5468							

Attachment 9 Soil Characterization Boring Data

Note(s):
(1) cpm = counts per minute
(2) Sample submitted to Lab for immediate analysis.
(3) Sample submitted to Lab only to hold for possible future analysis.
(4) pCi/g = picocuries per gram
(5) Lab qualifier "U" indicates that the result is less than the sample detection limit.
(6) No gamma logging data due to final depth not reached; possibly due to slough at bottom of boring.

Attachment 10
Building 27 and Building 2 Security Plan

Former Naval Station Puget Sound, Seattle Washington – Task Order FZN4
Building 27 and Building 2 Security Plan
12/7/10

FINAL

1. Purpose and Scope

This procedure describes the steps that will be taken to assure there is no unauthorized access to radiological controlled areas in and around Building 27 and Building 2 at Former NSPS following demobilization of Shaw at the end of survey activities. Survey activities are expected to be completed by the end of October 2010.

2. General

- The highest concentrations of radioactivity (in the former radium room sink drain piping, storm drain catch basins, and Building 27 flooring) will be removed prior to demobilization.
- All loose surface radioactivity on floors and building components will be contained with plastic and warning signs.
- All waste in Baker Tanks and Settling Tanks will be disposed of offsite prior to demobilization.
- Buildings and surrounding areas will be secured to prevent unauthorized access to remaining radioactivity. See the three attached drawings for details concerning placement of fencing, locked doors, plywood barriers and signage at Buildings 27 and 2.
- Padlocks placed on security doors for both the Bldg 27 South Shed and Bldg 2 will be liked-keyed with the keys maintained at the Shaw Bothell, WA offices.
- First responders will be notified of remaining radioactivity.
- Signage will be posted to provide warnings and response number. The three signs that will be used are attached.
- Shaw will provide weekly inspection of the site to ensure security remains intact. A Security Checklist (attached) will be used to conduct the weekly inspection. Shaw personnel anticipated to perform the weekly inspection are the following: Patrick Moore (Health and Safety Manager) as the primary inspector, with Tim O’Connor (Field Geologist), and Chris Generous (Project Manager) as backup inspectors in case Mr. Moore is not available.

3. Building 27 – South Shed

- Plywood will be placed over all existing windows to prevent access. Most of the first floor windows are currently covered with plywood but will be checked to assure they are secure.
- A heavy duty hasp and padlock will be installed on the single door on the south wall of the southwest tower. This is the only door to the SW tower. Only Shaw will have a key to the padlock in order to maintain control of the building. This will be the case for all locks on the south shed and south tower doors.
- Shaw will maintain access by Arena Sports employees to the former electrical room on the 1st floor of the SE Tower (in order to access main water shut off valve). A plywood barrier will be placed on the 1st floor stairwell of the SE Tower to prevent access to the 2nd floor and a plywood barrier will also be erected to prevent access beyond the former electrical room to the rest of the 1st floor spaces.

- "Controlled Area" signs will be placed on the outside doors of the south shed and tower doors. These signs include a mobile phone number for contacting Shaw personnel (Patrick Moore).
- "Radiological Controlled Area" signs will be placed inside the locked doors and in the case of the SE Tower inside the blocked stairwell.
- A temporary fence on blocks will be run from the southeast wall directly south to the fence that lines the NOAA Road.
- A temporary fence on blocks will enclose the southwest corner of the building and the grass area on the west side of Building 27 (approximately 120 feet by 70 feet).

4. Building 2

- Building 2 will not require as much security measures as it is relatively secure already.
- Hasps and padlocks will be placed on doors providing access to the former Instrument Shops. Only Shaw will have a key in order to maintain control of the building.
- "Controlled Area" signs will be placed on the outside doors of the 1st floor and 2nd floor entries into the affected areas.
- "Radiological Controlled Area" signs will be placed inside the locked doors.

Former Naval Station Puget Sound, Seattle Washington – Task Order FZN4
Building 27 and Building 2 Security Plan

Weekly Security Checklist

Item	Inspection Requirements	Sat	Unsat	Comments
1	Are all doors locked and secured?			
2	Are all plywood barriers in place and secured?			
3	Are all window barriers in place and secured?			
4	Are all "Controlled Area" signs in place and in good condition?			
5	Are all readily accessible "RCA" and "CA" signs in place and in good condition?			
6	Is the Bldg 27 South Shed perimeter fence in place and in good condition?			
7	Is filter mesh at catch basins within fenced area in place and functioning properly?			
8	Are perimeter fence radiation survey results at background levels?			

