de maximis, inc.
200 Day Hill Road
Suite 200
Windsor, CT 06095
(860) 298-0541
(860) 298-0561 FAX

April 29, 2024,

Ms. Kara Nierenberg, PE
Remedial Project
Manager EPA Region 1
5 Post Office Square, Suite 100
Mail Code OSRR 07-4
Boston, MA 02109-3912

Subject: **Amendment to 100% Design- Site-wide Sediment and Soils Phase 1 - Courtyard, Landfill, Sphagnum Bog and Cooling Pond Design (100% SSS Phase 1 RD)**
Nuclear Metals, Inc. (NMI) Superfund Site, Concord Massachusetts

Dear Ms. Nierenberg:

The 100% Site-side Sediment and Soils (SSS) Phase 1 was submitted to EPA on September 25, 2023, and the Approval from EPA was received on September 27, 2023. As part of the development of the Remedial Action Work Plan and sequencing of construction some changes to the limits of excavation within the Courtyard and Building E were adjusted. The Amendment includes the updated Drawings contained in Appendix A of the 100% SSS Phase 1 RD. These Drawings are also included in the Conditionally approved RAWP, dated April 16, 2024, and approved by EPA on April 23, 2024.This Amendment has been uploaded to Project Portal for your review and comment.

If you have any further questions or concerns, please contact me.

Sincerely,

Bruce Thompson
Project Coordinator

www.haleyaldrich.com

REPORT ON

100% DESIGN – SITE-WIDE SEDIMENT AND SOILS PHASE 1 – COURTYARD, LANDFILL, SPHAGNUM BOG, AND COOLING POND DESIGN
NUCLEAR METALS, INC.
2229 MAIN STREET
CONCORD, MASSACHUETTS

by
Haley & Aldrich, Inc.
Boston, Massachusetts

for
de maximis, inc.
Windsor, Connecticut

File No. 131884-003
September 2023

HALEY & ALDRICH, INC.
465 Medford St.
Suite 2200
Boston, MA 02129
617.886.7400

22 September 2023
File No. 131884-003

de maximis, inc.
200 Day Hill Road, Suite 200
Windsor, Connecticut 06095

Attention: Bruce and Jessie

Subject: 100% Design – Site-wide Sediment and Soils Phase 1 – Courtyard, Landfill, Sphagnum Bog, and Cooling Pond Design
Nuclear Metals, Inc.
2229 Main Street
Concord, Massachusetts

Ladies and Gentlemen:

The purpose of this letter is to transmit the 100% Design Report for the Site-wide Sediment and Soils (SSS) Phase 1 - Courtyard, Landfill, Sphagnum Bog, and Cooling Pond Design for the Nuclear Metals, Inc. site located in Concord, Massachusetts in accordance with the requirements set forth in the Statement of Work (SOW). The 100% Design Report was originally submitted on 6 September 2023, and comments were received on 18 September 2023. The Response to Comments on the 100% Design Report will be transmitted separately, and the changes requested in the comments are reflected in this 100% Design Phase 1 Report.

The planned remedial action for these Areas of Interest (AOIs) includes excavation, transportation, and disposal of impacted materials. The limits of excavation were determined using data collected during the Remedial Investigation (RI) and subsequent pre-design investigations (PDIs) to better define the remedial excavation boundaries for Exposure Areas and AOIs that are required to meet the Remedial Action Objectives set forth in the Record of Decision. The design process was outlined in the PDI Summary Report that was approved by the U.S. Environmental Protection Agency (EPA) on 18 May 2022.

This report contains the design information relative to a subsection of the SSS. This document excludes AOI 8 and AOI 9 as well as the Building Slabs and Outside Areas. The 100% Design Report for AOI 8 and AOI 9 was submitted under separate cover and approved by the EPA on 28 September 2022. The 100% Design for the Building Slabs and Outside Areas will be submitted as Phase 2 of the SSS Design, under separate cover at a future date to be agreed upon with EPA.

Please contact the undersigned with any questions regarding this 100% Design Report.

Sincerely yours,
HALEY & ALDRICH, INC.

Kelley, P.E.
Senior Hydrogeologist | Civil Engineer

Enclosures

\\haleyaldrich.com\share\bos_common\131884-NMI\Deliverables\SSS 100 Percent Design\2023-0922-HAI-SSS 100% Design Report-F.docx

HALEY & ALDRICH, INC.
465 MEDFORD ST.
SUITE 2200
BOSTON, MA 02129
617.886.7400

SIGNATURE PAGE FOR

REPORT ON

100% DESIGN – SITE-WIDE SEDIMENT AND SOILS PHASE 1 – COURTYARD, LANDFILL, SPHAGNUM BOG, AND COOLING POND DESIGN
NUCLEAR METALS, INC.
2229 MAIN STREET
CONCORD, MASSACHUETTS

PREPARED FOR

DE MAXIMIS, INC.
WINDSOR, CONNECTICUT

PREPARED BY:

Maris Mann-Stadt, P.E.
Technical Specialist | Environmental Engineer
Haley & Aldrich, Inc.

REVIEWED AND APPROVED BY:

Mark Kelley, P.E.
Senior Hydrogeologist | Civil Engineer
Haley & Aldrich, Inc.

PROFESSIONAL ENGINEER'S CERTIFICATION

FINAL 100% DESIGN – SITE-WIDE SEDIMENT AND SOILS PHASE 1 – COURTYARD, LANDFILL, SPHAGNUM BOG, AND COOLING POND DESIGN
Nuclear Metals, Inc. Superfund Site
Concord, Massachusetts

I certify under penalty of law that the design of the 100% Design – Site-wide Sediment and Soils Phase 1 – Courtyard, Landfill, Sphagnum Bog, and Cooling Pond Design for the Nuclear Metals, Inc. Superfund Site in Concord, Massachusetts dated September 2023 (including Figures, Tables, and Appendices A through E) was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my oversight of the person or persons who manage the system, or those persons directly responsible for evaluated the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete.

STAMP

COMMONWEALTH OF MASSACHUSETTS
MARK D.
KELLEY
CIVIL
No. 37806
REGISTERED
PROFESSIONAL ENGINEER

Mark D. Kelley, P.E.
(Licensed in MA)
Senior Hydrogeologist | Civil Engineer
Engineer-of-Record, P.E. License No. 37806

This document has been digitally signed, sealed, and locked by Mark D. Kelley. Document is not approved unless it contains a digital stamp and signature certification.

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HALEY ALDRICH

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
AOI	Area of Interest
bgs	below ground surface
BMP	Best Management Practice
CD	Consent Decree
CFR	Code of Federal Regulations
COC	contaminant of concern
CQAP	Construction Quality Assurance Plan
cu yd	cubic yard
DDES	Decontamination Decommissioning and Environmental Services, LLC
ddms, inc.	de maximis data management solutions
de maximis	***de maximis, inc.***
DETS	Dewatering Effluent Treatment System
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
FSP	Field Sampling Plan
ft	foot/feet
Haley & Aldrich	Haley & Aldrich, Inc.
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HI	Hazard Index
HP	Health Physicist
ILCR	Incremental Lifetime Cancer Risk
in.	inch
Mass DEP	Massachusetts Department of Environmental Protection
mg/kg	milligrams per kilogram
NAUL	Notice of Activity and Use Limitation
NMI	Nuclear Metals, Inc.
O&M	Operations and Maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/g	picoCuries per gram
PDI	Pre-Design Investigation
PEC-Q	Probable Effect Concentration Quotient
ppm	parts per million
PRG	preliminary remediation goal

Acronym/Abbreviation	Definition
QAPP	Quality Assurance Project Plan
RA	remedial action
RAL	Remedial Action Level
RAO	Remedial Action Objective
RAWP	Remedial Action Work Plan
RD	remedial design
RDWP	Remedial Design Work Plan
RFP	request for proposal
RI	remedial investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RSO	Radiation Safety Officer
SD	Settling Defendant
Site	Nuclear Metals, Inc. Superfund Site, Concord, Massachusetts
SOW	Statement of Work
SSS	Site-wide Sediment and Soils
SWPPP	Stormwater Pollution Prevention Plan
TRM	turf-reinforced mat
TSCA	Toxic Substances Control Act
UCL	Upper Concentration Limit

1. Introduction

1.1 SCOPE AND OBJECTIVE

This 100% Remedial Design (RD) Phase 1 has been prepared on behalf of ***de maximis, inc.*** (*de maximis*) for the Nuclear Metals, Inc. (NMI) Superfund Site (Site) in Concord, Massachusetts. The objective of this document is to present the 100% RD for the Courtyard, Landfill, Sphagnum Bog Sediment, and Cooling Pond as required pursuant to the terms of the Consent Decree (CD) entered in Civil Action No. 1:19-cv-12097-RGS and the Statement of Work (SOW) appended to the CD. This 100% RD Phase 1 Report addresses only the Site-wide Sediment and Soils (SSS) remedy for select areas, including the Courtyard, Landfill, Sphagnum Bog, and Cooling Pond. The Areas of Interest (AOIs) 8 and 9 were addressed under the 100% RD, submitted in August 2022. The 100% Phase 2 RD will include Buildings A, B, C, and D, select paved areas, and DU penetrometer locations and the Holding Basin and the groundwater remedy designs will be submitted under separate cover.

Pre-design investigations (PDIs) outlined in the Remedial Design Work Plan (RDWP; approved by the U.S. Environmental Protection Agency [EPA] on 18 May 2022) and the associated PDI modifications approved by EPA throughout the investigation were completed to gather information that supports the design of remedies that are consistent with the provisions of the CD and SOW.

1.2 DOCUMENT ORGANIZATION

1.2.1 Remedy Component Organization

This document includes the design for SSS Phase 1, the list of Specifications (Appendix A; Attachment A1), and Drawings (Appendix A; Attachment A2), Calculations (Appendix A; Attachment A3), Field Sampling Plan (FSP) Amendment (Appendix B), the Construction Quality Assurance Plan (CQAP) (Appendix C), and the Transportation and Disposal Plan (Appendix D). The designs for all other areas will be submitted under separate cover as described in Section 1.1.

1.2.2 SOW Requirements

The text under each remedy component will include:

- Design components and objectives to meet the Performance Standards identified in the Record of Decision (ROD) and CD/SOW, including the requirements outlined in the SOW:
  - *A design criteria report, as described in the Remedial Design/Remedial Action Handbook, EPA 540/R-95/059 (June 1995);*
  - *Preliminary drawings and specifications;*
  - *Descriptions of permit requirements, if applicable;*
  - *Preliminary Operations and Maintenance (O&M) Plan and O&M Manual;*

    A description of how the Remedial Action (RA) will be implemented in a manner that minimizes environmental impacts in accordance with EPA's Principles for Greener Cleanups (August 2009);

  - *A description of monitoring and control measures to protect human health and the environment, such as air monitoring and dust suppression, during the RA;*
  - *Any proposed revisions to the RA Schedule that is set forth in ¶7.3 (RA Schedule); and*
  - *Updates of all supporting deliverables required to accompany the RDWP, and as appropriate, the following additional supporting deliverables described in ¶6.7 (Supporting Deliverables [of the SOW]): FSP; Quality Assurance Project Plan (QAPP); Health and Safety Plan (HASP); Emergency Response Plan; and Site-wide Monitoring Plan.*
- References to drawings, calculations, and specifications relevant to the design;
- Design Basis, updated as needed from prior submittals; and
- Overview of the 100% RD.

Note that the following supporting deliverables were used to implement the PDI and will be used again for the SSS RA work. The following documents were a component of the RDWP approved by EPA in September 2020:

- FSP;
- QAPP;
- HASP;
- Emergency Response Plan; and
- Site-wide Monitoring Plan.

An Amendment to the FSP, detailing perimeter dust monitoring, as well as an FSP Amendment to cover details for the proposed on-Site laboratory is included as Appendix B. Additional amendments to the above plans will be submitted as needed during the progression of Work.

1.3 GENERAL APPROACH TO CONTRACTING, CONSTRUCTION, AND OPERATIONS

Consistent with the investigations completed to date, *de maximis* will serve as the Settling Defendant's (SD's) General Contractor, Project Coordinator, and Supervising Contractor (as defined in the CD) for the performance of all Work required by the CD. Contracts will be executed between *de maximis* and the consultants, contractors, laboratories, and waste transporters and disposal facilities, as necessary, to implement the Work.

As the SD Representative, *de maximis* personnel will act as the Site Project Manager and Construction Manager(s) during the RA completion. In addition, for the RA, we anticipate adding a Site Operations Manager, Health and Safety Manager, and Shipping Coordinator. Database management, data validation, lab coordination, file management (Project Portal), GIS, and website maintenance (see www.nmisite.org) will be provided by *de maximis data management solutions* (ddms, inc.).

A request for proposal (RFP) will be issued for the construction activities associated with the SSS RA, and a RAWP will be submitted after the contract is awarded and prior to the commencement of remediation. Specific details for contractors' daily activities once on Site, including photo documentation, are included in the contract documents (i.e., Specifications and Drawings) and the CQAP.

1.4 RESPONSIBILITY AND AUTHORITY OF ALL ORGANIZATIONS AND KEY PERSONNEL

The key management personnel for the RA are presented below, followed by a description and communication roles of each person or party in Sections 1.4.1 through 1.4.5. Regulatory entities involved in the project include EPA and the Massachusetts Department of Environmental Protection (MassDEP) as well as local authorities. EPA is the lead regulatory agency.

Organization	Role	Contact Information
EPA	Lead regulatory agency overseeing the RD/RA	Kara Nierenberg Remedial Project Manager (RPM) EPA Region 1 5 Post Office Square, MC OSRR07-MI Boston, MA 02109 (617) 918-1435 Nierenberg.Kara@epa.gov
MassDEP	State regulatory agency involved in project review and providing support to EPA	Garry Waldeck Environmental Engineer MassDEP-BWSC 100 Cambridge Street Suite 900 Boston, MA 02114 garry.waldeck@mass.gov
AECOM	EPA oversight contractor	Andrew Schkuta AECOM 250 Apollo Drive Chelmsford, MA 01824 (781) 290-9448 andrew.schkuta@aecom.com
Settling Defendants (SDs)	Signatories to the CD; responsible for overall performance of RD/RA	c/o Bruce Thompson of *de maximis* (see below)
de maximis	General and Supervising Contractor	Bruce Thompson Project and Community Involvement Coordinator *de maximis, inc*. 200 Day Hill Road, Suite 200 Windsor, CT 06095 (860) 298-0541 brucet@demaximis.com

Organization	Role	Contact Information
ddms, inc.	Subcontractor for data management services, including data validation and database management, and maintenance of www.nmisite.org	Database, GIS, and Website: Heidi R. V. Gaedy, PMP, GISP ddms, inc. 60 Plato Boulevard East, Suite 150, St. Paul, MN 55107 (651) 842-4236 HGaedy@ddmsinc.com Validation: Polly Newbold ddms, inc. 186 Center Street, Suite 290 Clinton, NJ 08809 pnewbold@ddmsinc.com
O&M, Inc.	Subcontractor for general work at the Site (Site inspections, maintenance, and snow removal)	David Fuerst O&M, Inc. 450 Montbrook Lane Knoxville, TN 37919-2705 (865) 691-6254 dfuerst@oandm-inc.com
Haley & Aldrich, Inc. (Haley & Aldrich)	Engineer-of-Record for SSS RD components Engineering and design support	Mark D. Kelley, P.E. (MA) Haley & Aldrich, Inc. 465 Medford Street |Suite 2200 Boston, MA 02129-1400 (617) 886-7338 (office) (857) 498-1276 (mobile) mkelley@haleyaldrich.com
Alpha Analytical Laboratories and GEL Laboratories, LLC	Laboratory analytical services	Dave Sanford, Project Manager Alpha Analytical Laboratories 8 Walkup Drive Westborough, MA 01581 (508) 439-5157 dsanford@alphalab.com Zachary Worsham, Project Manager GEL Laboratories, LLC 2040 Savage Road Charleston, SC 29407 (843) 769-7385 emk@gel.com

Organization	Role	Contact Information
Decontamination Decommissioning and Environmental Services, LLC (DDES)	Radiation safety, including screening of materials and equipment	Matt Norton Decontamination Decommissioning and Environmental Services, LLC (DDES) 25 Rundlett Way, Unit 10 Middleton, MA 01949 mdnorton@ddesllc.com
Construction	Excavation, transportation, disposal, and restoration activities	TBD for SSS

1.4.1 Agencies

All formal communication from the Agencies (EPA and MassDEP) regarding the Site will be directed to the Project Coordinator and the SDs, as provided in the CD.

1.4.2 Settling Defendants

The SDs are the signatories to the CD. All formal communication from the SDs regarding the Site will be directed to the Project Coordinator and the Agencies, as provided in the CD.

1.4.3 SD's General Contactor/Project Coordinator

The SDs have retained *de maximis* to function as the SD's General Contractor and Bruce Thompson of *de maximis* to serve as their Project Coordinator.

1.4.3.1 Supervising Contractor

On 12 December 2019, the SDs designated *de maximis* as their Supervising Contractor. On 31 December 2019, EPA approved *de maximis* for this role. All RD/RA-related work performed by the SDs pursuant to the CD will be carried out under the direction and supervision of *de maximis*.

1.4.3.2 Project Coordinator

On behalf of the SDs, Bruce Thompson will serve as the Project Coordinator. The SDs designated Mr. Thompson as their Project Coordinator in a 12 December 2019 letter to EPA. On 31 December 2019, EPA approved Mr. Thompson. The Project Coordinator will coordinate and supervise all Work under the RD/RA CD. In accordance with Paragraph 5.1 of the SOW, Monthly Progress Reports will be compiled and submitted to the Agencies by the Project Coordinator on behalf of the Respondents. The Project Coordinator is the primary contact for the SDs with EPA, MassDEP, and the community.

1.4.4 Subcontractors

Haley & Aldrich will be responsible for the RD remedy, including acting as the Engineer-of-Record for these remedial components.

Other subcontractors for the RD will be retained based on specific scopes of work. Subcontractors will report directly to the Project Coordinator. A project organization chart is provided in Figure 2.

1.4.5 Non-Project Personnel

Due to interest among the neighboring communities regarding the conditions at the Site and underlying groundwater, inquiries about the Work may be made by persons who are not officially associated with the project. The following procedures will be implemented by representatives of the general public to gain information about the Site:

- Telephone inquiries shall be directed to the EPA RPM;
- Citizens groups will work with the EPA Community Involvement Coordinator; and
- During the Work, on-Site staff will direct public inquiries to the on-Site Supervisor. Non-project persons will be asked not to violate the Site access guidelines described in the HASP. The Site Supervisor will state the company they are employed with and indicate that the company is working for *de maximis*. The supervisor will state the specific task being performed at the time (i.e., groundwater sampling) and direct the non-project persons to the EPA RPM if additional information is requested. The inquiries from non-project persons will be documented in the project field notes.

2. Stand-Alone Remedy Components

2.1 DESIGN COMPONENTS AND OBJECTIVES TO MEET PERFORMANCE STANDARDS

As stated in the ROD and the SOW, the scope of the SSS remedy includes:

"Excavation and off-site disposal of approximately 82,500 cubic yards of contaminated sediments, underground drain lines and debris, and non-Holding Basin soils (contaminated with depleted uranium (DU), polychlorinated biphenyls (PCBs), and other contaminants of concern found in Tables L-2 through L-4) in various areas of the Site."

This Phase 1 SSS 100% RD report specifically addresses contaminated soil and sediment to be removed in select areas of the site, including the Courtyard, Landfill, Sphagnum Bog, and Cooling Pond. Figure 3 shows the planned excavation areas, overlain on top of the original Site AOIs and exposure areas.

The ROD provides Remedial Action Objectives (RAOs), which are medium-specific goals that define the objective of RAs to protect human health and the environment. RAOs specify the contaminants of concern (COCs), potential exposure routes and receptors, and provide a general description of what the cleanup will accomplish. The RAOs relevant for the SSS RD are:

(1) Prevent direct human exposure by a future resident (by dermal contact, ingestion, inhalation, or ionizing radiation) to soil or sediment with contaminants (i.e., depleted uranium [DU], polychlorinated biphenyls [PCBs], polycyclic aromatic hydrocarbons [PAHs], and other inorganics) that exceed risk-based standards.

(2) Protect ecological receptors from exposure to contaminants (PCBs and copper) in sediments indicative of adverse effects at the Cooling Water Recharge Pond.

(3) Protect ecological receptors from exposure to contaminants (PCBs, copper, mercury, and lead) in sediments indicative of adverse effects at the Sphagnum Bog, while maintaining the physical and ecological integrity of the Bog.

RAO 1 is the primary RAO driving remedial action for the Courtyard and Landfill areas. RAO 2 and RAO 3 will drive the RAs at the Cooling Pond and Sphagnum Bog areas, respectively. The RAOs are guided by Cleanup Levels for COCs in soil and sediment which were specified in Tables L-2, L-3, and L-4 of the ROD. The Cleanup Levels are summarized in Table 2.1-1, 2.1-2, and 2.1-3 below.

Table 2.1-1
Soil Cleanup Levels for the Protection of Human Health

CONTAMINANT OF CONCERN	CLEANUP LEVEL	
	mg/kg	pCi/g
Benzo(a)anthracene	0.34	NA
Benzo(a)pyrene	0.22	NA
Benzo(b)fluoranthene	0.34	NA
Ideno(1,2,3-cd)pyrene	0.34	NA
PCBs	1	NA
Arsenic	13.7	NA

Table 2.1-1 Soil Cleanup Levels for the Protection of Human Health		
CONTAMINANT OF CONCERN	CLEANUP LEVEL	
	mg/kg	pCi/g
Uranium	2.7	1.1
U-238	NA	0.9
U-235	NA	0.01
U-234	NA	0.15
Thorium	7.4	0.81
Th-232	NA	0.81

Notes:

1. *Refer to Table L-2 of ROD for cancer classification, target endpoints, and Cleanup Level basis.*
2. *NA = not applicable*
3. *mg/kg = milligrams per kilogram; pCi/g = picoCuries per gram*

Table 2.1-2 Sediment Cleanup Levels for the Protection of Human Health		
CONTAMINANT OF CONCERN	CLEANUP LEVEL	
	mg/kg	pCi/g
Uranium	2.7	NA
PCBs	1	NA

1. *Refer to Table L-3 of ROD for cancer classification, target endpoints, and Cleanup Level basis.*

Table 2.1-3 Sediment Cleanup Levels for the Protection of Ecological Receptors		
CONTAMINANT OF CONCERN	CLEANUP LEVEL	
	mg/kg	pCi/g
Mean PEC-Q	0.64	NA
Total PCBs	1.08	NA
Copper	176	NA
Lead	97.3	NA
Mercury	1.3	NA

1. *PEC-Q = Probable Effect Concentration Quotient*
2. *Refer to Table L-4 of ROD for target endpoints and the Cleanup Level basis.*

One of the objectives of the SSS PDIs was to horizontally and vertically define COC concentrations to support remedial designs that will reduce risks to achieve the RAOs listed above. However, the areas designated for remediation under the SSS remedy are bordered by areas *not* designated for remediation because Incremental Lifetime Cancer Risk (ILCR) values were within a range of 1×10^{-6} to 1×10^{-4} and below a hazard index (HI) of 1. Those areas contain uranium concentrations *above* the Cleanup Levels listed in Tables 2.1-1 and 2.1-2 above. Therefore, it is generally expected that implementation of the RA for soils will necessitate an approach that focuses on achieving an acceptable level of residual risk, as opposed to sample-by-sample compliance with Cleanup Levels. The planned excavation is described herein, while additional details on the residual risk approach are included below in Sections 2.1.1 and 2.1.2, as well as in Appendix C – CQAP.

2.1.1 Remedial Action Levels

As described in greater detail in the CQAP included as Appendix C, EPA has published guidance which clarifies that the goal of RAs, and of achieving Cleanup Levels (also referred to as preliminary remediation goals [PRGs]), is to ensure that residual risks that remain after site cleanup will be within some specified limit of acceptability (an ILCR of between 1 x 10^{-6} and 1 x 10^{-4} and a hazard index that does not exceed 1). More specifically, EPA states that "*A key concept is that a PRG is the average concentration of a chemical in an exposure area that will yield the specified target risk in an individual who is exposed at random within the exposure area. Thus, if an exposure area has an average concentration above the PRG, some level of remediation is needed. However, it is not necessary that all concentration values above the PRG be remediated. Rather, all that is required is that the average concentration be reduced to the PRG or below. Thus, some concentration values may remain that are above the PRG. The concentration value that is to be removed in order to reduce the mean to the PRG or below is often referred to as the remedial action level (RAL)*."[1]

The current design presented in this document is based on comparison of existing data to the Cleanup Levels stated in the ROD. RALs specific to the excavation bottoms and sidewalls at each remediation area were calculated as described in the revised CQAP included as Appendix C. The established RALs will be used to guide the remediation effort, as was done during the remedial action at AOI 8 and AOI 9.

