DRAFT FINAL DEEP BOREHOLE FSP ADDENDUM
SANTA SUSANA FIELD LABORATORY SITE
AREA IV RADIOLOGICAL STUDY

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SUBJECT:	Deep Borehole FSP Addendum
CONTRACT NO:	EP-S7-05-05
TASK ORDER NO:	0038

INTRODUCTION

HydroGeoLogic, Inc. (HGL) has been tasked by the U.S. Environmental Protection Agency (USEPA) to conduct a radiological characterization study at Area IV and the Northern Buffer Zone of the Santa Susana Field Laboratory (SSFL) site in Ventura County, California. This work is being executed under USEPA Region 7 Architect and Engineering Services Contract EP-S7-05-05, Task Order 0038. The technical lead on the project is USEPA Region 9.

This document describes the placement of 12 deep boreholes for collection of soil samples at locations where use of direct push technology (DPT) was not practical. This document is an addendum to the Field Sampling Plan (FSP) for Soil Sampling (HGL, 2010a) and therefore, a description of the overall project goals; data quality objectives; sample handling; selection of sample depth intervals; ata quality control and data evaluation are omitted because they are already described in the FSP for Soil Sampling (HGL, 2010a).

PURPOSE

This addendum describes the rationale used to determine the location and depth of the boreholes as well as the soil sample collection depth intervals. The 12 boreholes are located within Subareas 5C, 5A, 6 and 7, and are shown in Figures 1 and 2.

The primary purpose of the deep boreholes is to characterize potential radiological contamination in soils beneath the nuclear reactor deep concrete vaults at the Systems for Nuclear Auxiliary Power (SNAP), former Building 4059, the Kinetic Experiment Water Boiler (KEWB), former Building 4073, the Sodium Reactor Experiment (SRE), former Building 4143, and the Shield Test and Irradiation Reactor (STIR), former Building 4028. At the SNAP location, soil samples below the DPT borehole depth within the excavation footprint but above the lowest point of the reactor vault will be collected to characterize potential radiological contamination that may be present in the soil used to backfill the excavation post completion of the decontamination and decommissioning (D&D) of this facility.

For convenience, sample locations depicted in Figures 1 and 2 are also summarized in Table 1 (Attachment 1). This table also presents the recommended laboratory analyses that will be performed for each soil sample according to default suite in Table 2.4 of the FSP for Soil Sampling (HGL, 2010a) and adding site-specific analytes to that list by location as appropriate. The site-specific analytes will include H-3, Ni-59, Ni-63, Tc-99. Samples collected in the SRE complex will also be tested for C-14. It should be noted that the additional radioanalytical methods Alpha 5, LCS 7, Alpha Spec 8, and Alpha Spec I will be requested if plutonium isotopes from method Alpha Spec 7 are reported above Radiological Trigger Levels.

A 100-C Sonic Drill will be used to advance deep borehole soil borings and collect continuous core soil samples. Sonic drilling will be able to drill through subsurface conditions where the DPT would otherwise encounter refusal, such as through concrete or other construction debris. A summary of sonic drilling equipment and capability can be found in Attachment 3.

BOREHOLE LOCATION RATIONALE

All aboveground facility structures and components have been removed from the four areas targeted for placement of these boreholes. At the SNAP location, all below ground structures were excavated and removed as well. However, the excavation and removal of below ground structures at the other three locations were conducted in a way that left some structures and demolition debris in place within the footprint of the excavation. To meet the stated purpose of these boreholes, it is important that these structures and debris be located within the excavation footprint at all four targeted locations. To this end, a review of the Round 1 DPT soil sampling borehole logs was conducted in conjunction with available as-built drawings, aerial photography, historical site assessments and information from the "Gold Standard" database (HGL, 2011a; 2011b; 2011c; and 2010b).

The total depth, location and soil descriptions of the DPT borehole logs were reviewed to determine if the projected building footprints were correct and to locate the reactor vaults. Sample intervals were reviewed to determine if the soil samples were collected at depths that would characterize the soils covered in this addendum. A short discussion of the DPT borings in each area is included below. Tables 2 through 5 in Attachment 1 summarize the borehole logs for each of the buildings.

SNAP Reactor Building (Former Building 4059)

Soil samples collected within the footprint of SNAP Reactor Building, located within Subarea 5C, will consist of three borings, which will be located in the center of the building footprint (Figure 1). Samples will be collected to characterize potential radiological contamination in soil fill used to backfill the excavation. Each boring will be advanced to the underlying bedrock, approximately 55 feet below ground surface (bgs) or the depth at which groundwater is encountered. Samples will be collected in the bottom 5 feet of each boring, if groundwater is encountered a sample will be collected just above the saturated zone. The general procedures for subsurface soil sampling outlined in the FSP for Soil Sampling, Section 4.3 (HGL, 2010a) will continue to be followed.