Inspector's Printed Name	Inspector's Signature	Date

Forward completed forms to:

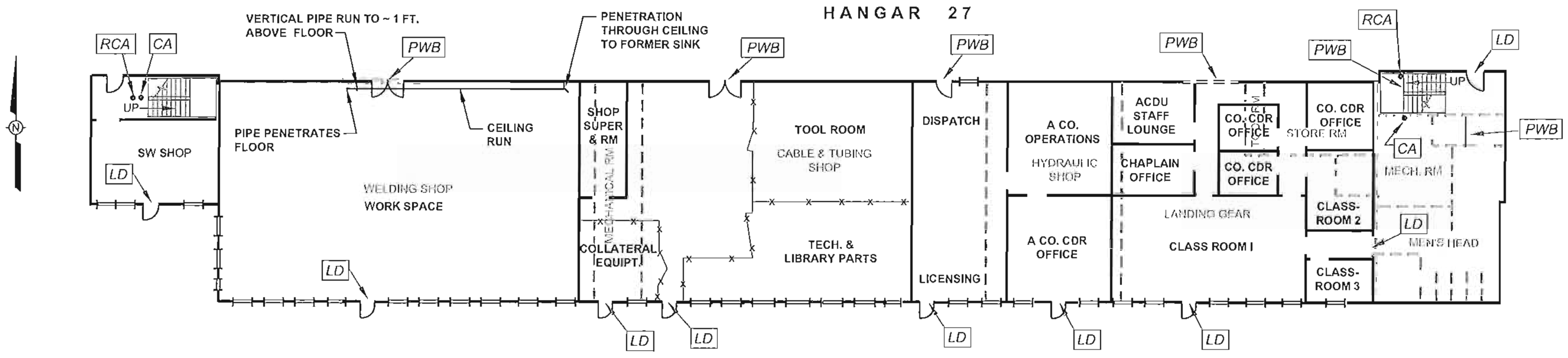
Dwight Leslie, NAVFAC NW
dwight.leisle@navy.mil

Patrick Moore, Shaw
pat.moore@shawgrp.com

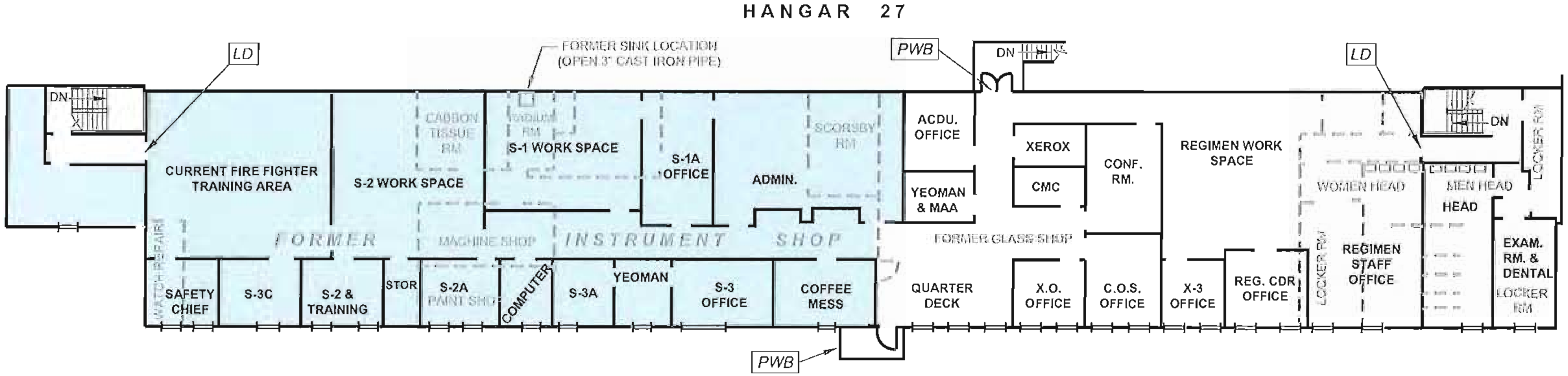
Marrell Livesay, Seattle
Marrell.Livesay@Seattle.gov