2.1.2 Demonstration of Compliance

After excavations are complete, the confirmatory soil sampling data will be used with data representative of soil that remained at the area (i.e., not excavated material) and with data representative of the imported fill material to calculate final residual volume-weighted Exposure Point Concentrations (EPCs; residual EPCs) using the methodology described in the CQAP attached as Appendix C. The residual EPCs will be calculated as follows:

- Analytical data generated by the off-Site laboratories for confirmatory and verification samples representative of soil that remains in-place (i.e., not excavated material) will be combined with analytical data from RI and PDI sampling that is representative of soil remaining in-place within the exposure areas. Exposure areas for each of the remediation areas are defined in the CQAP (Appendix C). Note that because the excavation footprints may be expanded beyond the original design, the RI and PDI datasets representative of soil remaining at the exposure areas may be different from the datasets presented in the CQAP.
- 95% Upper Concentration Limits (UCLs) will be derived for the datasets representative of soil remaining at the exposure areas using EPA's ProUCL version 5.2.
- EPCs representative of fill materials will be identified as the maximum detected concentrations from sampling of the gravel fill and topsoil. Separate EPCs will be identified for gravel, topsoil, or other imported material used.
- The volumes of soil remaining at the exposure areas, gravel fill imported to the exposure areas, topsoil imported to the exposure areas, and any other imported material will be identified.

[1] https://www.epa.gov/risk/calculating-preliminary-remediation-goals-prgs

- Residual EPCs will be calculated using the EPCs for each soil/fill type with associated volumes in accordance with the methodology described in the CQAP.

The residual EPCs will be compared to the Cleanup Levels published in the ROD. The residual EPCs will also be used to calculate residual ILCRs and non-cancer hazards (HI). A summary of how this was applied to support the compliance evaluations for AOI 8 and AOI 9 will be submitted under separate cover to further illustrate how this will be applicable to the future SSS evaluation.

2.2 SSS DESIGN

The approximate quantity of contaminated soils and sediments to be removed as part of the SSS Phase 1 RA is provided in the sections below, based on data collected during the PDI and current ROD Cleanup Levels. Volume adjustments may be made during remedial activities based on future pre-characterization sampling or the results of confirmation sampling during excavation activities.

2.2.1 Design Basis

2.2.1.1 PDI Data Applicable to Design

The SSS PDI was conducted to address data gaps from the Remedial Investigation (RI) to better define the remedial excavation boundaries for Exposure Areas and Areas of Investigation that are required to meet the RAOs set forth in the ROD. Data collected were provided in the SSS PDI report dated 27 April 2022 and approved by EPA on 18 May 2022. PDI SSS-1 data applicable to design for each remediation area are summarized in the following sections.

2.2.1.1.1 Courtyard

PDI SSS-1 focused primarily on the AOI 15 Transformer Pad section of the Courtyard. A total of 11 locations were sampled at various depths ranging from surficial soil to 8 feet below ground surface (ft bgs). Total PCBs were detected above laboratory detection limits in 23 of the 27 soil samples, 13 of which also exceeded the Cleanup Level of 1 mg/kg. Concentrations of total PCBs ranged from non-detect to 53.5 mg/kg. Total uranium was detected in the soil samples at concentrations ranging from 1.57 to 421 mg/kg. Total uranium was detected above Cleanup Levels in 21 of the 27 soil samples.

An excavation extending to a maximum depth of 10 ft is being designed based on the PDI results, with collection of confirmatory samples as necessary, such as in the area around SS-PD-15011. The remainder of the Courtyard area (AOI 11) was not characterized as a part of the PDI. Sampling data from the RI investigation is used as the basis for design.

2.2.1.1.2 Cooling Pond

PDI SSS-1 included characterization of the AOI 4 Cooling Pond. A total of 116 soil samples were collected from 70 locations at various depths ranging from surficial soil to 18 ft bgs. Total PCBs were detected above the Cleanup Level in 54 samples at concentrations ranging up to 51.3 mg/kg. Total uranium was detected in each soil sample. Total uranium was detected above Cleanup Levels in 93 of the 116 soil samples at concentrations ranging up to 55.2 mg/kg.

The PDI identified that additional deeper excavations are needed to address deeper detections of uranium and PCBs at the toe of the Gabion Wall at the northern portion of the Cooling Pond. The southern half of the Cooling Pond was generally considered well characterized, and the PDI identified excavations to be conducted to a depth of 6 ft, with post-excavation confirmatory samples proposed. Additional excavations on a point-by-point basis may be conducted during the RA, around the perimeter of the Cooling Pond slope, to address isolated detections of PCBs.

2.2.1.1.3 Landfill

PDI SSS-1 included characterization of the AOI 3 Landfill. A total of 32 soil samples were collected across the former Landfill at various depths ranging from surficial soil to 10 ft bgs. Total PCBs were detected at concentrations which exceed the Cleanup Level of 1 mg/kg in two soil samples. Total uranium was detected at concentrations above the Cleanup Levels in 15 soil samples at concentrations ranging up to 122 mg/kg.

A reduction in remedial excavations, from the limits shown in the ROD, in the south and east Landfill areas was identified using the PDI results. Additional delineation is proposed to refine the limits of impacted soil adjacent to the Sphagnum Bog following excavation and removal of the Landfill.

2.2.2 Courtyard Design

Drawings for the Courtyard are included in Appendix A; Attachment A2. An excavation volume estimate is included within the Drawing package (Note 2 on Drawing C-402). Additional excavation may be necessary as piping and utilities are uncovered and chased along the piping alignment.

2.2.2.1 Courtyard Design Overview

2.2.2.1.1 Soil Removal Volume

The soil removal volume from the Courtyard is estimated to be 8,415 cubic yards (cu yds) as shown on Drawings C-402, C-403, and C-404. The Courtyard excavation volume is based on the RI and PDI sampling results and removal of samples that exceed the Cleanup Levels. Pre-characterization Geoprobe borings were conducted in May 2023 at select locations where data gaps existed in the Courtyard, and data collected from those borings were used to refine the excavation areas. This quantity may be adjusted during construction to accommodate any additional removal deemed necessary after confirmatory samples are collected.

Soil removal areas will be staked out and surveyed prior to the start of excavation.

2.2.2.1.2 Soil Removal Method

The primary method of soil removal from the Courtyard excavation areas will be mechanical excavation. The Contractor will take precaution when excavating in the vicinity of historical acid and other process utility lines for visual signs of leakage to address the situation in a safe manner.

2.2.2.1.3 Confirmatory Sampling

The 30-ft by 30-ft confirmatory sampling grid for the Courtyard is shown on Drawing C-501. Confirmatory sampling will be performed within the excavation footprints to verify that remediation has reduced COCs to EPCs that will achieve compliance with the Cleanup Levels, using the approach described in the CQAP. Excavation of soil will continue until uranium and PCB concentrations in confirmatory soil samples do not exceed the RALs as described in Section 2.1.1. RALs are provided in Table 2.2-1 below. However, excavation will not be expanded down the slope that descends to the Cooling Pond due to concerns about de-stabilizing the slope; the slope is addressed in the Cooling Pond remediation area. Verification sampling for uranium, arsenic, and thorium will then be completed using the approach described in the CQAP.

Table 2.2-1
Courtyard Remedial Action Levels (RALs)

CONTAMINANT OF CONCERN	RAL (mg/kg)	
	Bottom	Sidewall
Uranium	3.5	3.9
PCBs	1	1

2.2.2.1.4 TSCA Sampling

Concentrations of PCBs exceeded 50 mg/kg in soil samples from the Courtyard area (SB-RI-11018 and SB-PD-15011) at 50.46 mg/kg and 53.5 mg/kg, respectively. A duplicate sample collected at PD_15011 indicated a concentration of 80.3 mg/kg. The Courtyard restricted area, which encompasses these Toxic Substances Control Act (TSCA) samples, was excavated and the TSCA confirmatory sampling was completed during the Enabling Phase RA. The results of confirmatory TSCA sampling did not show samples remaining with concentrations of PCBs exceeding 50 mg/kg; these results were submitted under separate cover during July 2023. All additional PCB remediation work will be conducted in accordance with the existing *AOI 8 and 9 RAWP Amendment* and any other existing 100% Design Documents, HASPs, and relevant 40 Code of Federal Regulations (CFR) Part 761 sections.

TSCA material will be live-loaded rather than stockpiled. In the event soils with PCBs ≥ 50 parts per million (ppm) cannot be loaded directly into trucks, those soils will be stockpiled in accordance with 40 CFR §761.65 – Storage for Disposal. A separate waste processing area will be established for TSCA material only in the area south of the Holding Basin as shown in Drawings C-200 through C-202 and on Detail 5 of Drawing C-703. Based on the current schedule for SSS Work, the area south of the Holding Basin is scheduled to be excavated after the completion of the Holding Basin work. If contractors elect to use the area for staging and materials management, soils under the area will be segregated from the staging area with appropriately maintained liners in accordance with TSCA regulations: a two-layer barrier consisting of a 40-mil high-density polyethylene (HDPE) liner and geotextile (Mirafi 1160N – non-woven geotextile), followed by a 6-inch cushion layer under the stockpile area to prevent impact to the paved surface, as shown in Detail 5 Drawing C-702). All stockpiles will be covered with poly sheeting when not in use. Any runoff generated will originate from the cover, which will be uncontaminated poly sheeting; therefore, no additional stormwater management is anticipated for the stockpile area. Additional measures for stormwater control will be implemented, if needed, to ensure no contaminated runoff is released from the stockpile area.

Field equipment will be decontaminated in accordance with 40 CFR §761.79 – Decontamination Standards and Procedures. In accordance with 40 CFR §761.79 (c)(2), a double wash/rinse will be used in lieu of swabbing surfaces. If a double wash cannot be completed, surfaces will be swabbed.

The truck wash area shown in Detail 6 of Drawing C-701 will be used to decontaminate all equipment used in the work zone. As shown in the drawing detail, a sump will be installed to capture and contain solvents and cleaners in accordance with 40 CFR §761.366 – Cleanup Equipment.

2.2.2.1.5 Restoration

Restoration in the Courtyard excavation area will be completed as shown in Drawing C-602. Restoration will generally follow the original grading but will also include the leveling of some existing mounded areas. Imported backfill or material from the Site with concentrations of COCs below the ROD Cleanup Levels will be used to restore to grade as depicted in Detail 4 of Drawing C-702.

2.2.2.2 Staging and Site Preparation

2.2.2.2.1 Access Considerations

The existing access roads through the Site will be improved with crushed stone as necessary; where needed, a 9-inch (in.) thickness of ¾-in. dense-grade stone will be added to connect segments of the access road (over existing Building Slabs and adjacent to Building A) as shown on Drawing C-200 and Details 1 and 2 of Drawing C-700.

Minimal vegetative clearing is needed for access to the Courtyard excavation areas. Surface paving material, primarily asphalt, will be removed to access soils below for excavation. Debris (such as surface materials, building remnants, or abandoned piping) will be broken down into pieces less than 1-ft across prior to off-Site disposal. Asphalt and concrete material will be mixed into the prescribed ratio of soils and debris in accordance with the accepting facility Waste Profile.

2.2.2.2.2 Construction Staging Area

Defined staging areas will be shared by all SSS remedy activities. The construction staging and clean backfill stockpile area will be located to the south of the Landfill area, which will be expanded as necessary (Drawings C-200 and C-202). Clean backfill stockpile areas will be lined with a single layer of non-woven 180N geotextile fabric or approved equivalent as shown on Detail 5 of Drawing C-700. The construction trailers will remain in their current locations.

2.2.2.2.3 Excavated Material Processing Area

Designated excavated soil stockpile areas will be established north of AOI 8, as indicated on Drawing C-200 and Detail 5 of Drawing C-701. Material processing areas may be expanded as necessary and could include the Building D Slab.

The excavated material processing areas will be constructed using a layer of 40-mil geomembrane between two layers of geotextile (Mirafi 1160 N or equal) as the base. A berm constructed of hay bales or common fill will surround the excavated material stockpile area. The material processing areas will be surrounded with straw wattles as indicated on Detail 8 of Drawing C-700.

2.2.2.3 Material Management Plan

2.2.2.3.1 Surface Water and Stormwater Controls

HydroCAD was used to model the Courtyard and surrounding areas to both determine the potential volume of runoff into the excavation and to select structural stormwater Best Management Practices (BMPs), primarily in the form of drainage improvements, to manage runoff. After a review of surface topography, subcatchment areas were created to estimate total runoff from the Buildings C and D Slabs, a portion of the Building E Slab, and the Courtyard. An approximately 145-ft-long, 6-ft-wide, and 2-ft-deep temporary drainage swale was installed along the western side of the Holding Basin to divert runoff from the subcatchment areas. The swale has a peak storage capacity of approximately 33 cubic feet per second, and water from the swale will be routed down a medium-riprap lined swale to the southern section of the Cooling Pond. The slopes surrounding the swale outlet to the Cooling Pond will be lined with the turf-reinforced mat (TRM). In addition, TRM will be installed along the steeper section of the slope and riprap at the bottom of the Cooling Pond. The drainage swale and Cooling Pond outlet are shown on Drawing C-300 and on Detail 2 of Drawing C-701. The full set of references and calculations used for the stormwater modeling are provided as Appendix A, Attachment A3.

2.2.2.3.2 Erosion and Sedimentation Controls

Erosion and sedimentation controls will be installed to prevent erosion of contaminated materials from the work area entering into the Site during construction as shown on Drawings C-200 through C-202 and Details on Drawing C-700. Straw wattles will be placed strategically around the edges of the excavation during and after the excavation work as needed. Straw bales will be placed around wetlands, stormwater features, and stockpile areas, while straw bales and filter fabric will be placed around existing drains in the vicinity of the work area.

Effectiveness of the erosion and sedimentation control measures will be monitored by performing visual inspections during construction in accordance with the Stormwater Pollution Prevention Plan (SWPPP), which will be submitted under separate cover, and logs will be maintained on Site.

2.2.3 Sphagnum Bog Sediment and Landfill Design

Drawings for the Sphagnum Bog Sediment and Landfill are included in in Appendix A, Attachment A2.

2.2.3.1 Bog Sediment and Landfill Design Overview

2.2.3.1.1 Pre-Excavation Activities

Geotechnical improvements to the slope on the western side of the Sphagnum Bog will be performed to create a safe work surface for excavators as shown in Drawing C-301. Specifically, timber mats will be placed along the toe of the slope to allow access to the sediment to be excavated using a long-stick excavator. A bench to the slope will be constructed to allow for removal of the excavated sediment along the western edge of the bog. The proposed access road for sediment excavations is shown as Detail 9 of Drawing C-700.

Gravel platforms will also be placed across the Landfill area following remedial excavations to facilitate sediment excavations on the southern bog area.

2.2.3.1.2 Soil Removal Volume

The Sphagnum Bog sediment removal volume is estimated to be1,127 cu yds, as shown in Drawing C-301 and Drawing C-400. The excavation area is currently based on the EPA ROD proposed excavation depth of 2 ft on the southern and western edges of the Sphagnum Bog. The excavation within the Sphagnum Bog will be minimized to protect the sensitive ecosystem.

The soil removal volume from the Landfill is estimated to be 5,975 cu yds, as shown on Drawings C-400 and C-401. The excavation area is based on the PDI sampling results in the Landfill and removal of samples that exceed the Cleanup Levels. This quantity may be adjusted during construction to accommodate any additional removal deemed necessary after confirmatory samples are collected. Soil removal areas will be staked out and surveyed prior to the start of excavation.

If large debris is encountered during Landfill excavations, debris will be sized to less than 1 ft prior to off-Site disposal.

2.2.3.1.3 Soil Removal Method

The primary method of soil removal from the Sphagnum Bog and Landfill excavation area will be by mechanical excavation. The Landfill area will be removed and regraded to establish a platform to reach the limits of excavation along the toe of slope to the limits of the wetlands excavation.

2.2.3.1.4 TSCA Sampling

Detections of PCBs in historical and PDI samples collected at the Landfill have not exceeded 50 mg/kg and are not subject to TSCA requirements. If PCBs are detected above 50 mg/kg during confirmatory sampling, then soil management, disposal, and confirmatory sampling within and around these locations will be completed in accordance with TSCA requirements, per 40 CFR Part 761 – Subpart D, Storage and Disposal. A TSCA excavated material processing area will be established in the area south of the Holding Basin as shown on Drawings C-200 through C-202 and on Detail 5 of Drawing C-703.

2.2.3.1.5 Confirmatory Sampling

The 30-ft by 30-ft confirmatory sampling grid for the Landfill is shown on Drawing C-500. Confirmatory sampling will be performed within the excavation footprints to verify that remediation has reduced COCs to EPCs that will achieve compliance with the Cleanup Levels, using the approach described in the CQAP. Excavation of soil will continue until uranium and PCB concentrations in confirmatory soil samples do not exceed the RALs as described in Section 2.1.1 and provided in Table 2.2-2 below.

Table 2.2-2 Landfill Remedial Action Levels (RALs)		
CONTAMINANT OF CONCERN	RAL (mg/kg)	
	Bottom	Sidewall
Uranium	4.5	9.6
PCBs	1	1

Confirmatory samples will be collected along the outer edge of the Sphagnum Bog excavation area at 30-ft intervals for documentation purposes only as shown on Drawing C-500. The remediation will not be expanded if residual concentrations are above cleanup levels. Therefore, no RALs are required for the bog.

2.2.3.1.6 Restoration

The Sphagnum Bog Sediment will be restored approximately to existing grade as shown on Drawing C-600. Wetland sediment and vegetative restoration shall be completed in accordance with Specification 32 30 00 – Wetland and Upland Restoration as shown in Drawing C-601.

The Sphagnum Bog and wetland boundary will be restored with the following considerations to meet the two primary goals:

1. <u>Re-establish pre-excavation grades:</u> Regrading will be achieved by backfilling the excavated area with two distinct Sphagnum Bog layers – the acrotelm and the catotelm. The acrotelm is the upper layer of the Sphagnum Bog (typically the top 30 to 50 centimeters) where plant growth occurs and peat formation begins. The acrotelm has a varying water level and supports both aerobic and anaerobic conditions. The catotelm is the lower accumulated peat layer which is permanently waterlogged and largely anaerobic.

   Following excavation activities, restoration will require harvesting and backfilling with catotelm peat and acrotelm sphagnum/plant material from appropriate donor sites. The most appropriate catotelm material will come from sites where peat has been harvested from a depth profile similar to that of the NMI Sphagnum Bog excavation profile (2- to 3-ft depth). Fortunately, most commercially available peat material is harvested from relatively shallow depths, making it feasible to find a compatible donor source.

   Restoring the acrotelm will involve constructing this layer to mimic original grades and microtopography with acrotelm material from donor sites. In addition to restoring impacts associated with sediment excavation, final grading for the restoration design will consider the historical alterations along the southern shore of the Sphagnum Bog, which has been altered by the placement of fill and the construction of an impermeable cover over a portion of the Old Landfill.

2. <u>Re-establish pre-excavation Sphagnum Bog vegetation communities:</u> In addition to sphagnum mosses that typically compose most of the donor acrotelm material, the planting plan for the acrotelm will be informed by the existing habitat zones discussed above and associated species.

Restoration of the Landfill excavation area will be completed as shown on Drawing C-600. The restoration grading is planned to provide an upper and a lower-leveled area for future use and viewing of the Sphagnum Bog area. Imported clean backfill will be used to restore to the proposed grade as depicted in Detail 4 on Drawing C-702.

2.2.3.2 Staging and Site Preparation

2.2.3.2.1 Access Considerations

An access road for Sphagnum Bog Sediment excavations will be constructed using timber mats for stability as necessary, which extends across the western section of the Pond as shown in Drawing C-301. Riprap will be reused for stability on the access road as shown on Detail 9 of Drawing C-700. Riprap may be sourced from the Gabion Baskets if suitable and baskets are not expected to be reused. Gravel platforms for sediment excavation and a sediment management area will be installed on the Landfill.

An existing dirt road located south of the Holding Basin extending to the top of the Landfill will be used for Landfill excavations, which may be improved, as necessary, using a 9-in. thickness of ¾-in. dense-grade stone. Clearing and grubbing has been completed in the Landfill area. Additional vegetation may be cleared as the Work progresses to enable access for excavations.

2.2.3.2.2 Construction Staging Area

A clean backfill stockpile and construction staging area will be located to the south of the Landfill as shown on Drawing C-201 and will be lined with a single layer of non-woven 180N geotextile fabric or approved equivalent.

2.2.3.2.3 Excavated Material Processing Area

Designated excavated soil stockpile areas will be established north of AOI 8 as indicated on Drawing C-200 and Detail 5 of Drawing C-701. Material processing areas may be expanded as necessary and could include the Building D Slab.

2.2.3.3 Material Management Plan

2.2.3.3.1 Surface Water and Stormwater Controls

Sandbag Super Sacks will be used around the perimeter of the Sphagnum Bog Sediment excavation area, approximately 10 ft from excavation boundary, to prevent surface water from entering the excavation as shown in Drawing C-301 and Detail 10 on Drawing C-700. Water that accumulates in the excavation will be pumped out and processed in the construction Dewatering Effluent Treatment System (DETS) staged within the Northern Parking Lot and shown on Drawing C-302.

2.2.3.3.2 Erosion and Sedimentation Controls

Straw bale erosion control will be installed around the clean backfill soil stockpile area located south of the Landfill as shown in Drawing C-201 and Detail 6 on Drawing C-700. Erosion controls for the Sphagnum Bog during Landfill excavations are shown on Drawing C-201. Specification 01 57 00 –

Temporary Erosion and Sediment Controls further describes erosion controls used around sensitive environmental areas.

2.2.4 Cooling Pond Design

Drawings for the Cooling Pond are included in Appendix A, Attachment A2.

2.2.4.1 Cooling Pond Design Overview

2.2.4.1.1 Soil Removal Volume

The soil and sediment removal volume from the Cooling Pond is estimated to be 5,536 cu yd as shown on Drawing C-405. These volumes include additional areas surrounding the pond that are outside of the areas requiring remediation, as shown in grey hatching on Drawing C-405. These areas require geotechnical stabilization as described in Section 2.2.4.3.2. Soil excavation quantities from remediation areas may be adjusted during construction to accommodate any additional removal deemed necessary after the confirmatory samples are collected. The Cooling Pond excavations shall be performed in accordance with the cross-sections shown in on Drawings C-406 and C-407 to maintain stability along the steep Cooling Pond Slopes. Stability calculations are included as part of Attachment A4.

As a part of the Cooling Pond RA, two courses or approximately 6 ft of Gabion Wall baskets will be removed from the top of the wall for additional stability during construction. The Gabion baskets will be reused for restoration, if possible, at the toe of the Cooling Pond slope as shown on Drawing C-407.

2.2.4.1.2 Soil Removal Method

The primary method of soil removal from the Cooling Pond excavation areas will be by mechanical excavation. A light riprap cover shall be placed over the remedial excavation on the toe of the Cooling Pond slopes to maintain stability as shown in the sections on Drawing C-407.

2.2.4.1.3 TSCA Sampling

Concentrations of PCBs exceeded 50 mg/kg in Cooling Pond surface soil and sediment samples SS-PD-04021 and SD-RI-04002 at 51.3 mg/kg and 366 mg/kg respectively. As shown in Drawing C-300, concrete blocks shall be placed as a protective barrier around the TSCA sample locations to prevent potential erosion associated with the proximate Courtyard drainage swale outlet. During August 2023, pre-characterization samples were collected for PCB analysis within a 30-ft by 30-ft area around each of the TSCA sample locations. Samples were collected on a 15-ft grid within the boxes at depths of 0 to 1 ft, 1 to 2 ft, and 2 to 3 ft. Results of pre-characterization sampling were be provided under separate cover.