All previous Round 1 DPT borings in and around the SNAP Reactor Building were in continuous fill material, the total exploration depth of the borings was 10 feet bgs. No samples were collected below 5 feet bgs (Table 2). Deep borehole locations were co-located where abundant construction debris was observed in the DPT borings which corresponded to the projected footprint and as built drawings of the building and reactor vault.

KEWB Reactor Building (Former Building 4073)

Soil samples collected within the footprint of KEWB Reactor Building, located within Subarea 5A, will consist of two borings in and around the excavated reactor vault (Figure 2). Samples will be collected to characterize potential radiological contamination immediately below the reactor vault and in the location of the waste tanks and fuel storage building. Some debris was left behind after the completion of D&D. Each boring will be advanced to the underlying bedrock, approximately 15 feet bgs. Samples will be collected in the bottom 5 feet of each boring. The general procedures for subsurface soil sampling outlined in the FSP for Soil Sampling, Section 4.3 (HGL, 2010a) will continue to be followed.

The four previous DPT boreholes during Round 1 were advanced in and around the KEWB Reactor Building. Only one borehole was located in the projected building footprint and hit refusal on concrete at 5 feet bgs. The other three boreholes hit refusal on bedrock at shallow depths or were located near the foot prints of auxiliary buildings. No samples were collected below 5 feet bgs (Table 3). The deep borehole locations were placed near the DTP borehole that hit refusal on concrete, this area corresponds to the location of the reactor vault in the as built drawings.

SRE Reactor Building (Former Building 4143)

Soil samples collected within SRE Reactor Building, located in Subarea 6 will consist of three borings in and around the former reactor vault (Figure 2). Samples will be collected to characterize potentially contaminated soil fill at the base of the reactor vault used to backfill the excavation of the SRE Reactor Building and vault after D&D was completed. Each boring will be advanced to the underlying bedrock, approximately 25 feet bgs or the depth at which groundwater is encountered. Samples will be collected in the bottom 5 feet of each boring, if groundwater is encountered a sample will be collected just above the saturated zone. The general procedures for subsurface soil sampling outlined in the FSP for Soil Sampling, Section 4.3 (HGL, 2010a) will continue to be followed.

The various boreholes in and around the SRE Reactor Building during Round 1 either encountered refusal on construction debris or encountered fill material at the desired depth of the boreholes. A few borings hit refusal on bedrock below concrete at 18 to 21 feet bgs, in locations that correspond to the as built drawings of the reactor vault. No samples were collected below 5 feet bgs (Table 4). The deep DPT borings helped locate the reactor vault and base of the building which were used to guide the location for the deep boreholes.

STIR Reactor Building (Former Building 4028)

Soil samples collected within STIR Reactor Building, located in Subarea 7, will consist of four borings in and around the former reactor vault (Figure 2). Samples will be collected to characterize potential radiological contamination in soil fill at the base of the reactor pool, fuel storage vault and test vault left behind after the completion of D&D. Each boring will be advanced to the underlying bedrock, approximately 30 feet bgs or the depth at which groundwater is encountered. Samples will be collected in the bottom 5 feet of each boring, if groundwater is encountered a sample will be collected just above the saturated zone. The general procedures for subsurface soil sampling outlined in the FSP for Soil Sampling, Section 4.3 (HGL, 2010a) will continue to be followed.

Three previous DPT borings during Round 1 sampling in the STIR Reactor Building projected footprint hit refusal on bedrock below concrete at 17.5 to 20 feet bgs on the east side of the probable reactor vault location. Samples in these boreholes were collected in the bottom 5 feet of the borehole, thus characterizing the soil at the base of the possible foundation of the reactor vault. The western side of the predicted reactor vault was not determined due to DPT borings hitting shallow refusal or were in locations that the DPT drill rig could not access (Table 5). The deep boreholes were placed around the locations that were not able to be characterized by DPT.

SCHEDULE

The deep borehole soil sampling within Area IV will commence in January 2012. USEPA will provide periodic updates to SSFL Stakeholders regarding the status of the deep boring strategy soil sampling program as well as the laboratory analysis and data interpretation.

REFERENCES

HydroGeoLogic, Inc., 2010a. Field Sampling Plan for Soil Sampling, Area IV Radiological Study, Santa Susana Field Laboratory Ventura County, California. October 2010.