Laurie Lowman, RASO
Laurie.Lowman@Navy.mil

Jarvis Jensen, RASO
Jarvis.Jensen@Navy.mil



FIRST FLOOR PLAN



SECOND FLOOR PLAN

LEGEND:

- - - - - OUTLINE OF BUILDING (1943)

——— OUTLINE OF BUILDING (1985)

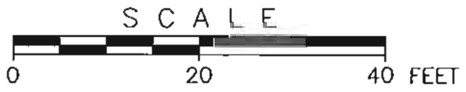
▭ FORMER INSTRUMENT SHOP AREA

PWB PLYWOOD BARRIER

LD LOCKED DOOR

RCA RADIOLOGICALLY CONTROLLED AREA SIGN

CA CONTAMINATED AREA SIGN



SOURCE: US NAVAL STATION, SEATTLE WASHINGTON
BUILDING 27 PLAN - 1985 (DRAWING #54151)
1943 (DRAWING #54080)

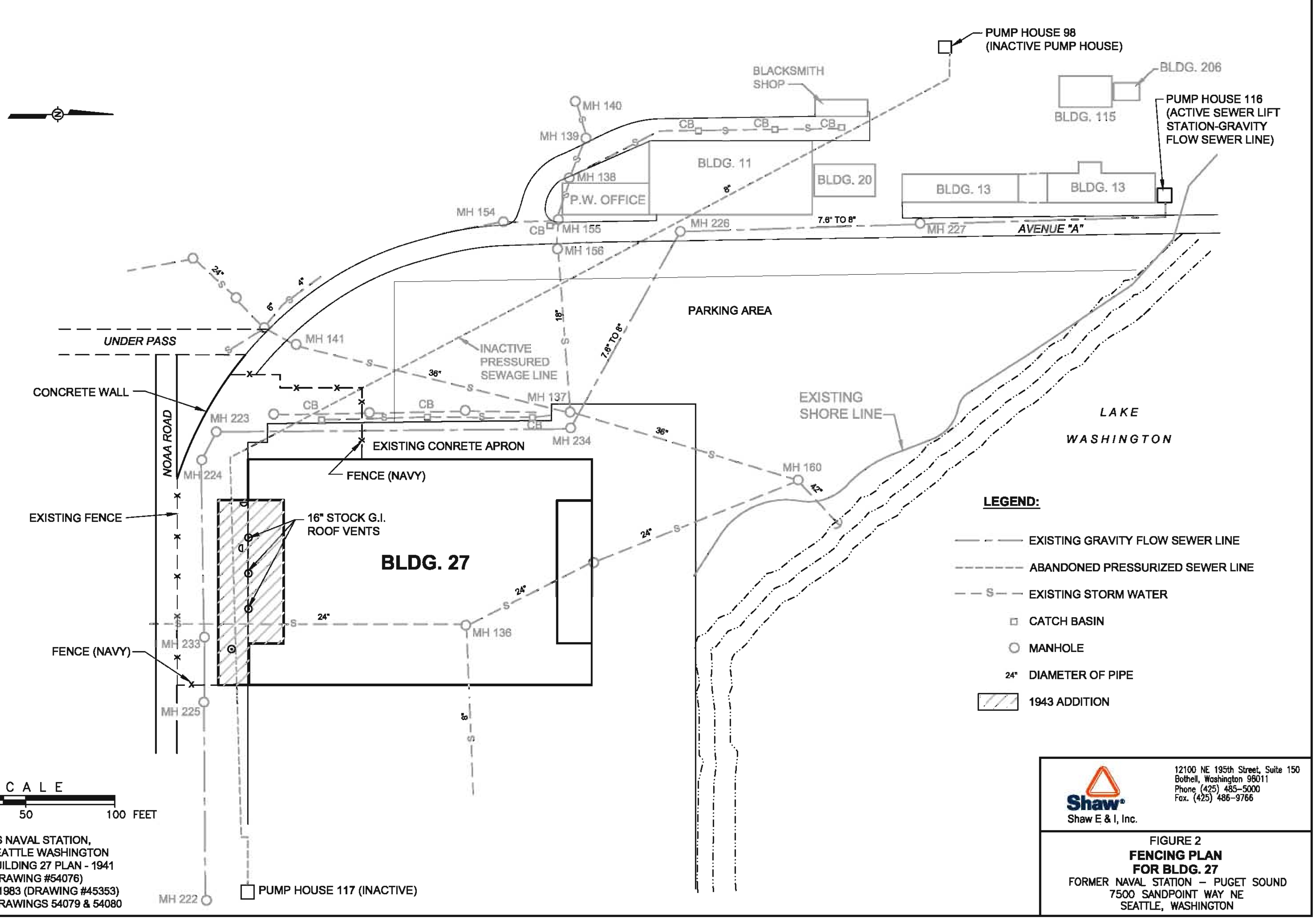
NOTE:
EACH PWB & LD WILL BE POSTED AS A "CONTROLLED AREA" WITH A SHAW CONTACT #________.