Excavation, disposal and confirmatory sampling within and around these locations will be completed as a part of the Enabling Phase remedial activities in accordance with TSCA requirements, per 40 CFR Part 761 – Subpart D, Storage and Disposal. A TSCA excavated material processing area will be established in the area south of the Holding Basin as shown on Drawings C-200 through C-202 and on Detail 5 of Drawing C-703.

2.2.4.1.4 Confirmatory Sampling

Confirmatory sampling will be performed within the footprints of the areas that require remedial excavation to verify that remediation has reduced COCs to EPCs that will achieve compliance with the Cleanup Levels, using the approach described in the CQAP. Excavation of soil will continue until uranium and PCB concentrations in confirmatory soil samples do not exceed the RALs, as described in Section 2.1.1 and provided in Table 2.2-3 below.

Table 2.2-3
Cooling Pond Remedial Action Levels (RALs)

CONTAMINANT OF CONCERN	RAL (mg/kg)	
	Bottom	Sidewall
Uranium	3.5	11.9
PCBs	1	1

2.2.4.1.5 Restoration

Cooling Pond restoration grading is shown on Drawing C-603. The slope stability analysis shows the restoration slopes and materials selected result in a factor of safety at or above the existing slope stability factor of safety. Details of the calculations and assumptions are included in Attachment A4.

2.2.4.2 Staging and Site Preparation

2.2.4.2.1 Access Considerations

A gravel access road will be constructed sloping down from the eastern edge of the Cooling Pond area with a turn-around at the bottom of the pond. The road will be supported by timber crane mats, as necessary, as shown on Drawing C-302. Timber mats will be placed in the center of the Cooling Pond for excavator stability after the pond is dewatered. Following the completion of Cooling Pond excavations, timber mats may be decontaminated and screened by a health physicist (HP) according to the Radiological Surveys (HP-NMI-05 in the FSP; RDWP Appendix I). Alternatively, timber mats may be sized to pieces no greater than 1 ft and disposed consistent with contaminated debris, such as slab material and fence posts. An access road to the treatment facility will be installed on the eastern side of the Cooling Pond area leading to the Northern Parking Lot.

2.2.4.2.2 Construction Staging Area

The closest clean backfill stockpile area to the Cooling Pond is a stockpile area south of the Landfill as shown on Drawing C-200. Clean backfill stockpile areas may be expanded as necessary.

2.2.4.2.3 Excavated Material Processing Area

Designated excavated soil stockpile areas will be established north of AOI 8 as indicated on Drawings C-200 and C-701. Material processing areas may be expanded as necessary and could include the Building D Slab.

2.2.4.3 Material Management Plan

2.2.4.3.1 Surface Water and Stormwater Controls

Dewatering of the Cooling Pond will be necessary to facilitate sediment excavations. The pump intake for dewatering will be placed in the northern portion of the pond. Water will be pumped to a DETS located northwest of the Cooling Pond on the paved area. Treated effluent will be discharged to a septic tank and existing leach fields as shown in Drawing C-302. Additional details pertaining to the DETS are included in the specifications (Attachment A1, Section 02 70 00 – Construction Dewatering and Water Management).

2.2.4.3.2 Erosion and Sedimentation Controls

Erosion and sediment control measures will be necessary along the Cooling Pond slopes following soil excavations for stability as shown in Drawing C-407. The Cooling Pond excavation area will be lined with straw wattles as shown in Drawings C-200 and C-202.

2.2.5 Material Handling

2.2.5.1 Radiation Safety

As part of the Site health and safety procedures, excavated materials will be screened for DU by the radiation safety officer (RSO). Material collected by the erosion controls measures will also be screened periodically as needed. In addition, where applicable, all equipment and tools entering the restricted area will be screened by a HP according to the Radiological Surveys (HP-NMI-05 in the FSP; RDWP Appendix I) to determine if background levels of radiation existed on the equipment prior to exposure to Site soils. To Haley & Aldrich’s knowledge, background levels of radiation were not detected on equipment prior to exposure to Site soils during the PDI and are not expected during remedial activities. Additionally, disposable barriers will be applied as directed by the on-Site HP or RSO to prevent contaminating equipment and tools while in the restricted area. Further details on the Radiation Protection Program are included in the HASP.

2.2.5.2 Soil and Concrete Disposal

Soil excavated from the Courtyard, Landfill, Sphagnum Bog, and Cooling Pond will be live-loaded for off-Site disposal or transferred to one of the proposed excavated material processing locations. The material will be covered with a poly tarp if left in a stockpile at the end of the workday (i.e., overnight). Measures, such as limiting the fill height, will be used to reduce the potential for spillage as the materials are relocated around the work area.

Debris encountered during excavation activities may be stockpiled prior to processing (crushing to less than 1 ft length) and then transported off Site in accordance with the specified soil disposal methods.

2.2.5.3 Waste Disposal

Stockpiled material will be removed from the Site at regular intervals, within the allowable truckloads per day (estimated to be eight to 15 trucks per day) as permitted by the rail yard and the Town of Concord, Massachusetts. All trucks will be lined, and material will be screened by the RSO prior to being allowed to leave the Site. Material will be handled and disposed in accordance with Specification 02 61 00 – Waste Management, Transporting, and Disposal (included in Appendix A) as well as the Transportation and Off-Site Disposal Plan (Appendix D).

3. Principles for Greener Cleanups Applied to SSS Remedial Actions

In accordance with EPA's Principles for Greener Cleanups (August 2009) and as required by Appendix B, Section 3.5(e) of the Consent Decree, efforts are being made during the design to minimize the impact of the remedial work. Measures taken during implementation of SSS RAs will specifically focus on the following elements of a greener cleanup, as described below.

1. Decrease air pollutants and greenhouse gas emissions. Measures included in the design to decrease air pollutants and greenhouse gas emissions include using rail as the primary transportation method (thus reducing both duration and quantity of trucks on the road) as well as making every effort to use local borrow sources which would again decrease the quantity and duration of trucks on the road. Additionally, a nearby transload facility was chosen for transfer of material from trucks to rail to minimize road travel to the extent practicable. Efforts to reduce any idling on Site will also be made for the duration of the project.

2. Optimize materials management and waste reduction. Measures included in the design to optimize materials management and waste reduction include the design and implementation of drainage features and stormwater controls that can be applied to the full Site, both during construction and during post-construction future use. Efforts were made to create features that could be reused to therefore reduce the work and materials movement required to create additional drainage controls in the future.

3. Optimize land management and ecosystems protection. Efforts will be made throughout the project to protect any surrounding ecosystems (with primary focus on improvements to the Sphagnum Bog area during future remedial work). Optimization of the land management is included as part of this design in that the design activities (such as the detention basin) will be implemented with future use in mind to reduce work performed around the natural ecosystems.

4. Schedule

The SSS Phase 1 RA will take place over the course of multiple years, with a projected start date in 2024. Excavation areas will be completed on a sequential schedule as currently planned, and a preliminary construction schedule for Phase 1 is included as Appendix E. Community updates will be provided as requested by EPA throughout the RA.

5. Operations and Maintenance

All work conducted as part of the SSS RA includes excavation followed by clean cover. There are no anticipated mechanical operations to maintain after construction, and as such, the only O&M will be the implementation of Site-wide institutional controls, as well as periodic inspections to ensure appropriate cover is maintained in any areas where residual contamination remains. Additional inspections will be conducted to ensure stormwater controls are maintained in accordance with the SWPPP during construction. In addition, the Post-Removal Site Control Plan (originally submitted with the 2020 RDWP) will be updated to add inspections of restored areas for erosion, growth, and other observations pending a final Site restoration plan.

References

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4. U.S. District Court for the District of Massachusetts Eastern Division, 2020. Remedial Design/Remedial Action Consent Decree, Civil Action No. 19-12097-RGS, effective 6 December.

5. U.S. Environmental Protection Agency, 2011. Administrative Settlement Agreement and Order on Consent for Non-Time-Critical Removal Action, Nuclear Metals, Inc. Superfund Site, Concord, Massachusetts, Docket No. CERCLA-01-2011-004 (includes Statement of Work as Appendix C). 9 August.

6. U.S. Environmental Protection Agency, 2015. Record of Decision (ROD), Nuclear Metals, Inc. Superfund Site, Concord, MA, September.

7. U.S. Environmental Protection Agency, 2016. Administrative Settlement Agreement and Order on Consent for Non-Time-Critical Removal Action for Groundwater, Nuclear Metals, Inc. Superfund Site, Concord, Massachusetts, Docket No. CERCLA-01-2015-008 (includes Statement of Work as Appendix C). 7 July.

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FIGURES

NOTES

1. EXISTING BASEMAP REFERENCES AUTOCAD FILE "CONCORD.DWG", FROM GEOSYNTEC, DATED 2005.

HALEY ALDRICH

NUCLEAR METALS, INC.
2229 MAIN STREET
CONCORD, MASSACHUSETTS

ROD EXCAVATION LIMITS

SCALE: AS SHOWN
SEPTEMBER 2023

FIGURE 1

Sheet: D010
Printed: 8/6/2020 7:49 AM
DTE
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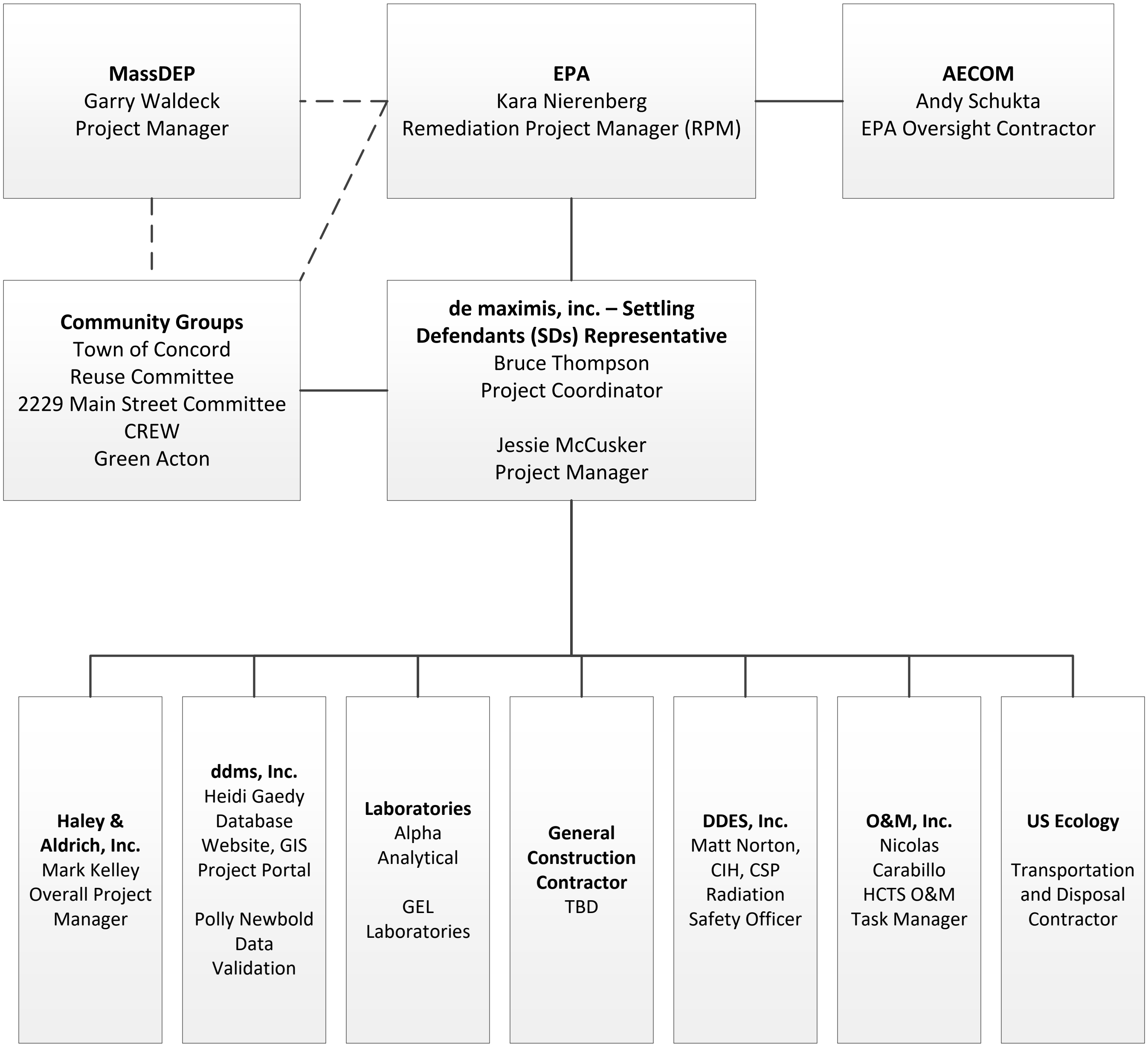


HALEY ALDRICH

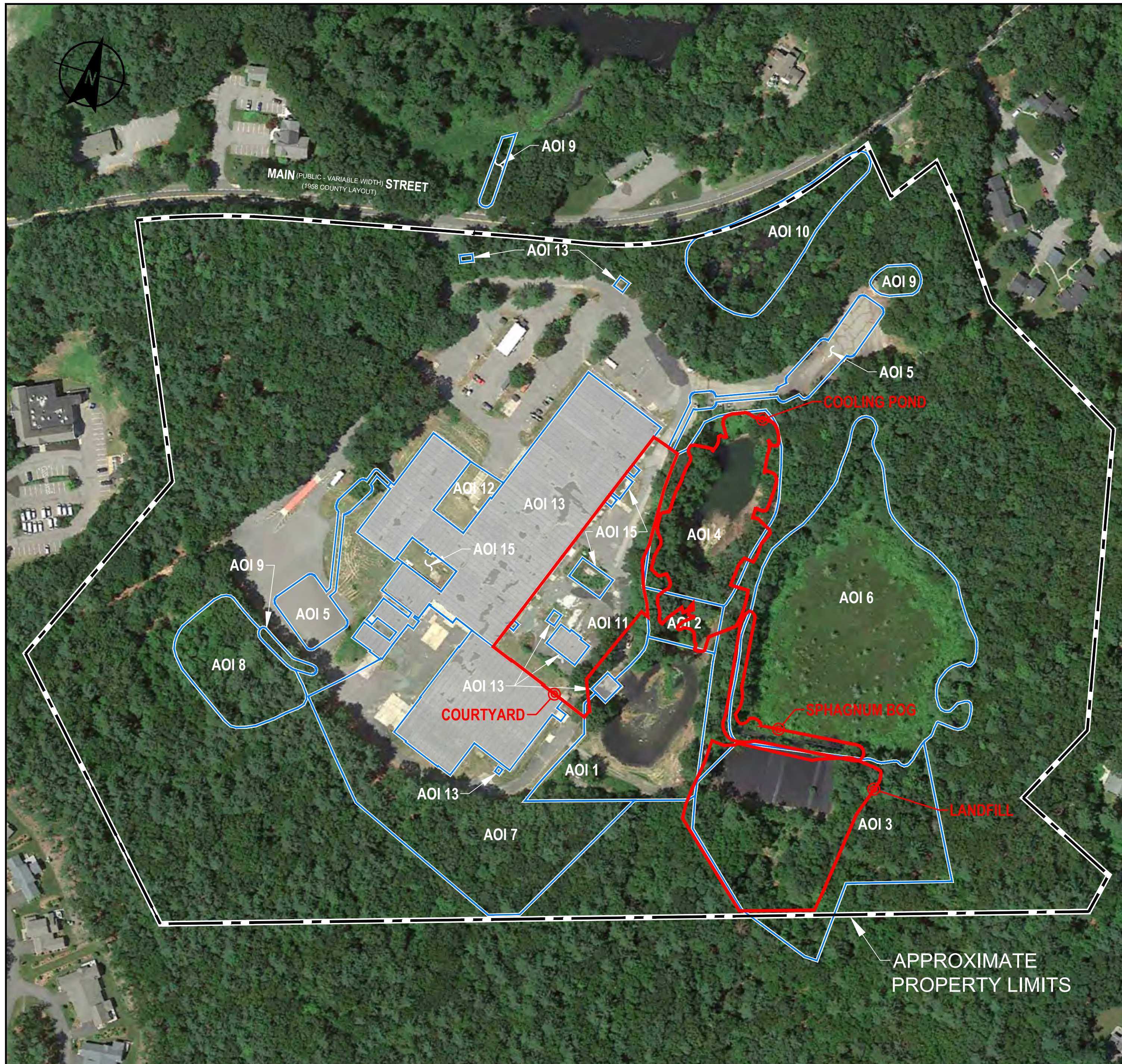
NUCLEAR METALS, INC. SUPERFUND SITE
2229 MAIN STREET
CONCORD, MASSACHUSETTS

PROJECT TEAM ORGANIZATION CHART

SCALE: NONE
SEPTEMBER 2023

FIGURE 2

\\haleyaldrich.com\share\bos_common\131884-NMI\Deliverables\SSS 100 Percent Design\Figures\2023-0630-Figure 2 - Project Team Organization Chart-D1.vsd



LEGEND

AOI 1 — DESIGNATION AND APPROXIMATE LOCATION OF AREA OF INVESTIGATION (AOI)

LANDFILL — DESIGNATION AND APPROXIMATE LOCATION OF REMEDIAL EXCAVATION AREA

NOTES

1. BACKGROUND IMAGE, DATED 22 JUNE 2019, TAKEN ELECTRONICALLY FROM GOOGLE EARTH PRO.
2. PROPERTY LINE TAKE FROM ELECTRONIC DRAWING NAMED TITLED "17368-EC-C3D (Preliminary 2020-06-18).dwg", DATED 15 MAY 2019, BY FELDMAN LAND SURVEYORS OF BOSTON, MASSACHUSETTS.
3. LIMITS OF AREA OF INTEREST (AOI) RECEIVED ELECTRONICALLY ON 22 JULY 2022 FROM DDMS OF WALTHAM, MASSACHUSETTS.

0 250 500
SCALE IN FEET

EXPOSURE AREA		NAME
"A" EXPOSURE AREA	A1	AOI 14 WEST
	A2	AOI 14 SOUTH
	A3	AOI 14 EAST
	A4	AOI 9
	A5	AOI 8 SWEEPING AREA
	A6	AOI 7 AND 11 INDUSTRIAL AREA EAST
	A7	AOI 5 INDUSTRIAL AREA WEST
	A8	AO1 14 OFF-PROPERTY
"B" EXPOSURE AREA	B1	AREA AROUND COOLING POND
	B2	AO1 2 AND 4 SOILS AREA AT COOLING POND
	B3	AO1 10 NE WETLAND SOIL AREA
	B4	RT. 62 OUTFALL AND EMBAYMENT AREA
	B5	AO1 1 HOLDING BASIN
SURFACE WATER / SEDIMENT EXPOSURE AREAS	SW/SD-1	SPHAGNUM BOG
	SW/SD-2	SPHAGNUM BOG SW CORNER
	SW/SD-3	COOLING POND
	SW/SD-4	NE WETLAND
	SW/SD-5	ASSABET RIVER

0 250 500
SCALE IN FEET

HALEY ALDRICH

NUCLEAR METALS, INC.
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXPOSURE AREAS AND
AREAS OF INVESTIGATION

SCALE: AS SHOWN
SEPTEMBER 2023

FIGURE 3

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APPENDIX A

100% Plans, Drawings, Sketches, Calculations, and Specifications

ATTACHMENT A1

General and Project Specifications

SECTION 01 01 01.01 AND SECTION 01 01 01.02

COVER AND SIGNATURE PAGE

Site Name/Project Name:	**Nuclear Metals, Inc. (NMI) – Remedial Design / Remedial Action**
Site Location:	Concord, Massachusetts
Document Title:	Site-Wide Sediment and Soils Remedial Design
Preparer's Name and Organizational Affiliation:	Jessie McCusker *de maximis, inc.*
Preparer's Contact Information:	jessie@demaximis.com, 860.817.7544
Preparation Date:	September 2023
Project Coordinator:	
	Signature
	Bruce Thompson, ***de maximis, inc.***
Investigative Organization's Project Manager:	
	Signature
	Bruce Thompson, ***de maximis, inc.***
Investigative Organization's Project Manager:	
	Signature
	Haley & Aldrich, Inc.
Investigative Organization's Project Manager:	
	Signature
	O&M, Inc.

SECTION 00 01 10

TABLE OF CONTENTS

Notes: Specification shown with an * indicates the specification will be prepared during the bidding phase if determined to be required.

END OF SECTION

SECTION 01 11 00

SUMMARY OF WORK

PART 1 – GENERAL

1.1 SUMMARY

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. The section includes a summary of all components of the Work which are further defined and detailed in subsequent specification sections. It also describes the parties involved with the Project and identifies additional documents that contain Project requirements.

C. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

D. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

E. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

F. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

G. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 PROJECT DESCRIPTION

A. Owner is de maximis, Inc (de maximis). This refers to the Project Owner and acting representative of the actual property owners (Settling Defendants).

200 Day Hill Road, Suite 200
Windsor, CT 06095

B. Engineer is Haley & Aldrich, Inc. including its affiliates and subsidiaries (Haley & Aldrich).

465 Medford St, Suite 2200
Boston, MA 02129-1400

C. Contractor shall perform work under a contract(s) that includes a combination lump sum and unit price items in accordance with the conditions of the Contract(s).

D. A brief description of the Site-wide Soils and Sediment (SSS) Remedial Activities:

1. Site-wide excavation of contaminated sediment and soils. Material will be excavated from under existing building slabs, the Courtyard Area, the Landfill, the Cooling Pond, the Sphagnum Bog, the Northern Parking Lot, and select paved areas across the site. The remedial action objectives applicable to this work are:

   a. Prevent direct human exposure by a future resident (by dermal contact, ingestion, inhalation, or ionizing radiation) to soil or sediment with contaminants (i.e., DU, PCBs, polycyclic aromatic hydrocarbons [PAHs], and other inorganics) that exceed risk-based standards.
   b. Protect ecological receptors from exposure to contaminants (PCBs and copper) in sediments indicative of adverse effects at the Cooling Water Recharge Pond.
   c. Protect ecological receptors from exposure to contaminants (PCBs, copper, mercury, and lead) in sediments indicative of adverse effects at the Sphagnum Bog while maintaining the physical and ecological integrity of the Bog.
   d. Prevent migration of DU/uranium from soils in the Holding Basin that would result in
   e. groundwater concentrations exceeding ARARs;

E. Chemicals of concern (COCs) in Site soils include Uranium (U-238, U-235), Thorium (Th-232), Polychlorinated Biphenyls, Arsenic, and PAHs.

F. The purpose of the remedial action is to implement an US EPA approved remedy which involves the remediation of contaminated soil and sediment across the Site.

G. The components of the SSS remedy, consist of the following activities:

1. Utility and concrete removal in targeted areas;

2. Installation of erosion controls and drainage improvements;
3. Removal of PCB and uranium impacted sediment and soil across the Site;
4. Grading and stormwater management implementation; and
5. Site restoration following excavation and grading.
6. Water management during sediment excavation as necessary and to dewater the Cooling Water Pond. Treatment of pumped water will be staged within the North Parking Lot.

H. Abbreviated summary of work:

1. Installation of temporary erosion and stormwater controls;
2. Demolition, removal of utilities, and excavation of impacted sediment and soils;
3. Stockpiling, stockpile management, and off-Site disposal of impacted materials; and
4. Backfilling and restoring area to design grades.

1.3 EXISTING CONDITIONS

A. See Specification Section 02 00 00 – Existing Conditions for information regarding Site conditions.

1.4 DEFINITIONS

A. Work: Activities to be performed by the Subcontractor as required by executed Contract for SSS Remedial activities are described herein as part of the scope of work and more completely by the Contract Documents.

B. Work Limits: The boundary indicated or described on the Drawings within which the Work for the Contract takes place, except if referenced as another area. Consult Owner (who will consult with Engineer as needed) to resolve any questions regarding definitions of areas for the Work.