HydroGeoLogic, Inc., 2010b. Revised Draft Technical Memorandum Subarea HSA-5C, Historical Site Assessment Santa Susana Field Laboratory Site – Area IV Radiological Study Ventura County, California. August 2010.

HydroGeoLogic, Inc., 2011a. Draft Technical Memorandum Subarea HSA-7, Subarea HSA-3, Northern Buffer Zone, Historical Site Assessment Santa Susana Field Laboratory Site – Area IV Radiological Study Ventura County, California. August 2011.

HydroGeoLogic, Inc., 2011b. Draft Technical Memorandum Subarea HSA-6, Historical Site Assessment Santa Susana Field Laboratory Site – Area IV Radiological Study Ventura County. June 2011.

HydroGeoLogic, Inc., 2011c. Draft Technical Memorandum Subarea HSA-5A, Historical Site Assessment Santa Susana Field Laboratory Site – Area IV Radiological Study Ventura County, California. January 2011.

LIST OF ATTACHMENTS

ATTACHMENT 1

Table 1
Summary of Sample Locations and Rational Deep Boring Strategy in Area IV

Subarea	Location Identification	Location Description	Borehole Depth	Technical Justification	Analytical Suite[1,2]
5C	1, 2, 3	SNAP Reactor Building, Former Building 4059 Footprint	55 feet bgs or until the underlying sandstone or groundwater is reached.	To characterize potential radiological contamination in soil fill and at the base of the reactor vault. Three borehole locations to be placed in the middle of the building footprint. The total excavation depth is 53 feet bgs.	Default + H-3+Ni-59+ Ni-63+Tc-99
5A	4, 5	KEWB Reactor Building, Former Building 4073 Footprint	15 feet bgs (approximate depth of bottom of reactor vault) or until the underlying sandstone or groundwater is reached.	To characterize potential radiological contamination in soils immediately below the reactor vault and to characterize soils used to backfill the excavations at the KEWB Reactor Building, waste tanks and fuel storage building excavation locations.	Default + H-3+Ni-59+ Ni-63+Tc-99
6	6, 7, 8, 9,	SRE Reactor Building, Former Building 4143 Footprint	25 feet bgs (approximate depth of the reactor vault) or until the underlying sandstone or groundwater is reached.	To characterize potential radiological contamination in soil fill used to backfill the excavation and soils at the base of the reactor vault in former Building 4143 after D&D was completed.	Default + H-3+ C-14 + Ni-59+Ni-63+Tc-99
7	10, 11, 12	STIR Reactor Building, Former Building 4028 Footprint	30 feet bgs or until the underlying sandstone or groundwater is reached.	To characterize potential radiological contamination in soil fill used to backfill the excavation at the base of the former reactor pool, fuel storage vault and test vault left behind after the completion of D&D.	Default + H-3+Ni-59+ Ni-63+Tc-99

Notes:

[1]The default suite includes the radionuclide analysis shown in Table 2.4 of the Field Sampling Plan for Soil Sampling (HGL, 2010a). ALL SAMPLES WILL BE ANALYZED FOR DEFAULT SUITE.

[2]Site-specific analytes were determined in accordance with the rationale presented in Table 2.4 of the Field Sampling Plan for Soil Sampling (HGL, 2010a).

bgs - below ground surface
D&D - decontamination and decommissioning
KEWB - Kinetics Experiment Water Boiler
SNAP - Systems for Nuclear Auxiliary Power
SRE - Sodium Reactor Experiment
STIR - Shield Test Irradiation Reactor
SSFL - Santa Susana Field Laboratory

Table 2
Summary of DPT Borehole Logs SNAP Reactor, Former Building 4059

Boring Identification	Depth (feet bgs)	Sample Interval (feet bgs)	Description of Soil
7	10	1-5	Fill material
9	10	1-5	Fill material, light staining with asphalt and concrete below 6 feet bgs
10	10	1-5	Fill material, staining in lower 6 inches of borehole
11	10	1-5	Fill material, with concrete debris below 7 feet bgs
12	10	1-5	Fill material, rust staining below 7 feet bgs
13	10	1-5	Fill material, asphalt debris and staining
14	10	1-5	Fill material
15	10	1-5	Fill material
16	10	1-5	Fill material
17	10	1-5	Fill material, with staining
21	10	1-5	Fill material
22	10	1-5	Fill material

Notes:

bgs - below ground surface

DPT - Direct push technology

SNAP - Systems for Nuclear Auxiliary Power

Table 3
Summary of DPT Borehole Logs KWEB Reactor Building, Former Building 4073

Boring Identification	Depth (feet bgs)	Sample Interval (feet bgs)	Description of Soil
128	10	1-5	Fill material, with concrete and asphalt debris
129	10	1-5	Fill material, with asphalt debris
133	5	1-5	Encountered refusal on concrete
134	3.5	1 - 3.5	Encountered refusal on bedrock, with asphalt just above Sandstone