Shaw®
Shaw E & I, Inc.
12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax (425) 486-9766

FIGURE 1
SECURITY PLAN
FOR BLDG. 27
FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
BOTHELL	MPortacio 08/2010	CG 08/10	CG 08/10	BT-137165-B27-F1

10:31am User: mario.portacio Aug 19, 2010 – 10:31am Layout: FIGURE
File: N:\Project\draft\USNavy\Sandpoint TCRA\Drawings\137165\BT-137165-B27-F1.dwg
XREF Files: IMAGE Files: 2835_001_Page_1.jpg
BLDG27-1943.jpg



LEGEND:

— · —	EXISTING GRAVITY FLOW SEWER LINE
- - - -	ABANDONED PRESSURIZED SEWER LINE
— S —	EXISTING STORM WATER
□	CATCH BASIN
○	MANHOLE
24"	DIAMETER OF PIPE
▨	1943 ADDITION

SOURCE: US NAVAL STATION,
SEATTLE WASHINGTON
BUILDING 27 PLAN - 1941
(DRAWING #54076)
& 1983 (DRAWING #45353)
DRAWINGS 54079 & 54080

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
BOTHELL	MPortacio 08/2010	CG 09/10	CG 09/10	BT-137165-B27-F5

XREF Files: IMAGE Files: 2835_001_Page_1.jpg
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File: N:\Project\draft\USNavy\Sandpoint TCRA\Drawings\137165\BT-137165-B27-F5.dwg Layout: FIGURE User: maria.portacio Sep 29, 2010 - 4:12pm

Shaw®
Shaw E & I, Inc.