1.5 WORK SCOPE

A. The Work includes the following tasks for the SSS Remedial Activities:

1. Submittal preparation in accordance with those listed in specifications.
2. Obtaining permits, where necessary.
3. Completing training(s) as required by the Radiation Safety Officer and in accordance with the Remedial Design Work Plan HASP.
4. Contacting "Dig Safe" and complying with Massachusetts General Laws, Chapter 82, Section 40 and all applicable codes, rules, regulations. Do not begin any excavation or other intrusive work without complying with the law. Ensure that all utilities have been located and marked prior to beginning any excavation or intrusive work.
5. Where applicable, coordinating work with the utility owners.
6. Mobilization.
7. Construction and/or maintenance of a material storage and laydown areas.

8. Construction of temporary access roadways.
9. Providing necessary office equipment (furniture, computers) for use by Contractor within the trailers set up by Owner.
10. Protection of existing utilities, monitoring wells, and other site features.
11. Protection of completed work.
12. Installing and maintaining erosion and sedimentation controls.
13. Dust and odor control.
14. Site clearing and grubbing, including chipping of all above-grade woody plant materials and containerizing for off-site management. Segregate, stockpile, and containerize grubbed root balls for disposal by others.
15. Installation of stormwater controls including berms and proposed drainage channels if not completed during the Enabling Phase remedial activities.
16. Earthwork, including but not limited to, excavation, material handling, temporary stockpiling, filling, compaction, material procurement (import materials), and other earthwork activities. Earthwork will include removal of PCBs > 50 ppm in surficial areas of Courtyard, under Building E, and within the Cooling Pond.
17. Select utility capping and removal.
18. Coordination of transportation and off-site disposal.
19. Coordination for the collection of confirmatory samples by the Engineer as described in the specifications and RD document and shown on the Drawings.
20. Remove temporary facilities and controls not designated to remain.
21. General Site cleanup.
22. Site restoration, including wetland and upland areas affected by the work.
23. Decontaminate equipment and personnel throughout Work and prior to removing equipment from the Site.
24. Provide safe access for the survey layout, including but not limited to verification of existing benchmarks through a baseline field survey, establishing supplementary survey control benchmarks in the vicinity of the Work, survey layout of proposed construction features, field verification while construction is in progress, setting grade stakes and other controls, and as-built construction documentation and final as-built drawings.
25. Demobilization.
26. All other work as indicated by the contract documents.

B. Regulatory Requirements

1. Comply with all rules, regulations, laws, and ordinances of the EPA, Commonwealth of Massachusetts, Town of Concord, Occupational Safety and Health Administration (OSHA), and of all other authorities having jurisdiction. All labor, materials, equipment, and services necessary to make Work comply with such requirements shall be provided without additional cost to the Owner.

1.6 WORK BY OTHERS

A. Owner or Engineer will perform the following Monitoring Work concurrently with the Work as needed:

1. Perimeter air monitoring.
2. Noise monitoring.

B. The Subcontractor shall cooperate with Work by Others at no additional cost and shall not cause or allow delays from the monitoring or waste transportation to incur any agency fines or delays in the Work in general.

1.7 INTENT OF DOCUMENTS

A. Subcontractor shall furnish the following:

1. All labor, tools, materials, equipment, transportation, taxes, and related items essential for completion of the Work.
2. All systems complete and left in good operating condition.
3. Apparatus, appliance, material, or Work not shown on Drawings but mentioned in Specifications, or vice versa.
4. Accessories, reasonably inferable from Drawings and Specifications, necessary to make Work complete and ready for operation.
5. New equipment and materials unless otherwise called for.

B. Notes or instructions shown on any one Drawing apply, where applicable, to all other Drawings.

C. References to codes, Specifications and standards called for in the Specification Sections and on the Drawings, mean the latest edition, amendment, and revision of such referenced standard in effect on the date of these Contract Documents.

D. Other Project Documents: Provide Work in accordance with the documents described/referenced in the Attachments (and as provided by Owner).

1.8 WORK SEQUENCE

A. Construct Work in stages as summarized on Drawings and Construction Sequence within Drawings.

1.9 ACRONYMS AND GLOSSARY

ALIs	Annual Limits on Intake
AOI	Area of Interest
ASTM	American Society for Testing Materials
CFR	Code of Federal Regulations
CHASP	Contractor Health and Safety Plan
CMR	Code of Massachusetts Regulations
COCs	contaminants of concern
CQAP	Construction Quality Assurance Plan
DACs	Derived Air Concentrations

DETS	Dewatering effluent treatment system
EPH	Extractable Petroleum Hydrocarbons
ft	Foot/Feet
GHS	Global Harmonized System
HASP	Health and Safety Plan
in	Inch
JHAs	Job Hazard Analysis
MADEP	Massachusetts Department of Environmental Protection
MHD	Massachusetts Highway Department
NAD	North American Datum
NAVD	North American Vertical Datum
NIOSH	National Institute for Occupational Safety and Health
NMI	Nuclear Metals, Inc.
OSHA	occupational health laws and regulations
PAHs	Polycyclic Aromatic Hydrocarbon
PCBs	polychlorinated biphenyls
PLS	Professional Land Surveyor
PPE	personal protective equipment
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RSO	radiation safety officer
SC	Substantial Completion
SDS	Safety Data Sheet
SDs	Settling Defendants
SRP	Survey Reference Point
SSO	Site Safety Officer
SSS	Site-wide Soil and Sediment
SWPPP	Stormwater Pollution Prevention Plan
TEDE	total effective dose equivalent
TPH	Total Petroleum Hydrocarbons
US EPA	United States Environmental Protection Agency
US DOT	US Department of Transportation

As Called For	Material and equipment, including the execution specified/shown in the Contract Documents.
Code Requirements	Minimum requirements.

Construction Water	Liquid waste produced from construction activities including but not limited to: • Precipitation, dust mitigation water, surface water, or stormwater runoff that comes in contact with soil or sediment disturbance areas; • Excavation dewatering; • Decant water collected in stockpile areas; • Rinse water from equipment decontamination; and • Dewatering necessary to enable backfill placement and site restoration
Contract Documents	Specifications, Drawings, and any other document described in the Contract that defines the Work.
Contractor	Successful party receiving the Award of Contract from the Owner to perform the Work.
Engineer	Haley & Aldrich, Inc. and its design subconsultants.
Equivalent	Equivalent acceptable as determined by the Engineer through the review process, as specified.
Drawings	Engineering drawings prepared by Engineer accompanying these specifications as part of the Contract Documents.
DETS Performance Criteria	Construction Water Quality Criteria found in Table 02 70 00 – 1 of this Section.
DETS Compliance Point	DETS Effluent sample port before treated water is discharged into the existing leach field (as per the Contractor's Construction Water Management Submittal reviewed and accepted by the Engineer).
Final Acceptance	Owner acceptance of the Project from Contractor upon completion.
Furnish	Supply and deliver to installed location.
Inspection	Visual observations by Owner, Engineer, or designated Owner representative
Install	Mount and connect equipment and associated materials ready for use.
Or Approved Equivalent	Approved equivalent as determined by the Engineer.

Owner	de maximis, inc. as representative for Settling Defendants.
Precedence	Stating that a provision in one document that is inconsistent with another is superseded, or that one document always takes precedence over another in the event of a conflict in language or requirements.
Project	Nuclear Metals, Inc.
Provide	Furnish, install, and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new location, then clean, test, and install ready for use.
Replace	Remove and provide new item.
Satisfactory	As specified in Contract Documents.
Site	Nuclear Metals, Inc., 2229 Main St, Concord, Massachusetts
Substantial Completion	Contractor's completion of specified work ready for final inspection by Owner and Engineer.
Work	Soil remediation as described in the Contract Documents.

1.10 SPECIFICATION CONVENTIONS

A. These Specifications are written in the imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

1.11 CONTRACT DOCUMENT PRECEDENCE

A. The Contract Documents are intended to be complimentary. In the case of discrepancy or ambiguity between Contract Documents (e.g., Specifications, Drawings), the Subcontractor shall submit a Request for Information (RFI) to the Owner. The Owner (and Engineer where appropriate) will respond to the RFI with a documented interpretation.

1.12 WORKMANSHIP

A. All workers employed on this Project shall be persons skilled in that work which they are to perform. Work will not be approved if it does not meet the quality of workmanship called for in these Specifications. If this quality of workmanship is not exactly defined herein, it shall be assumed to be the best standards of workmanship for that trade. The Owner shall determine whether the quality of workmanship is acceptable.

B. If workmanship for a portion of this Work is not acceptable, that portion of work shall be removed and replaced at the Subcontractor's expense.

1.13 SITE SAFETY AND WORK RULES

A. Contractor shall be responsible for strict adherence to the Contractor-Specific Health and Safety Plan (CHASP) prepared by the Contractor as specified in Section 01 35 29 – Health and Safety Requirements, which must be reviewed and approved by the Owner prior to the start of Work.

B. Contractor shall take all necessary precautions to provide safety provisions to adequately protect the public, the personnel, and property of the Owner, Engineer, and all other persons, property, and equipment involving their work at the job site.

C. Contractor shall protect the Work from theft, vandalism, and unauthorized entry. Subcontractor shall maintain responsibility for security of the Work throughout the construction period until the Owner acceptance precludes the need for Contractor security. Contractor shall maintain a list of authorized personnel and visitors and submit a copy to Owner upon request.

D. Contractor's equipment shall be managed in such a way as not to inhibit activity at other on-Site activities.

E. Contractor's personnel shall sign in and out daily on the daily sign-in log.

F. Contractor is responsible for the security of their tools, materials, equipment, and temporary facilities.

1.14 SUBMITTALS

A. Contractor shall submit to the Engineer an updated submittal register of all submittals required by this Contract**.**

B. Contractor shall submit a Construction Work Plan (CWP) which shall contain the following information:

1. Identify Project Manager, Site Safety Officer, Quality Control Manager, and Site Superintendent(s) who must be actively involved in day-to-day site supervision, implementation of Work at the Site, and must attend weekly Site meetings. Substitution or replacement of the Project Manager or Site supervisor is not allowed without approval of Owner.

a. A description of responsibilities for proposed key staff assigned to the Project. Include an organizational chart with noted lines of communications.
b. A complete Project directory by organization with name, title, address, telephone number(s), cell phone numbers, fax number, and email addresses.
c. A description on how the Contractor plans to coordinate and work with their subcontractors to perform other concurrent work on-Site.
d. A construction Project Gantt chart and related scheduling information, identifying major work activities and milestone dates, and contractor work elements.
e. The Contractor's proposed approach (means and methods) to the Work and construction sequencing. Include a description of each major task identified in the Project Schedule.
f. Site-Specific Health and Safety Plan described in Section 01 35 29 – Health and Safety Requirements;

C. Contractor shall submit materials testing and data sheets, manufacturers specifications, shop drawings, and any other pertinent information regarding materials or equipment used to perform the Work, as specified within the Contract Documents.

D. Contractor shall submit copies of all approved permits obtained by the Contractor.

E. Contractor shall submit a copy of the Contractor's License.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section contains general information that applies to all Work performed under the Remedial Design Documents and is inherently made a part of each Specification Section.

B. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

C. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

D. Coordinate work with that of all other trades affecting or effected by the Work of this Section. Cooperate with such trades to assure the steady progress of work under the Contract.

E. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

F. The Work described in these Remedial Design Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

G. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of the Record of Decision, the Consent Decree, federal, state, and local health and safety and occupational health and safety statutes and codes.

1.02 DESCRIPTION OF WORK

A. Requested information shall be submitted to the Engineer in accordance with the information outlined in this Section.

B. All submittals will be accompanied by the coversheet provided in Attachment A of this Section.

1.03 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. Drawings

C. Other Sections of the Specifications, not referenced above, shall also apply to the extent required for the proper performance of the Work.

1.04 DEFINITIONS AND REFERENCE STANDARDS

A. See Specification Section 01 11 00-Summary of Work for acronyms and definitions applicable to this Section.

1.05 EXISTING CONDITIONS

A. See Specification Section 02 22 00 – Existing Conditions for information regarding site conditions.

1.06 QUALITY ASSURANCE

A. See Quality Assurance Project Plan (QAPP) and Construction Quality Assurance Plan (CQAP) –for information regarding Quality Assurance.

1.07 SUBMITTAL PROCEDURES

A. Requested information shall be submitted to the Engineer in accordance with the information outlined in Specification Section 01 33 00 – Submittal Procedures.

B. Required Submittals: Submit shop drawings, product data, initial selection samples, verification samples, calculations, coordination drawings, schedules, and all other submittals as specified for each part of the Work.

1. Substitutions: Where a submittal proposes a material or product different than specified and for all "or equal" submittals, comply with requirements and procedures for substitutions in Section 01 60 00 - Product Requirements.

2. Submittals May Affect Payments: No payment will be made for any work requiring a submittal until a submittal has been made and until the submittal has been approved by the Engineer.

3. Submittal Limit: No submittal may be made more than three times. If a submittal is not fully acceptable after its second submission, the Contractor shall take effective action to

manage the submittal process and to resolve the problem so the third submission will be acceptable. The Contractor shall be solely responsible for all increased costs including, without limitation, project delays, professional fees, Engineer's review time, and other costs related to submittals made more than three times.

C. A draft submittal register will be provided to the Contractor. The Contractor shall submit a final submittal register to the Engineer including proposed dates of submittal submission to the Engineer's office and proposed due date to be returned to the Contractor. Schedule at least 2 weeks for reviewing each submission and time for possible required resubmission unless indicated otherwise.

D. Delays: Delays in the work due to improper submittal scheduling or incomplete or improper submission is not justification for an extension of Contract Time.

E. Submittal Reference Numbers:

1. Submittal Reference Numbers: Use Submittal Reference Numbers on Submittal Schedule and actual submittals. Identify each submittal with a unique identification number which is related to the specification section requiring the submittal and the specification paragraph numbers related to the submittal, including a project identifier prefix.

2. Specification References: Clearly identify, refer, and relate each submittal item to the specification paragraph numbers related to the submittal. This is intended to expedite the submittal review process.

3. Example Submittal Reference Number: "Excavation 011100-1.03.A-Rev 01".

F. Revisions: When a submittal is resubmitted with revisions or changes, the Contractor shall highlight and specifically call out all revisions and changes including revisions and changes which are not the result of comments, notes, or exceptions made on the previous submittal by the submittal reviewer. Approval of a submittal with revisions or changes which are not highlighted shall not apply to the revisions or changes which are not highlighted, and the non-highlighted revisions or changes shall be considered "Not Approved."

G. Electronic File type and Filename Convention for Submittals: Contractor to use Adobe Acrobat "PDF" (or approved equal) file format to facilitate submittal review process. Electronic filename shall include project reference, submittal reference number, specification reference, and revision number (if applicable). For example: "PExcavation 011100-1.03.A-Rev 01.pdf"

H. The Engineer shall review and return submittals to the Contractor within 5 business days of the stamped received date, except where indicated otherwise. Please note that regulatory agency approval is required for each submittal and the Agency submittal review is expected within three (3) working days following Engineer's review.

I. Resubmittals shall be made within 5 days of the date of the letter returning the material to be modified or corrected, unless within 2 days Contractor submits an acceptable request for an extension of the stipulated time period, listing the reasons the resubmittal cannot be completed within that time. When corrected copies are resubmitted, the Contractor shall work in "Track Changes" mode to direct specific attention to all revisions, and shall list separately any revisions made other than those called for by the Engineer on previous submissions.

J. Use the "Submittal Cover Sheet" included as Attachment A to this Section, leaving open space as shown for Engineer's submittal review stamp and notations. In addition, within the submittal provide clear notes and full description of all qualifications and all deviations from the requirements of the Contract Documents, if any. As applicable, clearly identify the following on each submittal:

1. Name of project.
2. Date of submittal origination or creation.
3. Contractor's name.
4. Subcontractor's name, complete address, contact person, and telephone number.
5. Manufacturer's name, complete address, contact person, and telephone number.
6. Supplier's name, complete address, contact person, and telephone number.
7. Fabricator's name, complete address, contact person, and telephone number.
8. Submittal name and description.
9. Unique and individual Submittal Reference Number as specified above.
10. Clear notes and full description of all qualifications and all deviations from the requirements of the Contract Documents.
11. Contractor's signed and dated review stamp, showing the Contractor's review and approval of each submittal before delivery to Engineer's office. Unstamped, undated, or unsigned submittals will be returned without action by the Engineer.
12. Open space as shown in Attachment A reserved for Engineer's submittal review stamp and notations.
13. Highlight and call out each and every change and revision made to a previously submitted submittal.

K. Submittal mechanics: Send all submittals to the Engineer in electronic format by e-mail (designated recipient to be identified upon contract award). Do not send submittals directly to the Engineer's consultants.

1. The Engineer will return submittals electronically to designated Contractor's staff.

L. Product Data: Provide electronic copy of manufacturer's literature including, without limitation, manufacturer's standard description of product, materials and construction, recommendations for application and use, certification of compliance with standards, instructions for installation, and special coordination requirements. Collect data into one submittal for each unit of work or system; clearly mark each copy to show which choices and options are applicable to project.

1. Installer Copy: Verify that the Installer has a current copy of the relevant product data, including installation instructions, before permitting installation to begin.

M. Shop Drawings: Provide accurately prepared large scale and detailed shop drawings prepared specifically for this project on reproducible sheets and provided in electronic format. Show adjacent conditions and related work. Show accurate field dimensions and clearly note field conditions. Identify materials and products in the work shown. Note special coordination required.

1. Field Measurements Required: The Contractor and its suppliers and Subcontractors shall jointly take and record in writing accurate field measurements for all built-in materials, products, and fixed equipment. Maintain field measurement record until built-in materials, products, and fixed equipment has been fully installed and accepted by the Engineer. The Contractor shall pay all costs involved in correcting improperly fitting built-in materials, products, and fixed equipment.

2. Maximum Sheet Size: 30 x 54 in.

N. Samples: Provide at least two sample units for each sample submission. Sample units shall be identical to final materials and products installed in the work. Work in the field that falls outside the accepted range shown by the samples will be rejected. Label each sample with description, source, product name or manufacturer's name and model number. Engineer generally will not test samples for compliance with Contract requirements, which shall remain the responsibility of the Contractor.

O. Timing of Submittals: Submit submittals in accordance with the Submittal Due Date Schedule.

1. Testing: Submit samples and materials for testing sufficiently in advance of need for use on project. Allow adequate time for testing and, if necessary, re-testing.

2. Substitutions: Additional submittal review time is required for substitutions. See Section 01 60 00 - Product Requirements

P. Engineer's Action on Submittals: Engineer will review submittals, stamp with "action stamp," mark action, and return to Contractor. Engineer will review submittals only for conformance with the design concept of the project. The Contractor is responsible for confirming compliance with other Contract requirements, including without limitation, performance requirements, field dimensions, fabrication methods, means, methods, techniques, sequences and procedures of construction, and coordination with other work. The Engineer's review of submittals shall be held to the limitations stated in the Contract Documents. In no case shall acceptance by the Engineer be interpreted as a release of Contractor of its responsibilities to fulfill all of the requirements of the Contract Documents. Engineer will indicate one or more of the following:

1. Reviewed: When so marked, the work covered by the submittal may proceed provided it complies with the requirements of the Contract Documents. Acceptance of the work will be based on that compliance.

2. Reviewed As Noted: When so marked, the work covered by the submittal may proceed provided it complies with the requirements of the Contract Documents and the Engineer's notes and comments. Acceptance of the work will be based on that compliance.

3. Reviewed As Noted, Resubmission Required: When so marked, make corrections or changes to original submittal or prepare a new submittal and resubmit to Engineer for record. Submittals with this action may be used at the project site or elsewhere where work is in progress.

4. Revise and Resubmit: When so marked, the submittal is not acceptable. Do not permit submittals with the action marking to be used at the project site or elsewhere where work is in progress.

5. Distribution: Contractor is required to make prints or copies and distribute to the Owner and Subcontractors involved. A total of four hard copies are required to be submitted to the Owner within five (5) calendar days after date of Engineer's review noting that no resubmittal or further action is required. Provide and pay for all copies for distribution from the final approved submittal. Maintain one complete set of submittals at the project site in a neat, organized file.

1.08 PROJECT PHOTOGRAPHS

A. Project Photographs: Provide digital photographs. Photographs should be clear and legible.

1. Preconstruction Photographs: Before beginning work, take sufficient photographs of the existing conditions and the site from different viewpoints to show all significant existing conditions.

2. Wetland Restoration Photographs: In addition to the General Construction Photographs, provide photographs representative of the wetland restoration area taken at the same location at the following stages of construction:

   a. Existing pre-excavation conditions;
   b. Completion of installation of Contractor-designed and contract-required erosion controls;
   c. Completion of final grades; and
   d. Completion of planting.

3. Digital Files: All digital photos shall become the property of the Settling Defendants (SDs). At the completion of the Contract and before final payment, deliver the digital files to the Owner for submission to the SD in a properly labeled CD or other approved media. Organize and label digital photo files by date photo taken and image summary.

1.09 OTHER REQUIRED SUBMITTALS

A. Emergency Contacts: The Contractor shall furnish to the Owner, the names addresses, telephone numbers, and pager/cellular numbers of its job superintendent and at least two other of its own authorized representatives so they can be contacted at times other than normal working hours in case of emergency. In addition, permanently and conspicuously post Contractor's emergency telephone numbers in a manner to be viewed from outside the field office.

1.10 REQUEST FOR INFORMATION (RFI) PROCEDURE

A. The request for information (RFI) process is a means of communicating deviations from the Contract Documents. At any point during the execution of the Contract Documents following the award of this Work, the Engineer, Contractor or Owner request additional information or clarification of the procedures, methods, or materials that may not be in accordance with the specifications or reviewed submittals and/or questions concerning the applicability or interpretation of a particular section or part of any Contract Documents. All requests for information shall be directed to the Owner.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECTUTION

Not Used

END OF SECTION

ATTACHMENT A
NUCLEAR METALS INC. SUPERFUND SITE
SITE-WIDE SEDIMENT AND SOILS
SUBMITTAL COVER SHEET

THE USE OF THIS SUBMITTAL COVER SHEET IS REQUIRED FOR ALL SUBMITTALS.

Contractor: ______________________________

Subcontractor: ______________________________

This Submittal Reference Number: ______________________________
Example: "Pond Outlet 011100-1.03.A-Rev 01"

Submittal Title: ______________________________

Drawing and Detail Reference: ______________________________

Date of Initial Submittal: ______________________________

Date of this Submittal: ______________________________

This Submittal Prepared By: ______________________________

Indicate one of the following:

[ ] This submission is not a proposed substitution or deviation from the Contract Documents.

[ ] This submission includes a proposed deviation from the Contract Documents as clearly identified in this submittal.

[ ] This submission is a proposed substitution or "equal." All requirements of Section 016000 – Product Requirements have been met.

The undersigned attests that the undersigned has examined this submission and that the requirements of the Contract Documents have been met.

By: ______________________________
Signature

____
Printed or Typed Name

____
Title

Reserved for Engineer's Submittal Review Stamp

END OF SUBMITTAL COVER SHEET

SECTION 01 35 29

HEALTH AND SAFETY REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. The Contractor is solely responsible for the health, safety, and protections of all their on-Site workers including its employees, all subcontractors, and material vendors during performance of the Work described herein. Therefore, the Contractor shall provide a Contractor's Health and Safety Plan (CHASP) to be approved by the Engineer meeting all applicable Federal, State, Local, and Owner requirements.

C. The CHASP prepared by the Contractor shall incorporate Health and Safety Plans (HASPs) from all Sub-contractors and be provided to Owner as one package.

D. The reviewed CHASP shall govern the health and safety requirements of the Subcontractor and its Sub-subcontractors during performance of the Work under these Contract Documents.

1.2 REFERENCES

A. NIOSH/OSHA/USCG/EPA: "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985.

B. Code of Federal Regulations (CFR): 8 CFR Chapter 17 Group 13

C. 29 CFR Parts 1910 and 1926: OSHA

D. EPA: Executive Order 3100.1.

1.3 RELATED SECTIONS

A. Section 01 11 00 – Summary of Work

B. Section 01 33 00 – Submittal Procedures

C. Section 01 57 19 – Environmental Controls

D. Section 02 22 00 – Existing Conditions Assessment

E. Section 02 41 00 – Demolition

F. Section 02 61 00 – Waste Management

G. Section 31 00 00 – Earthwork

1.4 GENERAL REQUIREMENTS

A. This Section contains general information that applies to all Work performed under the Contract is inherently made a part of each Specification Section.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Contractor shall examine all other Sections of the Specifications for requirements that affect Work of this Section, whether or not such Work is specifically mentioned in this Section.