Notes:

bgs - below ground surface

DPT - Direct push technology

KWEB - Kinetic Experiment Water Boiler

Table 4
Summary of DPT Borehole Logs SRE Reactor Building, Former Building 4143

Boring Identification	Depth (feet bgs)	Sample Interval (feet bgs)	Description of Soil
68	20	1-5	Encountered refusal at 20 feet bgs on concrete
69	10	1-5	Fill material
70	20	1-5	Encountered refusal on bedrock, sandstone encountered at 19.8 feet bgs just below concrete
71	15	1-5	Encountered refusal on concrete
74	10	1-5	Fill material
75	10	1-5	Fill material, concrete in bottom 2 feet of borehole
77	10	1-5	Fill material, construction debris
79	2.5	1-2.5	Encountered bedrock at 2 feet bgs
80	4	1-4	Encountered refusal on bedrock at 4 feet bgs
88	15	1-5	Encountered refusal on bedrock, sandstone encountered at 14.5 feet bgs
89	10	1-5	Fill material, with concrete debris
118	11.5	1-5	Fill material, encountered bedrock at 11.25 fee bgs
123	9.5	1-5	Encountered refusal on construction debris
124	14	1-5	Encountered refusal on concrete, no gamma scanning below 13.5 feet bgs
125	21	1-5	Encountered refusal on bedrock, sandstone encountered at 20.2 feet bgs

Notes:

bgs - below ground surface

DPT - Direct push technology

SRE - Sodium Reactor Experiment

Table 5
Summary of DPT Borehole Logs STIR Reactor Building Former Building 4028

Boring Identification	Depth (feet bgs)	Sample Interval (feet bgs)	Description of Soil
102	10	1-5	Possibly native soil with iron oxide staining
103	19	14-19	Encountered refusal on bedrock encountered at 19.8 feet bgs
104	20	15-20	Encountered refusal on bedrock encountered at 20 feet bgs
105	5	1-5	Fill material, refusal on sandstone
106	17.5	12.5 - 17.5	Encountered refusal on bedrock encountered at 17.5 feet bgs
107	NA	NA	Not accessible with DPT due to slope
108	NA	NA	Not accessible with DPT due to slope
109	10	1-5	Native soils encountered at 7 feet bgs
128	NA	NA	Not accessible with DPT due to slope
132	9.5	1-5	Encountered refusal on bedrock
171	NA	NA	Not accessible with DPT due to slope
172	10	1-5	Fill material

Notes:

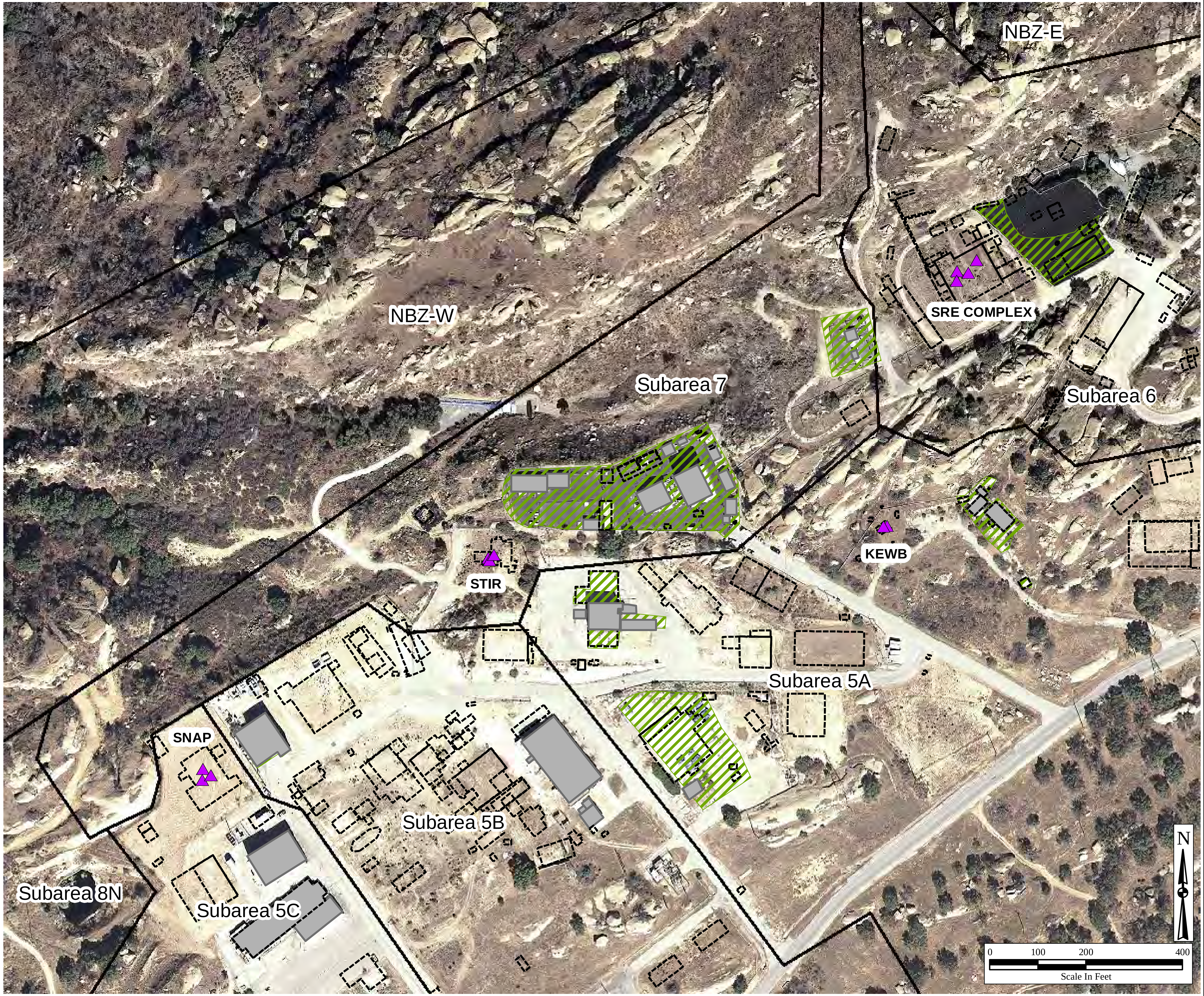
bgs - below ground surface

DPT - Direct push technology

N/A - not applicable

STIR - Shield Test and Irradiation Reactor

ATTACHMENT 2



HGL—Deep Borehole
Field Sampling Plan Addendum
SSFL— Ventura County, California

Figure 1
Proposed Deep Borehole Base Map
Santa Susana Field Laboratory

U.S. EPA Region 9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Legend

Deep Borehole Locations

Likely D&D Remediation Zones

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10/28/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007

HGL HydroGeoLogic, Inc

HGL—Deep Borehole
Field Sampling Plan Addendum
SSFL— Ventura County, California

Figure 2
Proposed Deep Borehole Sample Locations
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

- Deep Borehole Strategy Proposed Sample Locations
- Direct Push Technology Previously Sampled Locations
- Likely D&D Remediation Zones
- Previously Existing Structures

N

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10/28/2011 sdrallos-kopecky
Source:HGL 2010, CIRGIS 2007

HGL HydroGeoLogic, Inc.

ATTACHMENT 3

Summary of Sonic Drilling Technology

SONIC DRILLING SYSTEM

Sonic drilling employs the use of high-frequency, resonate energy to advance a core barrel or casing into subsurface formations. During drilling, the resonant energy is transferred down the drill string to the bit face at various sonic frequencies. Simultaneously rotating the drill string evenly distributes the energy and impact at the bit face.

The resonant energy is generated inside the sonic head by two counter-rotating weights, A pneumatic isolation system inside the head prevents the resonate energy from transmitting to the drill rig and preferentially directs the energy down the drill string.

The sonic driller controls the resonant energy generated by the sonic oscillator to match the formation being encountered to achieve maximum drilling productivity. When the resonant sonic energy coincides with the natural frequency of the drill string, resonance occurs. This results in the maximum amount of energy being delivered to the face. At the same time, friction of the soil immediately adjacent to the entire drill string is substantially minimized, resulting in very fast penetration rates.

The Sonic drilling method advances a casing as the borehole is drilled. While there are several ways to drill a bore hole with the sonic drilling method, the most common means involves advancing a core barrel, which is overridden by a larger diameter drill string that cases the open borehole and prevents collapse.

Typical Sonic drilling procedure:

1. Sonically advance core barrel into the undisturbed formation. No air, mud or water is used in the coring process.
2. Sonically override a larger diameter casing over the core barrel.
3. Return the core barrel to the surface for sample extraction.
4. Complete coring and overriding casing to desired depth.
    a. Core sizes of 3” through 8” are available.
    b. Standard borehole sizes of 3” through 12” can be drilled.
    c. Depths in excess of 600’ in a variety of formations and conditions.