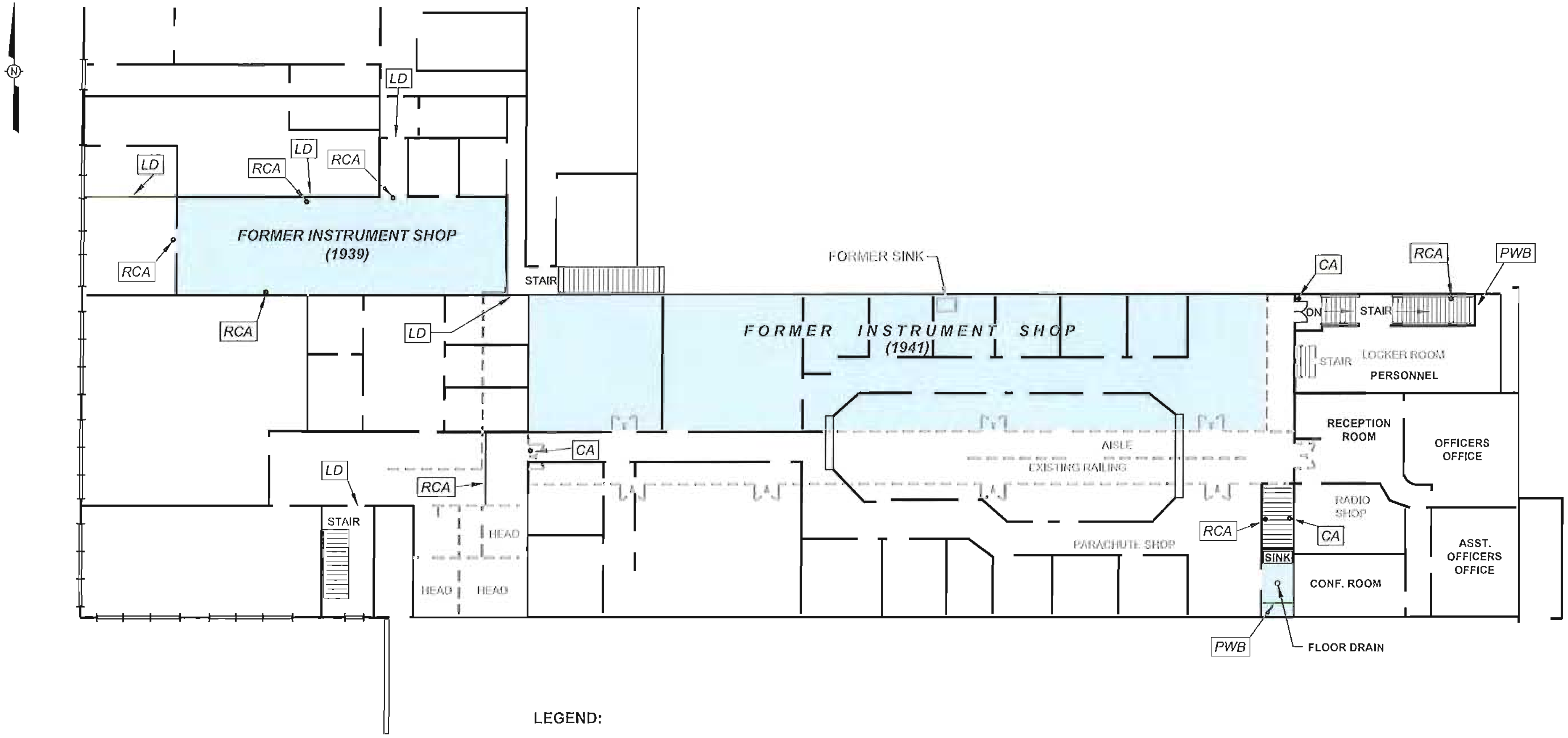
12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766

FIGURE 2

FENCING PLAN FOR BLDG. 27

FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
BOTHELL	MPortacio 08/2010	CG 08/10	CG 08/10	BT-137165-B27-F3



LEGEND:

– – – – –	OUTLINE OF BUILDING (1941)
———	OUTLINE OF BUILDING (1986)
🟦	FORMER INSTRUMENT SHOPS
PWB	PLYWOOD BARRIER
LD	LOCKED DOOR
RCA	RADIOLOGICALLY CONTROLLED AREA SIGN
CA	CONTAMINATED AREA SIGN

NOTE:
EACH PWB & LD WILL BE POSTED AS A "CONTROLLED AREA" WITH A SHAW CONTACT #________

SCALE
0 20 40 FEET

SOURCE: US NAVAL STATION, SEATTLE WASHINGTON
BUILDING 2 PLAN - 1986 (DRAWING #50263)
1941 (DRAWING #50106)
1939 (DRAWING #50030)

12100 NE 195th Street, Suite 150
Bothell, Washington 98011
Phone (425) 485-5000
Fax. (425) 486-9766

Shaw E & I, Inc.