D. Owner and Contractor shall coordinate Work with that of all other subcontractors and trades affecting or affected by Work of this Section. Coordinate with such subcontractors and trades to assure the steady progress of all Work under the Contract.

E. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. Contractor and all subcontractors shall take part in a pre-remediation safety meeting with the Owner.

1.5 DESCRIPTION OF WORK

A. The Contractor is required to prepare a Contractor's Health and Safety Plan (CHASP) prepared by a qualified health professional as described herein for all workers at the site, including Contractors, engaged in activity where exposure to contaminated media, including air-borne contaminants, is possible as determined by a qualified health professional retained by the Contractor. It may be necessary that workers who are in close proximity to excavated materials and groundwater to be trained in health and safety procedures according to the OSHA requirements and be current in their OSHA refresher course.

B. Opinions of the Engineer regarding expected site conditions do not relieve the Contractor of his responsibility to protect the health and safety of his employees, all sub-contractor employees, the public welfare, and the environment.

C. The Contractor shall implement health and safety procedures designed to protect health, safety, public welfare, and the environment during the performance of all Work. Such procedures shall include, without limitation, the following:

1. Measures to protect human receptors (the public and workers) from exposure to oil or hazardous material;

2. The institution of air monitoring activities, if necessary, to protect human receptors (the public and workers) from exposure to gases and air-borne particulates;
3. Measures that may be necessary to contain oil and/or hazardous material during the performance of the Work, including:
4. Measures to control fugitive dust and other environmental media;
5. Measures to control odors;
6. Measures to decontaminate vehicles and equipment;
7. Measures to secure soils from on-site excavation and temporary stockpiles of contaminated materials

D. Provide a health and safety coordination meeting prior to commencement of work at the site to inform each worker of the site conditions and proposed health and safety contingency actions.

E. The scope and detail of the health and safety procedures shall be commensurate with the degree and nature of the risks posed to human (worker and public) and ecological populations by the Work as determined by a qualified health professional retained by the Contractor. Standardized health and safety plans may be appropriate for non-intrusive or routine activities conducted at the site.

F. The Contractor shall appoint an OSHA qualified Health & Safety Supervisor/Coordinator who will be charged with overseeing site health and safety, instrument monitoring, personnel and equipment decontamination, control of equipment check out and emergency response.

1.6 SPECIAL SITE CONDITIONS

A. Refer to Section 02 22 00 – Existing Conditions Assessment and the Site-Wide Sediments (SSS) and Soils Pre-Design Investigation (PDI) Report for information relevant to environmental and subsurface conditions.

B. Groundwater, sediment, soil, and surface water have been sampled and analyzed. These investigations have identified elevated concentrations of depleted uranium and polychlorinated biphenyls (PCBs) in soil which are the main contaminants of concern (COCs) in soil. Total and dissolved arsenic, thorium, and other metals such as cobalt and manganese are the main COCs in the Cooling Water Recharge Pond (Cooling Pond) surface water. Uranium and copper are the main COCs in Cooling Pond sediments.

C. All contractors are required to complete a site-specific radiological training provided by the on-Site radiation safety officer (RSO) as specified in Appendix A of the Remedial Design Work Plan HASP (dated September 2020). The training is necessary to enter certain areas of the site and to handle radiologically impacted material.

D. Levels of personal protective equipment (PPE) shall be specified by the Owner depending on the task. It is anticipated that the majority of the work to be performed on this project may be performed at PPE Level D. The Contractor shall be responsible for determining if a higher level of Personnel Protection is required based on the criteria outlined in the Contractor's HASP. Higher level of PPE will be necessary for entering areas blocked off for radiologically impacted material.

E. The Work around the Cooling Pond and Sphagnum Bog will involve working near and on waters. Contractor shall identify all required personal safety procedures associated with working on water in the CHASP and implement all required personal safety procedures and equipment to address potential risks associated with work near waters and in/on waters within the CHASP.

1.7 REGULATORY AND PROJECT REQUIREMENTS

A. Contractor and all Sub-Contractors shall comply with applicable Federal, state, and local safety and occupational health laws and regulations (OSHA) as well as Owner's Contractor Safety Rules, and any other requirements that are appropriate in Massachusetts where the project is conducted.

B. The Contractor shall comply with the Massachusetts Regulations for the Control of Radiation, Standards for Protection Against Radiation, Vacating Premises (105 CMR 120.245 Standards for Protection against Radiation). These regulations specify that the annual total effective dose equivalent (TEDE) dose from any specific environmental source during decommissioning activities should not exceed ten millirem above background.

C. The Contractor shall comply with all Nuclear Regulatory Commission, Radiation Protection Programs (10CFR Part 20 - Appendix B) which provides Annual Limits on Intake (ALIs), and Derived Air Concentrations (DACs) for occupational exposure. ALIs and DACs will be determined for protection of the Contractor during remedial activities.

1.8 NEW MATERIALS AND PRODUCTS

A. Contractor, prior to bringing or use of chemicals on-Site, will submit their Safety Data Sheet (SDS) to the Owner for approval at least 14 Calendar Days prior to delivery to the Site.

B. All chemicals brought on to the Site shall have SDS and all containers shall be labeled according to the Global Harmonized System (GHS). Contractor shall follow safety data sheets and the manufacture's recommendations for worker protection, use, storage and disposal of products used on-Site. Contractor shall furnish and maintain a designated chemical storage area on the Site to store the chemicals. Storing incompatible chemicals together is prohibited. Contractor shall perform weekly inspections of chemical storage areas.

1.9 HEALTH & SAFETY OVERSIGHT

A. Contractor shall have sole responsibility for implementation of the CHASP. Contractor shall also be responsible for implementation of the HASP by all subcontractors. The Contractor shall provide a Site Safety Officer (SSO) who shall be assigned to the Project and be continuously present at the Site during execution of the Work. The SSO shall be responsible for ensuring that the CHASP is properly implemented. The SSO will be charged with: Overseeing Site health and safety; monitoring and protection of worker and public health and safety as it is related to the Work; instrument monitoring; personnel and equipment decontamination; control of equipment check-out; Site traffic control; Site visitors; and emergency response. The SSO shall be experienced in evaluating and observing health and safety concerns associated with work over water. Other SSO responsibilities include monitoring workers for weather-related exposures or stresses.

B. The Contractor's SSO shall have sufficient working knowledge of State and Federal occupational safety and health regulations and formal training in occupational safety and health. Prior to commencement of any Site activities, the SSO shall review the CHASP and provide training on PPE to all on-Site employees who will be working in or near contaminated materials. New employees or visitors to these areas shall be informed of the Site conditions by the SSO. If visitors enter those areas, PPE and training required at that time within that area by the Contractor's personnel shall be required. The SSO shall provide a pre-work safety training to all Site workers and all Site workers shall sign the CHASP log acknowledging they have read and understand the CHASP.

C. Pre-work training on the Site Health and Safety program shall be provided and documented to all Site workers at the start of the Work, and before each major phase of remedial activity commences to review JHAs and Site risks. All personnel working at the Site must attend the training prior to being allowed to work on the Site. Workers found to be blatantly disobeying health and safety requirements will be permanently removed from the Site at the discretion of the Owner.

1.10 SUBMITTALS

A. Prepare and submit in accordance with this Section and Section 01 33 00 - Submittal Procedures.

B. Contractor shall submit the following for Owner review within 14 Calendar Days of Notice of Award unless otherwise stated.

C. Contractor shall submit the names, qualifications and experience of the following individuals identified by the Contractor prior to the submittal of the CHASP:

1. Certified Industrial Hygienist, Certified Safety Professional or environmental health professional responsible for the preparation of the CHASP.
2. Site Safety Office (SSO)
3. Competent Persons from both the Contractor's and any Sub-Contractor(s') personnel (including but not limited to vessel captain, marine safety personnel, hot work safety personnel, and crane and lifting safety personnel).

D. Contractor CHASP and all Sub-Contractor Health and Safety Plans, and sample JHAs at least 30 Calendar Days prior to the commencement of Work. The HASP shall be prepared by a Certified Industrial Hygienist or environmental health and safety professional familiar with the site conditions and proposed construction activities. The minimum qualifications shall be 5 years of demonstrated experience in preparing similar health and safety plans. No work shall be performed until the Engineer has reviewed the CHASP. The CHASP shall apply to all work to be conducted at the site, including work by the Contractor and all Subcontractors. The plan shall include the following information:

1. A list of Contractor’s Work tasks that may involve contact with, excavation of, or handling of contaminated soil, sediment, surface water, or groundwater.
2. Compounds of concern and sign/symptoms of exposure.
3. Potential for worker exposure to the compounds of concern for each work task.
4. Requirements for OSHA training for each work task and a record or schedule for training of Contractor's and Subcontractor's workers in the use of personal protective equipment.
5. Work task specific levels of protection and a description of health and safety equipment including protective clothing, respiratory equipment and monitoring instruments.
6. Procedures for in-situ monitoring of particulates, hazardous gases or vapors for each monitoring equipment.
7. Procedures for containing oil and/or hazardous materials such as decontamination of heavy construction equipment and tools and dust and odor control.
8. Emergency Response Plan describing procedures that will be undertaken to control spills or sudden releases of hazardous material.

E. Levels of protection and a schedule for training of Contractor’s and all Sub-Contractors’ workers in the use of respiratory protection equipment and use of protective clothing. Generally protective clothing is considered disposable but respiratory equipment is reusable. Training will not be provided by the Owner.

F. SDS for all chemicals brought to the Site at least 14 Calendar Days prior to delivery to the Site.

G. Contractor shall submit the following as work progresses to the Owner:

1. Confined space entry Submittals at least 48 hours prior to confined space entry and within 48 hours of the completion of confined space work.
2. Worker breathing zone monitoring results.
3. Incident, near miss, or Stop Work reports.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 HEALTH AND SAFETY PLANNING AND IMPLEMENTATION

A. Contractor shall prepare a CHASP which will ensure the health and safety of all workers at the Site. Contractor shall implement the CHASP throughout the execution of the Work. Procedures for decontamination of heavy equipment, tools, and personnel if necessary.

B. The Contractor shall be responsible to monitor breathing zone in the area of the Work and will report any exceedance in accordance with the Contractor maximum allowable concentration defined in the CHASP and shall provide the Owner with monitoring results relevant to the selection of levels of PPE.

C. All workers who will engage in work at the Site which might result in exposure to contaminated soil or groundwater shall attend a pre-work health and safety briefing and daily tailgate safety briefings.

D. Subcontractor shall conduct health and safety meetings at the beginning of each workday to review specific hazards associated with the Work planned for that day, PPE and operational controls to mitigate those hazards, and contingency plans and emergency procedures to respond to potential problems. Subcontractor and all its employees are required to attend the daily health and safety meetings. Subcontractors and all their employees are required to conduct their own daily health and safety meeting or attend the daily health and safety meetings held by the Owner.

E. Personnel who have not received training or who are not equipped with the required protective clothing and equipment shall not be permitted access to the Site during execution of Work which may result in exposure to contaminated soil, sediment, water, air, or other materials.

F. Subcontractor shall perform work and breathing zone air monitoring of the workers in work area at the following minimum frequencies: at the start of work each day, at the beginning of any new work task, at the completion of work each day and at least every 15-minutes during the workday. The frequency of air sampling collection can be reduced if the air monitoring readings support it and with the approval of the Owner.

1. Air monitoring data shall be recorded daily for each monitoring event and shall be provided the Owner with all air monitoring data at the completion of each workday, or sooner if there are exceedances.
2. The contractor shall control dust in accordance with the requirements of Section 01 81 16 – Environmental Requirements. In addition, no visible dust shall be allowed. At the request of the Owner, additional dust suppression will be implemented.

G. All unsafe conditions or acts must be corrected immediately and reported to Owner. All accidents or “near misses” must be reported to Owner immediately. Subcontractor and Sub-subcontractors shall assist with incident investigation, Root Cause Analysis, and Reporting as required by the Owner.

H. All on-Site personnel have the right to Stop Work. Report a Stop Work to Owner immediately. Reasons for issuing a stop work order include, but are not limited to, any one or more of the following:

1. The belief/perception that injury to personnel or accident causing significant damage to property or equipment is imminent.
2. The Contractor is in breach of Site safety requirements and/or their own CHASP.
3. Identifying a sub-standard condition (e.g., severe weather) or activity that creates an unacceptable safety risk as determined by a qualified person.
4. The belief that the work is out of compliance with environmental or permit requirements.

I. Implement "SAFE" when a Stop Work is initiated:

1. "S"- stop the unsafe act during the task,
2. "A" - analyze the safety issue that warranted the stop,
3. "F" - fix the safety issue and resume work, and
4. "E"- evaluate the fix in relation to the issue as the task is continued to be performed.

J. Work shall not resume until the unsafe act has been stopped OR sufficient safety precautions have been taken to remove or mitigate the risk to an acceptable degree after a Stop Work has been initiated. Stop work orders will be documented as part of an on-Site stop work log. Once work has been stopped, only the Owner can give the order to resume work in consultation with the individual who initiated the Stop Work order.

K. All on-Site workers under employment of the Contractor, including Subcontractors, are required to receive, the Site-specific Radiation Protection Training.

3.2 DECONTAMINATION

A. Proper PPE must be worn while performing all Work activities in accordance with the approved CHASP.

B. Subcontractor shall decontaminate all equipment and tools which have come in contact with contaminated sediment, groundwater, and other materials to prevent the spread of contamination within the Site and outside the Site limits in accordance with Section 01 81 16 – Environmental Requirements.

C. Subcontractor shall dispose of all decontamination by-products in accordance with Local, State, and Federal regulations in accordance with Section 02 70 00 – Construction Water Management and Section 02 61 00 – Waste Management.

D. Run off from decontamination areas is prohibited.

E. Equipment that may have come in contact with contaminated soil and groundwater shall be turned into the radiological site contact for screening before it is cleared to leave the site. Equipment shall be screened as specified in Appendix A of the Remedial Design Work Plan HASP.

F. Air monitoring instrumentation and delicate instruments that are difficult to decontaminate or sensitive to water should be protected from contamination during use with plastic sheeting without interfering with equipment operation. To the extent possible, efforts should be taken to limit the degree of contamination to hand tools and sampling equipment during use.

G. Contractor shall implement a Medical Surveillance Program in accordance with the approved CHASP.

3.3 DISPOSAL OF CONTAMINATED MATERIAL

A. Contaminated materials must be segregated into liquids or solids and containerized separately for off-Site disposal. Contaminated material generated and containerized as a result of decontamination procedures will be segregated according to their type and contaminants, profiled, and labeled for disposal in accordance with Section 02 61 00 – Waste Management.

3.4 ACCIDENT REPORTING REQUIREMENTS

A. Should any unforeseen safety-related factor, hazard, or condition become evident during the performance of the Work, the Contractor shall immediately take prudent action to establish, maintain, and secure the Site and working conditions. This shall be followed by immediate notice to the Owner.

B. If a serious injury (requiring medical attention) or injury requiring first aid to a person or damage to property, environment, or natural resources result from an incident, the Contractor shall immediately report the incident to the Owner. The report shall be followed by a written document describing the incident, what hazards were created by it, and a detailed statement of what actions were taken to correct the incident within 24 hours of the event. The Subcontractor shall also include a description of why the actions taken were prudent and will be useful in preventing the incident from happening again.

END OF SECTION

SECTION 01 56 00

TEMPORARY BARRIERS AND ENCLOSURES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section contains general information that applies to all Work performed under the Contract and is inherently made a part of each Specification Section.

B. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

C. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

D. Coordinate work with that of all other trades affecting or effected by the Work of this Section. Cooperate with such trades to assure the steady progress of work under the Contract.

E. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

F. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

G. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of the Record of Decision, the Consent Decree, federal, state, and local health and safety and occupational health and safety statutes and codes.

1.02 DESCRIPTION OF WORK

A. The Contractor shall furnish and construct all temporary barriers and enclosures as required to complete the Work as outlined by the Remedial Design Documents and Drawings.

B. The Contractor shall install temporary engineering controls, including but not limited to fences and barricades, to protect people, including workers and the public, from injury resulting from Contract activities.

C. The Contractor is solely responsible for workplace safety and safety of the public with respect to Contract activities. The Contractor shall determine the appropriate means, methods, and techniques to be used to ensure safety.

1.03 RELATED SECTIONS

A. SECTION 02 00 00 – Existing Conditions

B. SECTION 02 61 13 – Waste Management

C. SECTION 31 00 00 – Earthwork

D. Drawings

E. Other Sections of the Specifications, not referenced above, shall also apply to the extent required for the proper performance of the Work.

1.04 DEFINITIONS AND REFERENCE STANDARDS

A. See Specification Section 01 11 00 - Summary of Work for acronyms and definitions applicable to this Section.

B. See Specification Section 02 22 00 – Existing Conditions for information regarding site conditions.

1.05 QUALITY ASSURANCE

A. See the Construction Quality Assurance Plan.

1.06 TEMPORARY FACILITIES

A. Contractor's Field Offices: The Contractor shall provide the Contractor's own field offices as needed. Maintain Contractor's field offices for the duration of the Contract as determined by the Engineer.

1. Location: Locate field offices as directed by the Owner.

2. Office Equipment: Provide office equipment needed for efficient administration of the project.

3. Contract Documents at Site: Keep copies of all Contract Documents and project paperwork neatly on file at job site. Maintain all sets of Contract Documents at the site current and up-to-date. In addition to maintaining a separate chronological file of

addenda and Contract Modifications, clearly note and paste in all addenda and Contract Modifications on the sheets and pages that are changed by addenda and modification. Bind, tape edge band, reinforce, and prepare job site copies of Contract Documents.

B. Storage: Locate storage areas where approved by the Owner and authorities having jurisdiction.

C. Solid Waste Containers: Provide and dispose of for all non-impacted material.

1.07 TEMPORARY UTILITY REQUIREMENT

A. Contact "Dig Safe": Comply with Massachusetts General Laws, Chapter 82, Section 40 and all applicable codes, rules, regulations. Do not begin any excavation without complying with the law. Ensure that all utilities have been located and marked prior to beginning any excavation work.

B. Temporary Water: Water service available for connection at the Site. Provide all connections and make all arrangements for this service. Provide all piping, hoses, fittings, water barrels, and other temporary facilities needed. The Contractor will be reimbursed for water consumed.

1. Freezing Weather: Protect temporary and permanent water systems from freezing and damage. Repair damage at no additional cost to the SDs.

2. Drinking Water: Provide clean, cooled drinking water for workers and all subcontractors. Provide disposable paper cups and waste container.

C. Temporary Lighting and Power: Power is available for connection at the Site. Provide all connections and make all arrangements for connection to temporary light and power service on Site. Provide all feeders, conductors, fuse boxes, fuses, disconnect switches, receptacles, fixtures, bulbs, and other temporary items needed. Provide adequate lighting for proper construction, inspection, safety, and security, including material storage areas.

1. Contractor shall design and install an electrical power supply to support the Work described in these Documents that may either be from a portable generator or from the location of the power supply tie-ins as shown on the Drawings. Payment Responsibility: The Contractor will pay for electricity consumed.

2. Contractor is required to obtain all permits and inspections.

3. All Electrical work shall be designed and installed in accordance with National Electrical Code and shall comply with all applicable rules and regulations of local and state laws and ordinances.

1.08 SUBMITTALS

A. Requested information shall be submitted to the Engineer in accordance with the information outlined in Specification Section 01 33 00 – Submittal Procedures.

B. Contractor shall submit in accordance with the General Provisions of the Contract, an electrical supply plan and design, prepared by an appropriately trained, experienced, and licensed electrical engineer/contractor.

PART 2 - PRODUCTS

2.01 CHAIN LINK FENCING

A. Provide chain link perimeter fencing and locked gates to protect the work, protect materials, prevent injury, and control access as directed.

2.02 PLASTIC BARRIER FENCE

A. Provide continuous plastic barrier fence at the limits of work if not otherwise marked by temporary fences indicated on the Drawings.

1. Height: Minimum 4 ft above grade.

2. Color: Orange or other approved color.

2.03 TEMPORARY GUARDS AND BARRIERS

A. Barricades, Warning Tapes: Provide effective barricades to ensure safety. Warning tapes may only be used for very minor hazards or walkway identification.

B. “Jersey” Barriers: Jersey barriers shall be used to protect above grade utilities from truck traffic within the areas of roadway improvement. Jersey barriers shall be used to separate and contain excavated materials.

2.04 TEMPORARY ENCLOSURES

A. Construct and maintain Temporary Enclosures in accordance with information shown on the Drawings and in accordance to manufactures specifications.

2.05 TEMPORARY ROADWAY AND ENTRANCE IMPROVEMENTS

A. Construct Temporary Access Roadways and Roadway Improvements in accordance with information shown on the Drawings.

B. Construct Temporary Stabilized Construction Entrances in accordance with the information shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Minimize disturbance to trees and shrubs during fence, barrier, and enclosure installation in areas that otherwise would not be disturbed by construction.

B. Temporary roadway installation shall include placement of geotextile and crushed stone along the temporary roadway, and placement of erosion control blankets along the edge of stone to minimize potential erosion of the existing landscaped areas adjacent to the temporary roadway.

SECTION 01 57 00

TEMPORARY EROSION AND SEDIMENT CONTROLS

PART 1 – GENERAL

1.1 SUMMARY

A. Attention is directed to the GENERAL CONDITIONS OF THE CONTRACT and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. This Section covers the requirements for temporary erosion and sediment controls related to Work at the Site. Temporary controls are defined as installations to support construction that are not part of the permanent installed Work.

C. Further information on erosion and sediment controls, dust and vapor controls, and decontamination procedures is described in Section 01 57 19– Environmental Controls.

D. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work on the Contract.

E. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

F. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

G. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 REFERENCES

A. "Stormwater Quality Handbook, Construction Site Best Management Practices (BMPs) Manual," Massachusetts Department of Environmental Protection (MassDEP), February 2008.

B. MassDEP Wetlands Protection Act, M.G.L. c. 131, § 40,

C. MassDEP Massachusetts Clean Waters Act, M.G.L.c. 21, §§ 26-53.

1.3 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. SECTION 02 22 00 – Existing Conditions Assessment

C. SECTION 01 57 19 – Environmental Controls

D. SECTION 31 00 00 – Earthwork

1.4 SUBMITTALS

A. Contractor shall prepare and transmit submittals to Owner for all products shown in the Drawings and any additional products required as a component of the installed temporary controls including, but not limited to, sediment/aggregate containment area, contaminated material stockpile containment areas, temporary access roads, and decontamination/wash pad.

B. Contractor shall submit drawing(s) to the Owner of Contractor staging/storage areas and the layout of other temporary controls for Owner review prior to start of construction if proposed locations and layout differ from depiction on Drawings.

1.5 DESCRIPTION OF WORK

A. Work will be completed as described in Section 01 11 00 Summary of Work. Straw wattles will be installed around work areas as needed and wattles or bales shall be installed around the temporary contaminated soil stockpile areas during the Work as described in Section 1.6. Protective erosion control features shall be installed around sensitive environmental areas such as the Sphagnum Bog and around catch basins during the Work.

B. The resources in the vicinity of the Work Areas cannot be further degraded by erosion resulting from the remedial excavation and construction activities. The erosion control measures involve a multi-tier approach. This approach includes, but is not limited to:

1. Construction of temporary access to the work area will require some initial rough grading, placement of crushed stone and timber matting.
2. Delaying grubbing and exposing erosion susceptible materials in small increments during the workday.
3. Placement of fills at the site in a controlled fashion and construction of final restoration covers on a piecemeal basis.
4. Management of the locations and protection systems for active and inactive stockpiles of materials, mitigating run-on and run-off.
5. Use of conventional straw bales, silt fences, straw wattles, coir rolls, and supplemental measures as needed strategically placed at locations shown on

the Drawings, chosen by the Engineer, or chosen by Contractor and approved by the Engineer based on work area location, work sequencing, and work to be performed.

6. Use of timber crane mats (or similar), gravel platforms, and gabion-lined access roads for stabilization and erosion control as needed to allow vehicle access in wet areas if necessary.