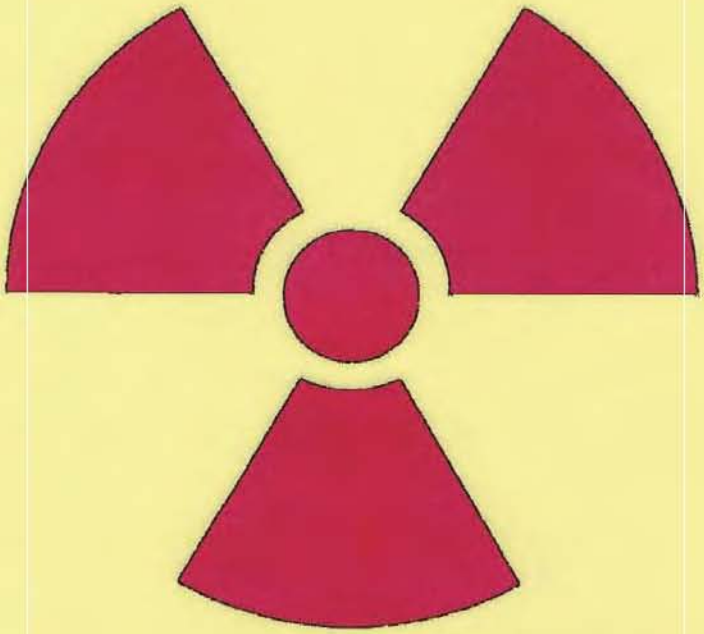
FIGURE 3
SECURITY PLAN
FOR BLDG. 2
FORMER NAVAL STATION – PUGET SOUND
7500 SANDPOINT WAY NE
SEATTLE, WASHINGTON

XREF Files: IMAGE Files: 50106.tif 50172.tif bldg2-1986.jpg
File: N:\Project\Draft\USNavy\Sandpoint TCRA\Drawings\137165\BT-137165-B27-F3.dwg Layout: FIG 3 User: maria.portacio Aug 19, 2010 - 11:02am

Controlled Area

Contact Shaw
206.478.6464

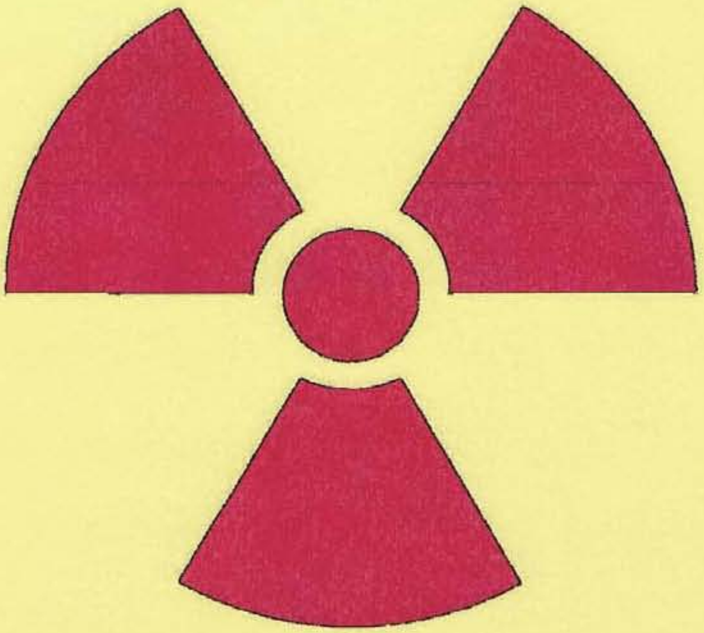
CAUTION



RADIOLOGICAL CONTROL AREA

RWP Required for Entry

CAUTION



CONTAMINATION AREA

Authorized Personnel Only

Attachment 11
Stormwater Catch Basin Sediment Removal and Stabilization Plan

Former Naval Station Puget Sound, Seattle Washington – Task Order FZN4
Stormwater Catch Basin Sediment Removal and Stabilization Plan
September 22, 2010

1. Purpose and Scope

The following field activities plan describes the steps that will be taken to remove sediment from Catch Basins #1 and #3 located south and Catch Basin #5 located west of Building 27. The plan is intended to supplement the Final Work Plan and Accident Prevention Plan, Time Critical Removal Action Former Naval Station Puget Sound, Seattle, Washington dated April 2010 prepared under Task Order FZN4. These interim measures are intended to reduce the potential for sediment containing elevated radium 226 found near the bottom of these three catch basins from migrating into larger down-gradient stormwater pipes during the winter rainy season in Seattle. A final remedy (if necessary) will be addressed at a later date once site data has been thoroughly reviewed and analyzed.

2. Catch Basin Sediment Removal

- The catch basin will be surveyed for radiological contamination and breathing zone air quality using appropriate meters and procedures as addressed in the existing work plans to determine appropriate PPE.
- Qualified and trained workers will don the necessary personal protective equipment (PPE) and appropriate worker safety monitoring will be performed prior and during work. Anticipated PPE will include hard hat, safety glasses, steel toed boots, Tyvek® coveralls, nitrile gloves, and protective shoe covers.
- Plastic (6 ml) will be placed on the ground surrounding each catch basin to contain liquids and sediments during sediment removal operations.
- The pipes at each catch basin will be plugged with expandable plugs to prevent water from entering and exiting the catch basin.
- Once the pipes are plugged, the liquid will be pumped to a DOT-approved 55-gallon drum. The sediment will then be removed with a trowel, shovel, or similar piece of equipment and transferred to a separate DOT approved 55-gallon drum.
- Field notes, instrument readings, and pictures will be collected and recorded during work activities.

3. Catch Basin Stabilization

- Once the sediments within each catch basin have been removed to the extent possible, the bottom of each catch basin will be surveyed to assess if contamination above release criteria remains.
- Radiological surveys will consist of total and removable alpha and beta/gamma contamination and results will be compared to site limits found in Table 3.12 of the Radiation Protection Plan (attached).
- In the event contamination remains above release criteria, a layer of fast setting cement will be placed over the bottom of the catch basin to encapsulate any remaining contamination. As stated, earlier the activities outlined in this plan are intended to serve as an interim measure. A final remedy (if necessary) will be developed at a later date.

- All equipment, plastic, and PPE used during this work will be surveyed, cleaned, and released or will be placed in a drum, moved to the radiological storage area in Building 27 and labeled pending disposal.

4. Waste Handling/Disposal

- The drums will be moved to the designated radiological waste storage area in Building 27, labeled, and secured pending disposal. Samples will be collected for laboratory analyses as required for waste characterization and disposal.
- The sediment will be treated with absorbent additive as necessary to meet the disposal requirement of no free standing water. This was addressed with the waste disposal contractor Mr. Thom Dias with EMS.
- The water will be discharged to the sanitary sewer under a current sewer discharge permit with King County upon receipt of laboratory analyses.

Table 3.12 (From Radiation Protection Plan)
Free Release Criteria for Surfaces/Objects

	Surfaces Equipment, Waste, and Structures[a]			
Radium-226	Total (dpm/100cm^2)	Removable (dpm/100cm^2)	Soil and Sediment[c]	Water[d] (pCi/L)
Alpha	100	20	Greater than mean statistical background level plus three standard deviations	3[e]
Beta-gamma	5,000	1,000		

Note(s):

[a] *These limits are based on Atomic Energy Commission Regulatory Guide 1.86 (1974) and are consistent with WAC 246-232-140, Schedule D.*

[b] *Deleted by FCN-02 (maximum limits removed).*

[c] *These limits are based on the Statement of Work for this Task Order (Revised 03 September 2009).*

[d] *Release criteria for water have been derived from Radionuclides Notice of Data Availability Technical Document (EPA, 2000) by comparing the limits from two criteria and using the most conservative limit.*

e Limit is for total radium concentration.

dpm denotes disintegrations per minute.

cm^2 denotes square centimeters.

pCi/L denotes picocurie per liter.

Attachment 12
King County Sanitary Sewer Discharge Permit

King County
Wastewater Treatment Division
Industrial Waste Program
Department of Natural Resources and Parks
130 Nickerson Street, Suite 200
Seattle, WA 98109-1658
206-263-3000 Fax 206-263-3001
TTY Relay: 711

September 1, 2010

Dwight E. Leisle, P.E.
Environmental Restoration
NAVFAC NW
1101 Tautog Circle
Silverdale, WA 98315-1101

Letter of Authorization 11204-01 to Discharge to the Sanitary Sewer

Dear Mr. Leisle:

The King County Industrial Waste Program has reviewed your request to discharge construction dewatering to the sanitary sewer from the United States Navy - Former Naval Station Puget Sound clean-up construction project located at 7500 Sand Point Way NE, Seattle, Washington (phone number, 425-402-3208). In accordance with King County Code 28.84.060 (copy available on-line at: www.kingcounty.gov/council/legislation), King County grants approval for the discharge of up to 25,000 gallons per day from September 2, 2010, through September 30, 2010, provided that:

- You obtain the required approval from Seattle Public Utilities before discharge to allow for permitting of a connection to the sanitary sewer and assessment of sewer charges. Please call Susie Larson, 206-684-5158, to obtain required approval.
- You meet the discharge limitations, special conditions, monitoring and reporting requirements listed below.