C. Contractor shall design and construct erosion control systems to prevent erosional movement of soil from the following:

1. Work Areas to resource areas outside Limit of Work.
2. Work Areas and drainage channels containing surface waters.

1.6 CONTAMINATED MATERIAL STOCKPILE CONTAINMENT

A. Contractor shall construct and maintain soil/material stockpile containment areas to store stockpiled contaminated materials isolated and protected from the environment. Containment shall be constructed in accordance with the Drawings, or as approved by the Owner, and shall include:

1. Polyethylene sheeting to cover and prevent precipitation from entering contaminated material stockpiles. Polyethylene cover shall have a minimum thickness of 10 mils. The cover shall be anchored to prevent it from being removed by the wind as per the Drawings.
2. Clean backfill stockpile areas will be lined with a single layer of non-woven geotextile fabric (Mirafi 180N or approved equivalent). Straw bales or straw wattles shall be placed around clean backfill temporary staging/stockpile areas underlain with geotextile.
3. Excavated material processing areas will be constructed using a layer of 40-millimeter (mil) geomembrane between two layers of geotextile (Mirafi 1160 N or equal) as the base. They shall be surrounded by berms constructed of pre-cast concrete barriers (e.g., Caltrans Type 60C Concrete Barrier), or similar pre-approved means, and a 40 MIL geomembrane liner (GSE H textured or approved equivalent) installed up and over the berms to establish a containment berm.
4. Straw bales shall be placed around drain inlets in order to protect drains from contaminated runoff during excavation activities. Filter fabric shall be placed under the grate of the drains and extend to the limit of the straw bales. In lieu of straw bales and filter fabric, a catch basin sediment device shall be used.
5. Berms a minimum of 12 inches high at points of vehicle access to the stockpile. Contractor shall have provisions in place to increase berm heights at the vehicle access point to account for potential flooding.

B. Contractor shall remove and store liquids which collect in contaminated stockpile containment areas. Liquids from stockpile areas shall be containerized onsite and will be treated once a site water treatment system is constructed.

C. Contractor shall inspect the stockpile containment areas on a weekly basis (at a minimum) or following a significant precipitation event, and as requested by the Owner.

D. Water-tight roll-off containers may be used to temporarily store contaminated materials. Roll-offs shall be provided by Contractor with secondary containment.

E. Contractor shall place an impermeable cover over stockpile areas to prevent precipitation from contacting stored material. Liquids which collect in stockpile units shall be managed by the Contractor.

1.7 TEMPORARY STORMWATER CONTROL

A. Contractor shall maintain work areas free of water to the extent possible. Contractor shall provide, operate, and maintain pumping equipment as required to remove accumulated/ponded water.

B. Contractor shall protect the Site from puddling or running water and provide stormwater controls to direct runoff away from disturbed areas, active work areas to the extent practical. Water that contacts stockpiled impacted materials must be managed by the Contractor. Liquids from stockpile areas shall be containerized onsite and will be treated once a site water treatment system is constructed.

C. Contractor shall construct stormwater controls in accordance with engineering drawings. They will consist of:

1. Temporary berms to divert clean storm water runoff from entering the active work area or to contain stormwater runoff captured within an active work area. Diversion berms include the following:
   a. Temporary stormwater diversion V-ditches constructed at an approximately 1:50 slope and underlain by compacted subgrade and non-woven geotextile.
   b. Temporary drainage berms constructed at a 1:3 slope from compacted subgrade and underlain with non-woven geotextile.
2. New detention ponds in accordance with engineering drawings to contain the estimated volume of runoff in the area. Berms shall be constructed with approximately 1:3 slopes and underlain by woven geotextile and compact subgrade.

1.8 REMOVAL OF TEMPORARY CONTROLS

A. Contractor shall remove temporary utilities, equipment, facilities, and materials prior to Substantial Construction Completion inspection as directed by Owner.

B. Contractor shall remove temporary underground installations completely.

C. Contractor shall clean and repair damage caused by installation or use of temporary work.

D. Contractor shall restore existing permanent facilities used during construction to original condition or as otherwise specified.

PART 2 – PRODUCTS

A. Straw Bales: Securely tied baled straw at least 14 inches (in) by 18 in by 30 in long. Secure with #2 re-bar steel pickets or 1-in by 1-in oak stakes, at least 4.0 feet (ft) in length, driven 1.0 ft into the ground. Clean straw bales shall be free of reproductive plant parts (e.g., seed heads, etc.) from the harvested plants that can contribute to invasive species development.

B. Erosion control materials used at the site shall not contain plant parts capable of reproducing (e.g., seed, rhizomes, etc.). Straw bales and other erosion control materials delivered to the site may be rejected by the Engineer for use if they contain reproductive plant parts.

C. Temporary Seed Mixture: Temporary seed is only to be required when or if it is impractical to establish permanent protective vegetation on disturbed earth by October 15. Use "Conservation Mix" or seed mixture approved by the Engineer and application rates acceptable to the Engineer.

D. Straw Wattles shall consist of North American Green Sedimax-SW (Straw Wattles) or similar.

E. Crushed Stone: ¾-in. Crushed Stone (MHD M2.01.4) as specified in Section 31 00 00 – Earthwork.

F. Erosion Control Blankets: Erosion control blankets shall consist of biodegradable natural fiber materials. The matting matrix shall consist of agricultural straw, coconut fibers, or a mixture of the two, depending on the matting type indicated on the Drawings. Erosion control blankets shall be as specified in Section 310000 – Earthwork.

G. Silt Fence: The filter fabric shall be a material suitable for erosion control applications and shall be one of those included on the Massachusetts Highway Department’s List of Approved Materials and Supplies. Wood posts shall be oak and sections shall measure 2-in by 2-in, and at least 4.5 ft in length. Support netting shall be heavy-duty plastic mesh. For prefabricated silt fence, 1 in by 1-in wood posts will be permitted.

PART 3 – EXECUTION

A. Straw Wattles, Straw Bales, and Silt Fences shall be installed in accordance with the following specifications:

1. The straw wattles shall be placed and anchored as shown on the drawings.
2. Embed straw bales into soil and anchor in place with stakes. Where used, bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another. All straw bales and silt fence shall be

entrenched 4 in below ground surface to prevent runoff from passing below the straw bales.

3. The erosion check bales shall be entrenched and backfilled. The trench shall be excavated the width of the bale and the length of the check to a minimum depth of 4 in. After the bales are staked and chinked, the excavated soil shall be backfilled against the check bales.
4. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake in each bale should be driven toward the previously laid bale to force the bales together.
5. Straw bales shall be replaced when they become clogged with soil particles or as directed by the Engineer
6. Erect silt fence as shown on the Drawings and maintain or replace as necessary or as directed by the Engineer.
7. A minimum 6-in deep by 6-in wide trench shall be dug where the silt fence is to be installed.
8. The silt fence shall be positioned in the trench with the fence posts set at 8 ft on center (maximum). The trench shall be backfilled and the soil compacted over the silt fence.
9. The silt fence shall be stapled to each post. When joints are necessary, silt fence shall be spliced together only at support posts. Splices shall consist of a 6-in overlap and shall be securely sealed.

B. Crushed stone shall be placed in accordance with engineering drawings and Section 31 00 00 – Earthwork specifications.

C. Erosion control blankets shall be installed in accordance with the manufacturer's recommendations. At a minimum, matting shall be secured to the soil surface by placing staples or stakes at 18 in by 24 in centers with smaller dimension oriented across slope. The edges of parallel matting shall be staked with a 4 in overlap.

D. Maintenance of Erosion and Sediment Control Measures shall be completed in accordance with the following specifications:

1. The Engineer has the authority to verify, enforce, and to specify maintenance activities and to require that erosion controls have been properly maintained. Erosion controls shall be maintained by the Contractor to the satisfaction of the Engineer or Owner.
2. Erosion and sedimentation controls shall be routinely inspected and maintained by the Contractor. At a minimum, erosion controls shall be visually inspected at the start of day, mid-day, at the end of the day, following a storm event, and as requested by Engineer. The Contractor shall conduct inspections of the erosion and sedimentation controls promptly after rain events or when directed by the Engineer. Impacted resource areas shall be restored to prior conditions.
3. At a minimum, erosion and sedimentation controls will be cleaned when sediment deposits reach 6 in height adjacent to the straw bales or silt fences. Any material removed from erosion controls will be screened by the on-site

radiation safety officer (RSO) and placed with other impacted material stockpiled for disposal.

E. Repair all damages caused by soil erosion or construction equipment at or before the end of each working day. Contractor shall maintain a supply of extra erosion control materials under cover on the Site in order to make emergency repairs to erosion controls, consisting of the following:

1. 50 straw bales (under cover)
2. 100 stakes
3. 200 linear ft of silt fencing
4. 200 linear ft of erosion control blanket
5. 20 cubic yards of ¾ -in crushed stone

END OF SECTION

SECTION 01 57 19

ENVIRONMENTAL CONTROLS

PART 1 – GENERAL

1.1 SUMMARY

A. Attention is directed to the GENERAL CONDITIONS OF THE CONTRACT and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. This Section covers the requirements for dust and vapor controls, decontamination procedures, air pollution control, water pollution control, erosion and sedimentation control, hazardous materials storage and management, spill prevention, biological species protection during construction, and import soil/fill materials. Temporary controls are defined as installations to support construction that are not part of the permanent installed Work.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work on the Contract.

D. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

E. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 REFERENCES

A. "Stormwater Quality Handbook, Construction Site Best Management Practices (BMPs) Manual," Massachusetts Department of Environmental Protection (MassDEP), February 2008.

B. MassDEP Wetlands Protection Act, M.G.L. c. 131, § 40,

C. MassDEP Massachusetts Clean Waters Act, M.G.L.c. 21, §§ 26-53.

D. Massachusetts Surface Water Quality Standards, 314 CMR 4.00.

E. Massachusetts Ambient Air Pollution Control Regulations, 310 CMR 7.00.

F. Massachusetts Groundwater Discharge Permit Program (3.14 CMR 5.10 (Permit Conditions) and 5.11 (Groundwater Standards).

G. Draft Stormwater Pollution Prevention Plan (SWPPP), Nuclear Metals Inc. Superfund Site Remedial Action, prepared by Haley & Aldrich, Inc., prepared for de maximis, Inc., dated March 2022

1.3 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. SECTION 02 22 00 – Existing Conditions Assessment

C. SECTION 01 57 00 – Temporary Erosion and Sediment Controls

D. SECTION 31 00 00 – Earthwork Specification

E. SECTION 02 61 00 – Waste Management

F. SECTION 01 35 29 – Health and Safety Requirements

G. SECTION 02 70 00 – Construction Dewatering and Water Management

1.4 SUBMITTALS

A. Contractor shall submit all submittals to the Owner and Engineer in accordance with Section 01 33 00 – Submittal Procedures.

B. Contractor shall submit product information on Stormwater Pollution Prevention Plan (SWPPP) Best Management Practice (BMP) products including erosion and sedimentation controls to be used by the Contractor at the Site.

C. Contractor shall submit a Decontamination Plan describing the means, methods, and location of decontamination occurring at the Site. The Decontamination Plan should also describe how water used for decontamination will be managed.

1.5 DESCRIPTION OF WORK

A. Work will be completed as described in Section 01 11 00 Summary of Work and includes soil and sediment excavation across the Site. Excavated contaminated soil shall be stockpiled in contained areas and brought off-site in shipments in accordance with

Section 02 61 00 Waste Management Clean backfill soil shall be stockpiled onsite and used to fill in excavations and restore remediation areas.

B. Excavation of contaminated sediment shall occur along the edges of the Sphagnum Bog during SSS remediation. The wetland shall be restored in accordance with Section 32 30 00 Wetland and Upland Restoration.

C. Temporary erosion controls such as straw wattles shall be installed temporary contaminated soil stockpile areas, catch basins, and environmentally sensitive areas in accordance with Section 01 57 00 – Temporary Erosion and Sediment Controls.

D. Water that contacts stockpiled impacted materials must be managed by the Contractor in accordance with Sections 02 61 00 Waste Management and 02 70 00 – Construction Dewatering and Water Management. Liquids from stockpile areas shall be containerized onsite and will be treated once a site water treatment system is constructed.

E. Contractor shall place an impermeable cover over stockpile areas to prevent precipitation from contacting stored material.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Contractor shall furnish all materials, equipment, appurtenances, and facilities as required for installing, maintaining, and removing all environmental protection measures described in the Contract Documents.

PART 3 – EXECUTION

3.1 GENERAL

A. The Owner will notify the Contractor in writing of noncompliance with the provisions of this Section and the action required to become compliant. The Contractor shall respond in writing within 3 business days and take immediate corrective action. Contractor shall record the submittal of written response in daily reports. Such notice, delivered at the Site, shall be sufficient for the Contractor to take action. The Owner or Engineer may issue an order stopping all or part of the Work for failure to comply until corrective action has been taken. No time lost or other costs, or damages due to such stop orders, shall be the subject of a claim for extension of time or for costs or damages unless it is later determined that the Contractor was in compliance.

B. Construction activities and vehicle encroachment into areas outside the Work Limits or off access roads are prohibited, except as approved by the Owner in communication with the property Owner in writing prior to the activity or encroachment.

C. Contractor shall notify the Owner immediately upon observation of construction-related uncontrolled dust, other fugitive emission, or unsanctioned environmental condition.

D. Should any sudden, continuous, or intermittent release of oil or hazardous material occur during the Work, the Contractor shall notify the Owner immediately and shall immediately begin actions to contain or abate the release. The Contractor shall immediately arrange for clean-up activities either by themselves or through a pre-approved Contractor who is contracted with them to provide such services. The Owner shall make necessary notifications to the Massachusetts Department of Environmental Protection (MassDEP) 24-hour Spill Reporting Line at 888-304-1133, to report a release of oil or hazardous material (OHM) and other environmental emergencies. The 2-hour Reportable Quantity of OHM in Massachusetts is more than 10-gallons of oil, a spill of any amount which results in a sheen on surface water, and a detection of OHM which exceeds a Reportable Concentration. Contractor shall maintain a sufficiently stocked spill kit on-Site to immediately respond to an oil or hazardous material release.

E. All equipment and materials shall be used in a manner to minimize the potential for, and extent of, any unnecessary contamination. Methods to minimize unnecessary contamination could include, but are not limited to, using separate equipment for handling excavated/dredged material and clean imported material, tracking equipment across HDPE sheets to minimize tracking across contaminated material, and/or having multiple or mobile decontamination/wheel wash pads to minimize the travel distance to decontamination.

F. Any earthwork equipment that performs intrusive activities in any part of the Site within the Work Limits or is used to handle contaminated materials shall be decontaminated prior to leaving either the area of contamination or the Site, or prior to being repurposed for use with clean construction materials.

3.2 WATER QUALITY

A. The discharge of floating oil or other floating materials from any vicinity in quantities sufficient to cause deleterious bottom deposits, turbidity, or discoloration in surface water, or otherwise adversely impact beneficial uses is prohibited.

B. No refuse, garbage, debris, soil, silt, sand, cement, concrete, or washings thereof, or other construction related materials or wastes including oil or petroleum products, or other organic or earthen material shall be allowed to enter into or be placed where it may be washed by the rainfall or run-off into Waters. These materials shall not be placed within or where they may enter a surface water body or wetlands, and if so placed, shall be removed immediately. Catch basins shall be protected with straw wattles during earthwork activities.

C. All water associated with construction activities shall be handled in accordance with Section 02 61 00 – Waste Management and Section 02 70 00 – Construction Dewatering and Water Management.

D. Contractor shall implement the SWPPP, any updates to the SWPPP, to prevent Site runoff and/or accidental discharge. The discharge of materials other than non-impacted stormwater to site water bodies is prohibited. Impacted stormwater, dewatering water, and other water generated by construction activities shall be monitored and managed by the contractor. Liquids in contact with impacted stockpile areas shall be containerized onsite and will be treated once a site water treatment system is constructed.

1. Contractor shall prevent or minimize the transfer of sediments with runoff from any portion of the Site (e.g., access road, parking area) to adjacent properties.

E. Contractor shall prevent stormwater and non-stormwater from contacting waste and hazardous materials to minimize the generation of Construction Water. Contractor shall utilize engineering controls, best management practices, stormwater controls, and other related means and methods including, but not limited to, the following:

1. Provide double containment for any electrical generator or other device containing fuel, lubricants, or other potential contaminants; The contractor shall use mobile diesel fueling trucks as necessary during the work for fueling of equipment;
1. Prior to completion of the Work, remove any contamination from within the containment and legally dispose, remove containment barriers, and restore the area;
2. Each construction crew shall have sufficient supplies of absorbent and barrier materials on-hand to allow the rapid containment and recovery of any spills;
3. Collect waste generated during spill cleanup or equipment maintenance and dispose of waste in accordance with Section 02 61 00 – Waste Management;
4. Remove spills by excavation and disposal of any soil or materials contaminated by a spill;
5. Inspect vehicles daily and provide routine and required maintenance to detect and repair leaks of fuels, lubricants, or other fluids. Repair immediately following detection of leaks. Perform maintenance of vehicles no less than 50 feet from Waters; and
6. Provide drip pans under stationary equipment such as motors, pumps, generators, compressors, and parked or idle vehicles that are within or immediately adjacent to a wetland or body of water to prevent impacts from oil or other fluids.

3.3 DECONTAMINATION

A. Contractor shall decontaminate vehicles, equipment, tools, and materials that come into contact with waste materials and manage the waste material as specified in Section 02 61 00 – Waste Management:

1. Contractor shall conduct thorough removal of materials from the exterior of all trucks and construction vehicles/equipment within the active work area prior to final rinsing/cleaning at the decontamination/wheel wash pad to minimize the amount of soil and sediment collected in the wash water. Remove soil and debris from undercarriage and wheels/tracks prior to departing the active work area.

2. Contractor shall clean all vehicles and equipment leaving the Work Limits and rendered free of any visible solids. Contractor shall accomplish this by washing with water until visible solids are no longer present on the piece of equipment. Steam cleaners, water jets, scrub brushes, and non-phosphate detergent may be used in an approved manner to aid in the removal of solids and the decontamination of equipment. All washing activities shall be conducted at a designated wash area selected by the Contractor and Owner.
3. For equipment used to load TSCA materials (materials with PCBs ≥ 50 ppm), equipment will be decontaminated in accordance with 40 CFR §761.79 - Decontamination Standards and Procedures as well as the provisions within this specification. In accordance with 40 CFR §761.79 (c)(2), a double wash/rinse will be used in lieu of swabbing surfaces. If a double wash cannot be completed, surfaces will be swabbed. A sump will be installed in the truck wash area to capture and contain solvents and cleaners in accordance with 40 CFR §761.366 - Cleanup Equipment.

B. Contractor shall handle and dispose of water and solids collected during decontamination procedures as specified in Section 02 61 00 – Waste Management.

C. Contractor shall provide all protective clothing and equipment necessary to comply with the decontamination procedures as specified in the Contractor’s approved CHASP, specified in Section 01 35 29 – Health and Safety Requirements. Perform personnel decontamination as needed prior to leaving the Site.

3.4 DUST, VAPOR, AND ODOR CONTROL

A. The Contractor shall take measures to control dust, vapor, and odor within the Contractor’s active work zone, in accordance dust monitoring requirements in the Dust Monitoring Amendment to the Field Sampling Plan (FSP) and Table 3.4-1 below. The Contractor shall discuss the dust, vapor, and odor conditions with the Owner and Engineer to select the most appropriate dust, vapor, and odor control measures to be implemented. Upon selection of the appropriate dust, vapor, or odor control measures, the Contractor shall initiate the control measures immediately.

B. The Contractor will be notified as soon as possible if exceedances of air-born particulates (dust) occur. Upon notification, Contractor shall cease excavation activities and apply dust control in accordance with the Contractor’s approved Dust Monitoring Amendment to the Field Sampling Plan (FSP) and Table 3.4-1 Below. Contractor shall be ready to apply wet suppression or other approved dust control measures within a 5-minute period of notification from Owner.

Table 3.4-1
Perimeter Dust Thresholds by Work Area

Work Area	Dust*
Holding Basin Area (Earthwork and Containment Wall Construction)	130 µg/m^3
AOI-8 and 9, Courtyard, Landfill, Cooling Water Pond, and Sediment Building Slabs and Building Footprint (Building A-D) and Paved Areas and Islands Identified During Penetrator Hunt Survey and Sampling Building E and All other Areas	150 µg/m^3**
* Dust levels at the downwind location are "corrected" by subtracting the upwind dust levels, which represents background ambient air quality, with comparison to the noted criteria. The Contractor shall implement active dust control measures before the dust action level in this table is exceeded. The value in this table represents a stop work threshold that, once exceeded, dust generating activities must stop pending the Contractor's resolution of work practices and dust control measures. Work may continue when the work practices and dust control is corrected to the satisfaction of the Owner and Engineer. ** This value represents USEPA's National Ambient Air Quality Standard (NAAQS) for particulates (PM_{10}) and, consequently, dust levels cannot exceed this value during the remedial activities (i.e., the 150 µg/m^3 value is a ceiling dust concentration).	

C. The Contractor shall conduct operations and maintain controls to minimize the creation and dispersion of dust. If water suppression is insufficient to control dust to acceptable levels, Contractor shall employ additional measures to control dust, including but not limited to the following: calcium chloride, tackifier, mulch, tarps/covers, temporary seeding, and mulching.

D. Contractor shall pave, apply water as needed, or apply nontoxic soil stabilizers on all unpaved access roads, parking areas, and staging areas shown on the Drawings to suppress dust.

E. The Contractor shall be responsible for any damages caused by fugitive dust emissions. If the Work is stopped because of dust or odor emissions, the Contractor shall be responsible to implement additional mitigative measures at their own cost. Failure to meet these restrictions may result in cessation of construction activities.

F. Contractor shall immediately inform the Owner and Engineer of any dust, vapor, or odor conditions exceeding regulatory criteria within the work and breathing zones based on

Contractor's monitoring in accordance with the Contractor's CHASP, specified in Section 01 35 29 – Health and Safety Requirements.

G. Water for dust control shall be provided by the Contractor.

H. Contractor shall manage waste generated as a result of dust control measures in accordance with Section 02 61 00 – Waste Management. When the waste removal and handling activities on-Site are complete, the sweepings shall be properly disposed off-Site at an approved disposal facility.

I. General Requirements:

1. Contractor shall apply dust suppression at all active construction areas as needed to minimize and control dust. Dust control for stockpiles and the access roads shall be achieved through the application of water as necessary to prevent wind-blown dust. Water shall also be used to control dust associated with loading and hauling operations.

    a. Contractor shall utilize spraying equipment to provide complete coverage of surfaces with water prior to, during, and subsequent to soil moving activities. Apply water in a manner to prevent movement of spray beyond application area and Work Limits to minimize excess water use.
    b. Contractor shall apply water without interfering with earthmoving equipment or on-Site operations.
    c. Contractor shall keep surfaces damp without creating nuisance conditions such as ponding, runoff, erosion, or excessively wet and muddy conditions.
    d. Contractor shall provide periodic water misting/sprinkling on active stockpiles during active period when covering is not practicable. During inactive periods, cover stockpiles with weighted and anchored tarps/covers or with a soil stabilizer/tackifier approved by the Owner.
    e. Contractor shall cover or stabilize areas and stockpiles that are inactive (no disturbance for more than 10 days) with application of a soil stabilizing product.

2. Contractor shall cover all trucks hauling soil, sand, aggregates, and other loose material with the potential to create dust during transport, and require all trucks to maintain at least 2 feet of freeboard (the space between the top of the load and the top of the truck bed).
3. Track-out Controls: Contractor shall remove all visible mud or dirt track-out onto adjacent public roads using wet power vacuum street sweepers at least once per day, and as dictated by the Owner. Clean all paved access roads, parking areas, staging areas, and adjacent public streets if soil material is visible. The use of dry power sweeping is prohibited.

    a. Contractor shall maintain clean pavement surfaces within the designated work areas (within Work Limits) and Site egress routes.

b. Contractor shall clean pavement at the construction entrances to the Work Limits and along facility travelled ways, daily. Deposits of dirt/mud/stones on paved surfaces that may cause safety issues or damage to vehicles, property, or pedestrians shall be wet swept clean immediately.
c. Contractor shall wash the tires or treads of a vehicle at the decontamination/wash pad if the tires become soiled with soil or sediment.

4. Contractor shall provide dust controls for sediment/stockpile management areas, including providing enclosed structures and active collection systems as necessary.
5. During excavation or soil movement activities, drop heights shall be kept to a minimum.
6. Any pavement demolition debris (and concrete demolition debris) shall be directly loaded into trucks or roll-off bins or stockpiled to be sorted for recycling or disposal. If asphalt residue remains after saw cutting, the cuttings/grindings shall be swept or vacuumed up to prevent wind-blown dust generation.
7. Contractor shall evaluate sources of odors if excessive odors are noticed during construction and work may be stopped by the SDs Representative or Engineer. Contractor shall employ additional efforts to reduce odors to acceptable levels during construction. No additional compensation will be allowed for odor control measures outside of what was agreed to in the Contract Documents.

3.5 AIR POLUTION CONTROL

A. Products, equipment, and work practices shall conform to air pollution control requirements of applicable federal, state, and local laws and regulations, and with the requirements of this Sub-Part. The Contractor shall utilize such methods and devices as are reasonably available to prevent, control, and otherwise minimize atmospheric emissions and discharges of air contaminants in accordance with relevant permits and authorizations.

B. Contractor shall provide air quality and controls for enclosed spaces and for equipment or operations that generate emissions or dust in accordance with all local, state, and federal requirements as well as any additional permit requirements.

C. Contractor shall routinely maintain construction equipment and vehicles to ensure that engines remain tuned and emission control equipment is functioning properly as required by law. Equipment and vehicles that show excessive emissions of exhaust gases, as determined by the Owner, shall not be operated until corrective repairs or adjustments are made to reduce emissions to acceptable levels. The Contractor shall also limit excessive equipment idling time whenever possible.

3.6 NOISE CONTROL

A. Trucks and construction equipment shall be required to have adequate mufflers for noise suppression. Equipment without noise suppression or proper maintenance will not be allowed on-Site.

B. It is the responsibility of the Contractor to verify sound levels. Noise levels shall be evaluated by the Owner or Engineer to determine potential disruptions to neighboring properties. Controls to minimize or contain noise shall be installed as necessary.

END OF SECTION

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes product delivery, storage, and handling requirements. It also specifies the requirements for certain prefabricated products and product substitutions.

B. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

C. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

D. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

E. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

F. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

G. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 PRODUCTS

A. Contractor shall furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

C. Furnish interchangeable components from the same manufacturer for components being replaced.

1.3 PRODUCT DELIVERY REQUIREMENTS

A. Contractor shall transport and handle products in accordance with manufacturer's instructions.

B. Contractor shall promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Contractor shall provide equipment and personnel to receive and handle products by methods to prevent soiling, disfigurement, deterioration, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Contractor shall store and protect products in accordance with manufacturers' instructions.

B. Contractor shall store products with seals and labels intact and legible.

C. Contractor shall store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to the product.

D. Contractor shall place fabricated products or materials to be incorporated into the Work on sloped supports above ground for exterior storage. Location of storage shall be proposed by Contractor and approved by Owner.

E. Contractor shall provide off-Site storage and protection when Site does not permit on-Site storage or protection, with the approval of the Engineer.

F. Contractor shall cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

G. Contractor shall store loose granular materials on solid flat surfaces in well-drained areas. Prevent mixing with foreign matter or contaminated materials. Comply with stormwater pollution control requirements for stockpiled materials as specified in Section 03 00 00 – Earthwork.

H. Contractor shall furnish and utilize storage containers, equipment, and other means to separate hazardous materials used for construction (e.g., small volumes of fuel, cleaning supplies) specifically designed for storage of such materials. Contractor shall not store incompatible materials together that potentially create a health and safety hazard.

I. Contractor shall keep Safety Data Sheets (SDSs) on-Site for all construction materials brought on-Site. SDSs shall be stored in a readily accessible location and be available for inspection at any time.

J. Contractor shall provide equipment and personnel to store products by methods to prevent soiling, disfigurement, deterioration, or damage.

K. Contractor shall arrange storage of products to permit access for inspection. Contractor shall periodically inspect to verify products are undamaged and are maintained in acceptable condition.

L. Designated areas for storage of materials shall be approved by the Owner. The Contractor shall be responsible for any damage/loss/theft of materials stored on-Site.

1.5 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting Specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Contractor shall submit request for substitution for any manufacturer not named in accordance with the following Sub-Part.

D. Submittal Procedure for prefabricated products specified on the drawings (such as, but not limited to, the concrete V-ditch)

1. Contractor shall submit an electronic request for Substitution in Portable Document Format (.pdf) to Owner for consideration. Limit each request to one proposed Substitution.
2. Contractor shall submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
3. Owner will obtain Engineer review of proposed substitution and notify Contractor in writing of decision to accept or reject request.

1.6 PRODUCT SUBSTITUTION PROCEDURES

A. Owner will consider requests for substitutions only within 30 Calendar Days after date established in Notice to Proceed. Owner must get concurrence from the Engineer in writing before proceeding with substitutions for permanent elements of the work, however Owner may authorize substitutions for temporary components of the work.

B. Substitutions will be considered when a product becomes unavailable through no fault of Contractor.

C. Contractor shall document each substitution request with complete data substantiating compliance of proposed substitution with Contract Documents.

D. A request for substitution constitutes a representation that Contractor:

4. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
5. Will provide same warranty for Substitution as for the specified product.
6. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
7. Waives claims for additional costs or time extension which may subsequently become apparent.
8. Will reimburse Owner and Owner for review or redesign services associated with re-approval by authorities having jurisdiction.

E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:

1. Contractor shall submit an electronic request for Substitution in Portable Document Format (.pdf) to Owner for consideration. Limit each request to one proposed Substitution.
2. Contractor shall submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
3. Owner will obtain Engineer review of proposed substitution and notify Contractor in writing of decision to accept or reject request.

1.7 SUBMITTALS

A. Submit a Product Request in accordance with Sub-Part 1.5 as required.

B. Submit a Product Substitution Request in accordance with Sub-Part 1.6 as required.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF SECTION

SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section contains general information that applies to all Work performed under the Contract and is inherently made a part of each Specification Section.

B. Attention is directed to the GENERAL REQUIREMENTS and all other sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

C. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

D. Coordinate work with that of all other trades affecting or effected by the Work of this Section. Cooperate with such trades to assure the steady progress of work under the Contract.

E. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

F. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

G. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of the Record of Decision, the Consent Decree, federal, state, and local health and safety and occupational health and safety statutes and codes.

1.02 DESCRIPTION OF WORK

A. This section includes information on the following items:

1. Examination and Preparation Procedures

2. Survey layout, including but not limited to verification of existing benchmarks through a baseline field survey, establishing supplementary survey control benchmarks in the

vicinity of the Work, survey layout of proposed construction features, field verification while construction is in progress, setting grade stakes and other controls, and as-built construction documentation and final as-built drawings.

3. Closeout procedures.

4. Final cleaning.

5. Protecting installed construction.

6. Project record documents.

7. Manual for materials, equipment, and finishes.

8. Product warranties and product bonds.

1.03 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. SECTION 01 33 00 – Submittal Requirements

C. SECTION 01 60 00 – Product Requirements

D. SECTION 02 21 00 – Surveys

E. Drawings

F. Other Sections of the Specifications, not referenced above, shall also apply to the extent required for the proper performance of the Work.

1.04 DEFINITIONS AND REFERENCE STANDARDS

A. See Specification Section 01 11 00 Summary of Work for acronyms and definitions applicable to this Section.

1.05 EXISTING CONDITIONS

A. See Specification Section 02 22 00 – Existing Conditions for information regarding site conditions.

1.06 QUALITY ASSURANCE

A. See Quality Assurance Project Plan (QAPP) and Construction Quality Assurance Plan (CQAP) –for information regarding Quality Assurance.

1.07 EXAMINATION AND PREPARATION PROCEDURES

A. Review all relevant project documents, including reports containing subsurface information.

B. Review existing survey data and locate previously established benchmarks.

C. Prior to bid, walk site, review conditions, and note anything that may affect progress of required work.

1.08 SURVEY AND LAYOUT

A. Complete work in accordance with SECTION 02 21 00 – Surveys and content presented within this specification.

B. The Contractor shall be responsible for layout and survey control and establishing all locations and elevations required based on the benchmarks and survey control points indicated on the Drawings or other points acceptable to the Engineer. The Contractor shall be responsible for the maintenance and protection of survey control points and construction location stakes.

C. Submit the resume, including qualifications and experience information, of the Massachusetts Licensed Registered Land Surveyor and Registered Civil Engineer proposed by the Contractor to perform site survey, layout, as-built surveys, and drawings. The Registered Land Surveyor or Professional Engineer should be familiar with earthwork construction is subject to the Owner's and Engineer's approval prior to employment.

D. All survey work shall be referenced to the following datum (the "Project Coordinate System"):

1. Horizontal Datum (X, Y): Massachusetts State Plane, NAD27 in US Survey Feet

2. Vertical Datum (Elevation, Z): National Geodetic Vertical Datum of 1929 (NGVD1929) in US Survey Feet

E. The Surveyor shall perform baseline land survey prior to beginning work to document existing conditions, including but not limited to, topography, bathymetry, edge of water, above- and below-grade utilities (including ownership of utility), surface type change boundaries (e.g., rip rap - topsoil boundaries), access roads, fences, monitoring wells and piezometers, roadways, paths, drainways and culverts, rights-of-way, tree masses, structures, significant improvements on the land, and other site features located within the area of Work. Contractor shall submit survey drawing in hard copy and electronic form (AutoCAD meeting the requirements described herein and PDF) to the Engineer for review.

F. Capture topographic spot elevations and generate ground surface contours. Sufficient field verification and topographic spot elevation measurements shall be obtained to facilitate accurate topographic plans to support as-built documentation requirements. Note regarding contour generation requirements: 2-foot contours in upland areas; 1-foot contour detail in the proposed edge of water/underwater excavation areas.

G. Capture location of edge of water (noting elevation and date/time of measurement).

H. The Contractor's survey benchmarks shall be established in areas that will be unaffected by the placement of new fill or other work.

I. Conduct initial survey control base line layout, including verification of existing survey control benchmarks, establishing additional control benchmarks, and other survey layout to facilitate the Work. All layouts, offsets, checking of all grades and the plumbness of the Work shall be provided by the Contractor's qualified registered land surveyor.

J. Field-locate and mark existing property and easement corners.

K. Layout of Work: Establish and be responsible for all subsequent lines, elevations, and measurements of the work executed under the Contract including without limitation, grading, utilities, culverts, manholes, structures, and other work. Establish all subsequent lines needed to accurately lay out and construct the work.

L. Temporary Working Points: Provide and maintain stakes, lines, benchmarks, batter boards, and other temporary working points, lines, and levels. Construct temporary working points to be "permanent" during construction. Remove working points when they are no longer needed after obtaining Engineer's approval of removal prior to removal.

M. Deviations: Do not deviate from indicated lines and grades without the Engineer's written prior approval.

N. Engineer's Review of diversion structure and bypass system layout: After completion of subgrade preparation, and before continuing work, request Engineer's review and obtain Engineer's acceptance of layout.

O. Field Measurements and Discrepancies Between Field Conditions and Contract Documents: Before ordering materials and fabricated components, and before beginning work, verify actual field dimensions and locations. Take field measurements and ensure the complete and proper interface of all work.

1. Notification Required: If there are any discrepancies between the Contract Documents and the actual field conditions, notify the Engineer immediately in writing describing the discrepancy. Do not proceed until the discrepancy is resolved to the satisfaction of the Engineer.

2. Adjustment: If approved by Engineer, adjust work to actual field dimensions and conditions, and adjust work to ensure the complete and proper interface of all work at no change in Contract Amount.

3. Cost of Adjustment: The Contractor shall adjust and correct ill-fitting work.

P. Adjustments: Make minor adjustments in layout as requested by the Engineer at no change in Contract Amount.

Q. Change of Scope: If, in the Contractor's opinion, the Engineer's field instructions measurably and significantly increases or decreases the scope of work, the Contractor shall notify the Owner and Engineer in writing by a formal "Change Order Request" and obtain the Owner and Engineer's written authorization prior to implementing the field instructions.

R. The Contractor shall determine the Limits of Work shown on the Drawings by accurate field survey and shall clearly mark the limits using plastic barrier fence per Section 015000 – Temporary Facilities and Controls, or other methods that are acceptable to the Engineer. Notify the Engineer a minimum of one (1) week prior to the start of work to review the marked Limits of Work. Adjust the limits as directed by the Engineer.

S. The Contractor shall be responsible for the correct location in plan and elevation of all excavation and filling, and all other construction indicated on the Drawings and as specified herein.

T. Finished grades, contours, and elevations indicated on the Drawings describe final surface elevations for completed construction unless indicated otherwise. Contractor shall be responsible for documentation of final as well as intermediate excavation grades. Survey after completion of the following construction activities or as otherwise described herein:

1. Final excavation limits in soil/sediment removal areas;

2. Excavation subgrade (i.e., the interface between the existing site soil remaining in place and placed fill) before placing imported fills;

3. Wetland restoration (subgrade elevation and final grading prior to planting);

4. Finish grades and final set elevation of the other structures/features shown on the Drawings.

U. On as-built plans, show all grade lines, constructed features, pre-existing and new utilities, property lines, and other relevant information. Certify that work is located as required by the Contract Documents. Deliver the survey to the Owner through the Engineer as a submittal pursuant to the closeout requirements described herein.

V. Electronic Files for Survey Mapping - Survey data will be processed and documented onto an existing condition and as-built site plans by the Contractor. Mapping requirements include:

1. Prepare base map on Project Coordinate System and to scale using CAD software (AutoCAD 2008, or newer) illustrating the features surveyed. Submit the AutoCAD version to verify compatibility.

2. Basic CAD standards and layer naming convention:

    a. Nothing shall be placed on layer "0"

    b. All entities in the drawing shall be "Color by Layer".

    c. All entities in the drawing shall be "Linetype by Layer".

    d. All drawings shall include a North Arrow.

    e. All drawings shall include a bar scale so the scale of the drawing is "graphically represented" when it is printed

    f. Any Hatch patterns used in the drawing file shall not be exploded.

    g. All drawings shall be to scale on the "Project Coordinate System" and shall include a note referencing the horizontal and vertical datum.

    h. Any references files/base maps sent to or from the Engineer will use 0,0 as the insertion point

    i. Layers names shall be easily identifiable as to what is on that layer (for example "BLDG" for layers with buildings is easily identifiable but something like "10" would not be). A list of layer names and a description of what is on that layer shall be provided by the Contractor.

    j. Create PDFs "To Scale" and include a North arrow and a scale bar on the PDF.

3. Provide x, y, z coordinate file (comma-delimited) for benchmarks and other points.

1.09 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for final review by Owner.

B. Provide submittals to Owner.

C. Contractor shall survey in process and completed work as described in these specifications and provide submittal with all As-Built Drawings and documentation.

D. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

1.10 FINAL CLEANING

A. The Contractor will provide final cleaning after final acceptance.

1. Contractor shall clean site; sweep paved areas, rake clean landscaped surfaces.

2. Contractor shall remove waste and surplus materials, rubbish, and construction facilities from site.

1.11 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual specification sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

C. Prohibit traffic on landscaped areas.

1.12 PROJECT RECORD DOCUMENTS

A. Maintain on site one hard copy set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, Product Data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjustment.

B. Ensure entries are complete and accurate, enabling future reference by Owner and Engineer.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, on a daily basis.

E. Specifications: Legibly mark and record a description of actual products installed, including the following:

1. Manufacturer's name and product model and number.

2. Product substitutions or alternates utilized.
3. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:

1. Measured depths of foundations in relation to ground surface datum and condition of subgrade.
2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
3. Field changes of dimension and detail.
4. Details not on original Contract drawings.

G. Contractor shall submit documents to Owner and Engineer with claim for final Application for Payment**.**

1.13 MANUAL FOR MATERIALS, EQUIPMENT, AND FINISHES

A. Submit two copies of preliminary draft or proposed formats and outlines of contents. Owner will review draft and return one copy with comments.

B. Submit one copy of completed volumes. Draft copy be reviewed and returned after final inspection, with Owner comments. Revise content of document sets as required prior to final submission.

C. Submit two sets of revised final volumes in final form.

D. Building Products, Equipment, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for re-ordering custom manufactured products.

E. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

F. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.

G. Additional Requirements: As specified in individual product specification sections.

H. Include listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

1.14 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.

B. Unless indicated otherwise herein, warranty period shall begin at the date of substantial completion of construction. Where warrantee items are subcomponents integrated into the overall construction shown on the Drawings, the date of substantial completion is the date of substantial completion of the comprehensive remedial excavations and associated components.

C. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.

D. Verify documents are in proper form, contain full information, and are notarized.

E. Co-execute submittals when required.

F. Include Table of Contents and assemble in three D side ring binder with durable plastic cover.

G. Submit prior to final Application for Payment.

H. Time Of Submittals:

1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

PART 2 - EXECUTION

2.01 GENERAL

A. All work shall be surveyed by Massachusetts Licensed Registered Land Surveyor or Registered Civil Engineer, to ensure compliance with the specifications and Drawings. As-built drawings prepared by the Contractor shall be signed and stamped by the Contractor’s Massachusetts Licensed Registered Civil Engineer.

END OF SECTION

SECTION 02 21 00

SURVEYS

PART 1 - GENERAL

1.1 SUMMARY

A. Attention is directed to the GENERAL CONDITIONS OF THE CONTRACT and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

E. The Work described in the Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 REFERENCES

A. Feldman Land Surveyors, “Existing Conditions Plan,” dated 15 May 2020.

B. Benchmark Information:

1. TGS-1: Magnetic nail set up 1' on the southerly side of utility pole at the intersection of Main Street and the driveway to #2228 Main Street. Elevation=151.79'
2. TGS-2: Magnetic Nail Set Up 1’ in utility pole - Elevation=167.98’
3. TBM PS-1: Chisel Square set in northwest corner of light pole base - Elevation=172.60'
4. TBM PS-2: Chisel square set in northwest corner of light base - Elevation=193.53'

1.3 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. SECTION 01 33 00 – Submittal Procedures

C. SECTION 01 35 28 – Health and Safety Requirements

D. SECTION 02 22 00 – Existing Conditions

E. SECTION 01 70 00 – Preparation and Closeout Requirements

1.4 SUBMITTALS

A. Submit the resume, including qualifications and experience information, of the Massachusetts Licensed Registered Land Surveyor and Registered Civil Engineer proposed by the Contractor to perform site survey, layout, as-built surveys, and drawings. The Registered Land Surveyor or Professional Engineer should be familiar with earthwork construction is subject to the Owner's and Engineer's approval prior to employment.

1.5 DESCRIPTION OF WORK

A. Periodic surveys shall occur as excavations are in progress to confirm if depths of excavation shown in engineering drawings are achieved. Surveys shall also occur in the event where an excavation is left open over the winter before backfilling. Surveys will be completed after restoration of the excavations is complete to document the new ground surface.

B. Horizontal survey datum shall be Massachusetts State Plane Coordinate System North American Datum of 1927 (NAD27).

C. Vertical survey datum shall be National Geodetic Vertical Datum of 1929 (NGVD29).

D. The Contractor shall be responsible for layout and survey control and establishing all locations and elevations required based on the benchmarks and survey control points indicated on the Drawings, reference section, or other points acceptable to the Engineer. The Contractor shall be responsible for the maintenance and protection of survey control points and construction location stakes.

E. Capture topographic spot elevations and generate ground surface contours. Sufficient field verification and topographic spot elevation measurements shall be obtained to facilitate accurate topographic plans to support as-built documentation requirements.

F. Generate 1-ft contours.

G. Capture location of edge of water (noting elevation and date/time of measurement).

H. Conduct survey line layout, including verification of existing survey control benchmarks, establishing additional control benchmarks, and other survey layout to facilitate the Work. All layouts, offsets, checking of all grades and the plumbness of the Work shall be provided by the Contractor's qualified registered land surveyor.

I. Layout of Work: Establish and be responsible for all subsequent lines, elevations, and measurements of the work executed under the Contract including without limitation, grading, utilities, culverts, manholes, structures, and other work. Establish all subsequent lines needed to accurately lay out and construct the work.

J. Temporary Working Points: Provide and maintain stakes, lines, bench marks, batter boards, and other temporary working points, lines, and levels. Construct temporary working points to be "permanent" during construction. Remove working points when they are no longer needed after obtaining Engineer's approval of removal prior to removal.

K. Deviations: Do not deviate from indicated lines and grades without the Engineer's written prior approval.

L. Electronic Files for Survey Mapping - Survey data will be processed and documented onto an existing condition and as-built site plans by the Contractor. Mapping requirements include:

1. Prepare map on Project Coordinate System and to scale using CAD software (AutoCAD 2008, or newer) illustrating the features surveyed. Submit the AutoCAD version to verify compatibility.

1.6 QUALIFICATIONS

A. A Massachusetts Licensed Registered Land Surveyor and Registered Civil Engineer shall be selected by de maximis to perform the survey.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

A. All work shall be surveyed by Massachusetts Licensed Registered Land Surveyor or Registered Civil Engineer, to ensure compliance with the specifications and Drawings. As-built drawings prepared by the Contractor shall be signed and stamped by the Contractor's Massachusetts Licensed Registered Civil Engineer.

END OF SECTION

SECTION 02 22 00

EXISTING CONDITIONS ASSESSMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Attention is directed to the GENERAL CONDITIONS OF THE CONTRACT and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

E. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 REFERENCES

A. Prior to submitting a bid, the contractor shall review and understand the information contained in the following documents:

1. 100% Remedial Design Submission for Nuclear Metals, Inc. Site Wide Sediment and Soil Remedial Activities, dated XX MONTH YEAR.
2. Report on Site-Wide Sediments and Soils Pre-Design Investigations, Nuclear Metals, Inc. Superfund Site, Concord, Massachusetts, Haley & Aldrich, Inc., Boston, Massachusetts, dated 31 March 2022.
3. Remedial Design Work Plan, prepared by Haley & Aldrich, Inc., prepared for de maximis, inc., dated 10 September 2020.

B. Prior to submitting a bid, the Contractor shall also review and understand the information contained in the following regulatory documents. These documents are made available to the Contractor by the Engineer:

1. EPA, 2015. “Record of Decision: Nuclear Metals, Inc. Superfund Site, Concord, Massachusetts,” dated September 2015.

1.3 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. SECTION 01 35 29 – Health and Safety Requirements

1.4 SUBMITTALS

Not Used.

1.5 DESCRIPTION OF WORK

A. Prior to submitting a bid, the Contractor shall review and understand the information contained in the documents prepared by the engineer and regulatory documents that are listed in the References Section.

B. The subsurface and environmental conditions information presented in these documents, as applicable, are for information only and shall not be interpreted as a warranty of subsurface or environmental conditions whether interpreted from written text, test boring logs, test pits logs, chemical test results, or other data.

C. The Contractor shall expect to encounter existing and remnant utilities, foundations, granite blocks, brick and granite walls, boulders and other oversized materials, wood piles, and other buried structures during excavation. Historic utility maps have been digitized to show estimated locations and depths of various utilities and shall be provided to the Contractor by the Engineer.

1.6 QUALIFICATIONS

A. The subsurface data are provided to the Contractor for information. The Contractor shall interpret said data according to the Contractor’s own judgment and shall understand that subsurface conditions may differ from those recorded in the reports or as shown on the test boring logs, test pit logs, or other subsurface explorations. The subsurface data represents the conditions at the sampling location at the time of exploration only. The Engineer and Owner shall not be liable for any error or discrepancy in the information provided on existing conditions.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 02 41 00

DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. 'Structural Demolition' refers to the demolition of structures, slabs and foundations, and all related debris.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

E. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Owner and Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 REFERENCES

A. Feldman Land Surveyors, "Existing Conditions Plan," dated 15 May 2020.

1.3 RELATED SECTIONS

A. SECTION 011100 – Summary of Work

B. SECTION 026100 – Waste Management

C. SECTION 022200 – Existing Conditions Assessment

D. SECTION 310000 – General Earthwork Specification

PART 2 – PRODUCTS
Not used.

PART 3 - EXECUTION

3.1 DEMOLITON

A. Work described in this section may be completed in phases and described in multiple drawing packages.

B. The Contractor shall demolish the designated structures including concrete slabs from Buildings B through D, former utility pads, and other small Butler building slabs. Site debris, fencing, including fence posts, and refuse may also require demolition. Contractor shall conduct building slab demolition so as not to disturb soils contaminated soils beneath the building.