Discharge Limitations

Discharge Rate	50 gallons per minute (gpm)
Maximum Daily Discharge Volume	25,000 gallons per day (gpd)
Settleable Solids (by Imhoff Cone)	7.0 mL/L
pH Minimum	5.5 s.u.
pH Maximum	12.0 s.u.

There shall be no odor of solvent, gasoline, or hydrogen sulfide (rotten egg odor), oil sheen, unusual color, or visible turbidity. The discharge must remain translucent. If any of the discharge limits are exceeded, you must stop discharging and notify the King County Industrial Waste Program at 206-263-3000.

Special Conditions

1. The discharge shall not cause hydraulic overloading conditions of the sewerage conveyance system. During periods of peak hydraulic loading, King County and Seattle Public Utilities representatives reserve the authority to request that the discharge to the sewer be stopped.

2. This document permits the discharge of limited amounts of construction dewatering from the construction site into the sanitary sewer. Wastes or contaminants from sources other than permitted herein shall not be discharged to the sanitary sewer without prior approval from the King County Industrial Waste Program.

3. The contractor shall implement erosion control best management practices (BMPs) to minimize the amount of solids discharged to the sanitary sewer system. As a minimum precaution, the wastewater must be pumped to an appropriately sized settling tank prior to entering the sewer system.

    a. Discharge point is sanitary sewer manhole number 234 or as otherwise designated by Seattle Public Utilities representatives.

4. Wastewater monitoring logs containing the results of the required field monitoring specified below must be maintained on-site and must be available for review at reasonable times by authorized representatives of King County.

5. This discharge approval is being issued with the understanding that no known soil or groundwater contamination is present on site other than low levels of radium-226. The levels of radium-226 in the wastewater were sampled and the results provided to the Washington State Health Department for review and were approved. The permit holder is responsible for contacting King County should site conditions indicate potential for contamination.

Monitoring Requirements

You shall conduct the following self-monitoring requirements for this discharge authorization:

Parameter	Frequency	Sample Type/Method
Discharge Volume	Daily	Pump estimate
Settleable Solids	Daily	Grab by Imhoff Cone[1]
pH	Daily	Hand held meter

[1] The settleable solids field test by Imhoff Cone must be performed as follows:

- Fill cone to one-liter mark with well-mixed sample.
- Allow 45 minutes to settle.
- Gently stir sides of cone with a rod or by spinning. Settle 15 minutes longer.
- Record volume of settleable matter in the cone as mL/L.

Reporting Requirements

A self-monitoring report (form enclosed) containing results of required self-monitoring and total volume discharged to the sewer shall be submitted to the King County Industrial Waste Program by October 15, 2010.

If you propose to increase the volume of your discharge or change the type or quantities of substances discharged, you must contact the King County Industrial Waste Program at least 60 days before making these changes.

Chapter 28.84 of the King County Code – Water Pollution Abatement sanctions a fee for each letter of authorization issued by the Department of Natural Resources and Parks. The fee for issuance of a letter of authorization in 2010 is $245. You will be sent an invoice for this amount. In addition, the total volume discharged to the sewer is subject to sewer charges that will be billed following the County's receipt of the final self-monitoring report. Normally you will receive the sewer bill from the local sewer agency that operates the sewers where the discharge occurred.

If you have any questions about this authorization, or other questions about your wastewater discharge, please call me at 206-263-3007 or e-mail me at dave.haberman@kingcounty.gov. You may also wish to visit our program's Internet pages at: www.kingcounty.gov/industrialwaste.

Thank you for helping support our mission to protect public health and enhance the environment.

Sincerely,

Dave Haberman
Compliance Investigator

Enclosure

cc: Chris Generous, The Shaw Group
Susie Larson, Seattle Public Utilities
Doug Hilderbrand, King County