C. The septic utility lines and tanks in the northern parking lot shall also be demolished and removed during remedial excavations in that area. Utility maps for the septic lines will be provided by the Engineer or Construction Manager and shall be reviewed by the Contractor prior to demolition work.

D. All asphalt paved area shall be removed and replaced as directed indicated on drawings.

E. The Pump House in the front of the property at main entrance shall be demolished in accordance with drawings and directions from Engineer and Owner.

F. Wooded areas near in the vicinity of the Landfill and Cooling Pond shall be cleared in accordance with maps provided by the Engineer or Construction Manager. Grubbing and stump removal shall be included in the clearing of wooded areas.

G. The Contractor shall provide, erect, and maintain suitable barriers or other controls to ensure that unauthorized personnel do not enter areas in which demolition is taking place.

H. Blasting or burning of buildings, materials or debris will not be permitted.

I. As designated in the drawings, site monitoring wells shall be protected in place during demolition as described in Section 33 29 00 - Well Abandonment and Protection.

3.2 DEBRIS CLEAN-UP AND DISPOSAL

A. Should select debris or refuse require recycling or disposal at an off-site facility, Contractor shall submit the name, address, and phone number of the disposal facility and a listing of Site materials to be sent.

B. Areas of demolition work shall be left in clean condition.

3.3 RESTORATION

A. Contractor shall backfill any depressions or voids created by the demolition work in accordance with Section 32 30 00 – Site Restoration.

B. No debris, including loose concrete or other structural materials, shall remain exposed unless specifically excluded from removal as part of the Contract.

END OF SECTION

SECTION 02 61 00

WASTE MANAGEMENT

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes provisions for processing, staging and load-out of excavated material (e.g., soil, sediment, crushed and sized concrete, pavement, and debris), which can be generally classified as non-hazardous waste. All waste characterization, profiling, and waste classification will be performed by the Owner with assistance from the contractor as requested. This includes existing wastes, as well as the waste generated by the Contractor during construction activities.

B. Contractor shall process excavated materials brought to the Material Processing Area according to the specifications described herein using the means and methods selected by the Contractor and reviewed by the Engineer.

C. Contractor is responsible for coordinating excavation production (see Transportation and Off-Site Disposal Plan updated May 2023) with excavated material management and processing capacity.,

D. Contractor shall apply dust, vapor, and odor control agents in accordance with Section 01 57 19 – Environmental Controls.

E. Contractor shall perform all waste management, including processing, staging, and load-out in compliance with these specifications, the references, and related documents.

F. All waste leaving the Site shall have a waste profile and corresponding manifest, as necessary, for each waste stream to each facility. The material leaving the site shall be in accordance with the Transportation and Off-Site Disposal Plan.

1. An exception to the waste profile and manifest requirement is typical rubbish or garbage (solid waste) created by on-Site personnel. Subcontractor is responsible for removal and disposal of such solid waste, but it does not require a waste profile, manifest, or disposal at an Owner-approved disposal facility.

G. Contractor shall be solely responsible for exercising reasonable precaution to protect public health, safety, and welfare; all on-Site personnel; and the environment during performance of the Work described in this Section. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes, as well as the requirements specified in Section 01 35 29 – Health and Safety Requirements.

H. All Site facilities and equipment will be inspected by the Owner to evaluate compliance with Project Health and Safety Requirements (see Section 01 35 29 – Health and Safety

Requirements). Site facilities and equipment will only be permitted to be used after they pass the RSO and Owner's inspection.

1.2 REFERENCES

A. 40 CFR 260 to 273: Hazardous Waste Management.

B. 49 CFR 172: Tables, Hazardous Materials Communication Requirements, and Emergency Response Information Requirements.

C. 42 USC Chapter 82: Resource and Recovery Act

D. 310 CMR 40.0018: Health and Safety Procedures.

E. OSHA Regulation 29 CFR 1910.120. HAZWOPER: Hazardous Waste Operations and Emergency Response.

1.3 RELATED SECTIONS

A. Section 01 11 00 – Summary of Work

B. Section 01 57 19 –Environmental Controls

C. Section 31 00 00 –Earthwork

D. Section 02 70 00 – Construction Dewatering and Water Management

E. Transportation and Off-Site Disposal Plan, dated December 2022

F. Drawings

1.4 DEFINITIONS

A. Construction and Demolition Debris: Materials including boulders; cobbles; riprap; logs/trees/stumps/branches; lumber; metal or concrete piles; chains; ropes; cinderblocks; scrap and other metal; utility structures; and other man-made or naturally deposited material located within the limits of excavation that is larger than 3 inches in the largest dimension. Does not include cohesive soils that can be broken down to be smaller than 3 inches in diameter.

B. Contaminated Material: Any waste material located on-Site or generated as a result of the Work that has come into contact with impacted soil, impacted sediment, or solids generated or accumulated during water treatment (including but not limited to spent carbon, used bag filters, etc).

C. General Construction Waste: Miscellaneous packaging, personal protective equipment (PPE) not visibly soiled/stained with Site-related impacts, and office trailer solid waste generated during construction activities. Such material shall be disposed of at a proper facility without the need for waste classification.

D. Impacted Debris: Debris that is impacted, based on debris testing or observed indications, and includes materials that are found to be in direct contact with impacted material.

E. Liquid Waste: Construction Water that is not acceptable for discharge to the sewer based on applicable permits and requires off-Site disposal.

F. Stockpile Management Area: The location shown on the Drawings that are to be used for processing of excavated material, sediment and debris, and clean material storage, as described in Section 01 57 00 Temporary Erosion and Sediment Controls and 31 00 00 Earthwork.

G. Potentially Hazardous Material: Any waste identified that may be potentially harmful to health or the environment that would not be accurately represented by the profile for Impacted Sediment or Impacted Debris.

H. Recyclable Metal: Bulk metal sized as needed based on transporter and recycling facility requirements from debris removal without contamination due to contact with Site sediment, or decontaminated bulk metal.

I. Processed Concrete and Asphalt Pavement: Building slabs or pavement that is crushed and processed. The material shall be sized to less than 3 ft.

1.5 SUBMITTALS

A. All submittals and plans noted in this Section shall be submitted to the Owner and the Engineer for review and approval in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 – PRODUCTS

2.1 DEWATERING EQUIPMENT AND PRODUCTS

A. Subcontractor's dewatering equipment and products are detailed in Section 02 70 0 - Construction Dewatering and Water Management.

2.2 OTHER ANCILLARY PRODUCTS

A. Other ancillary products shown on the Drawings or otherwise needed to perform the Work may be governed by other specifications included in the Contract Documents. Contractor shall refer to applicable specification Sections for those product requirements.

PART 3 – EXECUTION

3.1 WASTE AND RECYCLABLE TYPES

A. Waste and recyclable materials, classified by type, shall be disposed of, or recycled at, the Owner-approved facilities. It is anticipated that the following wastes and recyclable material will be generated during the Work:

1. Soil;
1. Processed Sediment;
2. Impacted debris including concrete and pavement Sized below 3 ft.;
3. Construction and Demolition Debris for disposal (e.g., Material from Landfill, including metal debris);
4. General Construction Waste; and
5. Construction Water.

B. All materials (waste and recyclable material) subject to off-Site disposal will likely fall into one of the following categories:

1. Non-Hazardous Waste;
2. RCRA and/or Non-RCRA Hazardous Waste;
3. Construction and Demolition Debris waste that is non-recyclable requiring disposal in accordance with its waste classification category;
4. Liquid Waste that is not treated on-Site requiring disposal in accordance with its waste classification category; or
5. Recyclable Construction and Demolition Debris (e.g., Recyclable Metal).

3.2 MATERIAL HANDLING

A. General:

1. Contractor shall amend waste material at the Sediment Management Area if it is wet sediment or at designated Material Processing Area. The materials will be managed such that it meets the landfill/disposal facility requirements, compliance requirements specified in Section 01 57 19 – Environmental Controls, the requirements specified in this Section, and the guidance provided by the Owner in the Transportation and Off-Site Disposal Plan, dated 24 May 2023.
2. If the Owner or Engineer believes that waste is being mishandled or there is insufficient management of the waste, the Owner or Engineer may stop work until the Subcontractor corrects the problem.
3. Watertight containers and trucks shall be used to transport sediment on-Site.
4. Maximum particle size of demolished concrete and all other debris shall be a maximum of 1 ft. Contractor is solely responsible for attaining and complying with maximum particle size requirements imposed by waste haulers and disposal or recycling facilities.
5. The use of explosives will not be permitted.

B. Handling:

1. Contractor shall stockpile waste in separate and segregated piles in accordance with waste disposal requirements described herein. All stockpiled materials shall be stored in a manner to minimize the potential for impacts to storm water runoff.

   a. In the event that visually impacted (e.g., observation of visible staining, or identification of any other potentially hazardous material) debris, including General Construction Waste or PPE that has come in contact with Site-related waste and is visibly stained, is encountered, it shall be considered Impacted Debris and staged in a separate stockpile or roll-off containment area from other debris.
   b. In the event TSCA material is encountered, TSCA material shall be live loaded directly onto disposal trucks. In the event soils with PCBs ≥ 50 ppm cannot be loaded directly into trucks, those soils will be separately stockpiled in accordance with 40 CFR §761.65 – Storage for Disposal.
   c. Impacted Debris shall be stockpiled on-Site prior to removal and disposal in accordance with all federal, state, and local requirements.
   d. Recyclable Metal, which is metal segregated from clean construction and demolition debris that has not come into contact with Site sediment or soil, is without contamination due to contact with Site sediment or soil confirmed based on laboratory analytical results or has been decontaminated shall be stockpiled on-Site prior to removal and recycling at a permitted recycling facility.

2. When Construction Water cannot be disposed of on-Site and is classified as Liquid Waste, Contractor shall containerize the Liquid Waste in Department of Transportation (DOT)-approved 55-gallon drums for transport and disposal, unless volume of Liquid Waste warrants a larger container (e.g., tanker truck). Contractor shall obtain approval from Owner prior to containerizing Liquid Waste in any container other than DOT-approved 55-gallon drum. Liquid waste shall be containerized onsite and will be treated once a site water treatment system is constructed.

C. Pollution Controls:

1. Contractor shall use water sprinkling, temporary enclosures, and other suitable methods to limit dust, vapor, and odor emissions into air to lowest practical level.

2. Contractor shall comply with the Subcontractor's Dust, Vapor, and Odor Control Plan, as described in Section 01 57 19 – Environmental Controls.

3. Contractor shall not use water when it may create hazardous or objectionable conditions such as runoff beyond Site erosion controls, ice, flooding, or pollution.

4. Contractor shall containerize Liquid Waste within secondary containment of appropriate volume for the volume of Liquid Waste being handled at the time.

3.3 WASTE SEGREGATION

A. Contractor shall segregate waste streams during performance of the Work such that material is not cross-contaminated and is placed in designated waste storage locations as shown on the Drawings. Differing stockpiled materials shall be separated with dividers or stockpiled apart to prevent mixing of soil types or contamination.

B. Contractor shall segregate Liquid Waste from other Construction Water that is suitable for treatment and discharge.

3.4 WASTE CHARACTERIZATION

A. The Engineer will provide existing chemical analytical data and supporting documentation to Contractor. The Owner and Engineer will be responsible for pre-characterization field efforts (i.e., conducting supplemental soil and sediment sampling and analysis for waste characterization purposes) and other administrative tasks to facilitate waste classification, profiling, and manifesting. Any additional characterization/classification of waste shall be performed as specified herein, in conformance with disposal facility testing requirements.

B. Contractor shall collect samples from waste stockpiles, frac tanks, and other approved containers to verify characterization of the waste as requested by Owner as necessary.

3.5 PROFILING

A. Owner or Engineer will provide analytical data and supporting documentation including approved waste classification based on pre-characterization efforts.

3.6 WASTE LOADING

A. Contractor shall not load material containing any liquid prior to loading for transportation and disposal.

B. Contractor shall load-out waste at the Waste Processing Area designated on the Drawings.

C. All trucks transporting materials off-Site shall be covered with tarps or sealed to minimize the release of dust and material during movement.

3.7 DECONTAMINATION

A. Trucks and roll-offs not acceptably lined as determined by the Owner or Engineer shall be decontaminated in accordance with Section 01 57 19 – Environmental Controls prior to putting the equipment into service for hauling other on-Site materials of lesser contamination.

3.8 WASTE TRANSPORT AND DISPOSAL

A. General:

1. Contractor shall handle, store, transport, and dispose all materials, both contaminated and non-contaminated, in accordance with all applicable local, state, and federal regulations, as well as those outlined in the Transportation and Off-Site Disposal Plan. No materials, contaminated materials, or potentially contaminated materials shall be removed from the Site without prior notification and approval of the Owner.

END OF SECTION

SECTION 02 70 00

CONSTRUCTION DEWATERING AND WATER MANAGEMENT

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the Work of this Section.

C. Coordinate work with that of all other trades affecting or affected by Work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Provide all facilities, labor, material, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the work specified in this Section, and as shown on the Drawings.

E. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Owner and Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.02 DESCRIPTION OF WORK

A. Design, furnish, operate, and maintain dewatering measures and/or equipment for the control, collection, treatment, and disposal of Construction Water (as defined in this Section) as required to complete the Work.

B. Establish and maintain temporary power to Construction Water management system components, at the location shown on the Drawings. This is an existing Power connection that needs to be maintained and protected by the Contractor.

C. Collect, store, and dispose of Construction Water in accordance with federal, state, and local codes, ordinances, regulations, and these Contract Documents, governing this Work.

Construction Water will be conveyed and discharged following treatment into the existing leach field system at the location shown on the Drawings and as specified in this Section.

D. Conduct system startup and prove-out of Construction Water treatment efficacy through collection, conveyance, treatment, storage, and testing in batch mode (no discharge of effluent) for each work area or water quality type as further described herein.

E. Prior to system startup the existing leaching field will be load tested to verify that the system can handle the proposed 100 to 500 gallons per minute discharge from the Dewatering Effluent Treatment System (DETS). Water will be discharged from the on-site fire hydrant at a flow rate equivalent to the DETS system for a period of 8 hours. The mounding of water within the leaching system manholes will be monitored to evaluate system performance.

F. Dewater as required to conduct Work in-the-dry as defined herein, unless indicated otherwise.

G. Construct temporary cofferdams at the locations and configuration indicated on the Drawings and Specifications.

H. Minimize storm water or precipitation flow into open excavations, stockpile areas, and other areas of Work to reduce unnecessary Construction Water management.

I. Control groundwater and surface water seepage into excavations using cofferdams or other means in accordance with Contract Drawings, applicable Specifications, and the Construction Water Management submittal reviewed and accepted by the Engineer.

J. Repair damage, disruption, or interference to any facility resulting directly or indirectly from dewatering/groundwater recharging activities (e.g., leach field discharge), including inadequate performance of such systems.

K. Remove dewatering sump materials and other equipment upon completion of Construction Water management to facilitate site restoration unless otherwise indicated.

L. Mobilize, set up, prove out, operate, and maintain a DETS for Construction Water capable of extracting, conveying, and treating water at whatever flow rates enter the excavation area(s) to maintain excavation in-the-dry, as well as accommodate other sources of Construction Water collected incidental to the Work.

M. Monitor water quality to ensure compliance with the criteria presented in Table 02 70 00 – 1 (DETS Performance Criteria), at the frequency outlined in this Section. Contractor will provide access to sampling port(s) in the DETS to allow the Engineer to sample if needed. The Contractor may conduct water quality sampling and analysis more frequently to assess the efficiency of their treatment system at their own discretion, and at no additional cost to the Owner.

N. Work stoppages are the responsibility of the Contractor and will not be a basis for an extension of time or additional funds for down time.

O. While not anticipated to be encountered, notify Owner immediately, segregate, containerize, and secure on Site at a location approved by the Owner any oil, non-aqueous phase liquid (NAPL), or other liquids inconsistent with known Site contamination encountered during the Work.

1.03 RELATED SECTIONS

A. SECTION 01 57 00 – Temporary Erosion and Sedimentation Controls

B. SECTION 02 22 00 – Existing Conditions

C. SECTION 02 41 00 – Demolition

D. SECTION 02 61 00 – Waste Management

E. SECTION 31 00 00 – Earthwork

F. SECTION 31 36 00 – Gabions

G. SECTION 35 24 00 – Dredging

H. SECTION 35 24 00 – Capping

I. SECTION 35 60 00 – Wetland and Upland Restoration

J. Drawings

K. Other Sections of the Specifications, not referenced above, shall also apply to the extent required for the proper performance of the Work.

1.04 DEFINITIONS

A. Construction Water: Liquid waste produced from construction activities including but not limited to:

1. Precipitation, dust mitigation water, surface water, or stormwater runoff that comes in contact with soil or sediment disturbance areas;

2. Excavation dewatering;

3. Decant water collected in stockpile areas;

4. Rinse water from equipment decontamination; and

5. Dewatering necessary to enable backfill placement and site restoration.

B. DETS: Dewatering Effluent Treatment System.

C. DETS Performance Criteria: Construction Water Quality Criteria found in Table 02 70 00 – 1 of this Section.

D. DETS Compliance Point: DETS Effluent sample port before treated water is discharged into the existing leach field (as per the Contractor's Construction Water Management Submittal reviewed and accepted by the Engineer).

E. See Specification Section 01 11 00 – Summary of Work for acronyms and definitions applicable to this Section.

1.05 EXISTING CONDITIONS

A. Refer to Section 02 22 00 – Existing Conditions Assessment for information regarding Site conditions.

B. Available groundwater and surface water chemical test data proximate to the work areas are provided in the documents referenced in specification Section 02 22 00 – Existing Conditions.

1.06 QUALITY ASSURANCE

A. Design and Performance Criteria

1. Design, furnish, operate, and maintain all pumps and equipment required for Construction Water collection, conveyance, treatment, and leach field discharge such that the Work is conducted in-the-dry, unless otherwise indicated. The DETS shall be capable of treating 100 to 500 gallons per minute (gpm), and final sizing will be determined based on treatment throughput, space constraints, and weather conditions. A minimum design flow rate shall be 100 gpm, but for initial pond dewatering flows may need to be higher, provided the leaching field has the capacity to handle the higher flows as determined by the loading test.

2. Take measures to prevent damage to properties, buildings or structures, sewers and other utility installations, pavements, sidewalks, and other work.

3. Repair damage, disruption, or interference to any facility resulting directly or indirectly from Construction Water management activities, including inadequate performance of such equipment and systems, at no additional cost to the Owner.

4. As necessary, and in addition to providing the primary power source in accordance with Section 01 56 00 Temporary Barriers and Enclosures, Contractor shall provide backup power generation and Construction Water management system components and devise emergency procedures for maintaining continuous, uninterrupted operations.

5. Performance of DETS as measured at the DETS effluent sample location defined in this Section shall meet the numeric DETS Performance Criteria (Construction Water Quality Criteria) found in the following table:

Table 02 70 00 - 1
Construction Water Quality Criteria

Parameter	Construction-related Water Quality Criteria
TSS	30 mg/L
Tetrachloroethene	5 µg/L
Trichloroethene	5 µg/L
Vinyl chloride	2 µg/L
1,4-Dioxane	0.46 µg/L
bis(2-Ethylhexyl)phthalate	6 µg/L
Barium	NA µg/L
Chromium	100 µg/L
Cobalt	6 µg/L
Copper	1.8 µg/L
Iron	14000 µg/L
Lead	0.3 µg/L
Manganese	300 µg/L
Mercury (dissolved)	0.77 µg/L
Mercury (total)	0.91 µg/L
Molybdenum	100 µg/L
Depleted Uranium	30 µg/L
Natural Uranium	30 µg/L
Nitrate-N	10000 µg/L
Nitrite-N	1000 µg/L
Thorium	0.33 µg/L
pH	6 -8

If total metals values exceed, reanalyze for dissolved concentrations unless otherwise noted. All parameters shall be analyzed in accordance with laboratory methods listed in the project specific QAPP provided as part of the Remedial Design Work Plan, prepared by Haley & Aldrich, Inc., prepared for de maximis, inc., dated 10 September 2020.

B. Sampling and Analysis

1. Sampling performed by the Contractor.

2. Analysis at the designated Project Chemical Testing Laboratory. Except where noted otherwise in this and other specifications, the cost for analytical testing will not be borne by the Contractor.

3. Routine DETS Sample Locations: Routine water quality sampling to monitor the effectiveness of the DETS will occur from sample ports in the following DETS locations: 1) DETS Influent; 2) Between the particle filtration and granular activated carbon (GAC) vessels; 3.) After the Uranium ion exchange resin, and 4) the DETS Effluent before it is discharged into the existing leach field (i.e., the DETS Compliance Point). The Contractor may at their discretion collect additional samples at other locations and frequencies at the Contractor's own expense to assess treatment performance.

4. The DETS system prove out in batch treatment mode includes at a minimum one set of samples from the Routine DETS Sample Locations defined in this Section to demonstrate system efficacy.

5. Routine Sample Frequency: The sampling events at the Routine DETS Sample Locations defined in this Section shall occur on the first and third day of operation, followed by weekly testing through the end of the DETS operation and discharge. Adding or removing treatment equipment or making material changes to the treatment process (as determined by the Owner or Engineer) constitute a change that would re-set the above sampling frequency.

6. Performance/Breakthrough Monitoring: Collect additional samples to monitor the system performance and expected capacity of the active treatment media (e.g., GAC and Uranium ion exchange resin vessels) based on expected and actual flow rates, contaminant concentrations anticipated and measured in the field, and estimated time to breakthrough of the media.

7. Parameters and Laboratory Methods: As listed in Table 02 70 00-1.

   Additional confirmatory sampling may be performed by the Engineer to verify treatment system performance. The Owner retains the right to request compensation from the Contractor for the cost of retesting/re-characterizing material which is contaminated by the mismanagement of stormwater and/or groundwater. This includes the cost of resampling, analysis, and ultimately disposing of the impacted material.

1.07 SUBMITTALS

A. The Construction Water Management Submittal shall be prepared and stamped by an experienced, registered Professional Engineer licensed in the Commonwealth of Massachusetts. The Construction Water Management Submittal shall be submitted to sooner of 14 calendar days prior to mobilization or 1 month after contract award and include, at a minimum:

1. Specifications of all pumps used for transmitting water from the excavations and pumps required to meet the specifications of the DETS.

2. Shop drawings showing proposed types and details of dewatering and conveyance systems, including a complete description of equipment and materials to be used.

3. Specifications and shop drawings showing proposed types and details of treatment system components. At a minimum, the treatment systems must include particle filtration (fractionation tanks, multi-media granular filters, and bag filters), granular activated carbon, uranium treatment (ion exchange resin) and any other necessary treatment for specific treatment for all COCs listed in Table 02 70 00-1 (such as ion exchange or equivalent technology for treatment of other metals), pumps, conveyance piping, and equipment to measure flow rate and volume.

4. Calculations supporting the proposed system components, including flow rates, design concentrations to be treated, estimated breakthrough times and volumes for each media, and the proposed media vessel size and capacity.

5. The arrangements and locations of the proposed systems, including their location on Site, treatment components, secondary containment, emergency shut-off and related safety systems.

6. Procedure to be followed for installation, primary power source connection, system operation, maintenance, and system removal at the completion of the Work, including a discussion of the relationship to the Contractor's Construction Sequencing Plan prepared part of the Construction Work Plan submittal and described in Section 01 11 00 Summary of Work.

7. Standby treatment equipment and power supply.

8. A contingency plan in the event the DETS Performance Criteria are not achieved, including at a minimum a description of standby equipment, temporary storage equipment, turnaround time on mobilization of additional equipment, and related contingency measures to be undertaken by the Contractor to maintain site operations and avoid dewatering and Construction Water management stoppage.

9. Details regarding schedule, frequency, and procedure for: 1) cleaning fractionation tanks, backwashing multi-media granular filters, and replacing bag filters; 2) replacing active treatment media (e.g., GAC and ion exchange resins); and 3) maintaining other equipment.

10. Methods and information about the handling, storing, recycling, and disposal of sediment in the fractionation tanks, bag filters, and any other materials used in conjunction with the DETS.

11. Name and qualifications of Contractor's certified treatment system operator.

B. Submit samples collected from the DETS to the labs conducting analytical testing for the Owner, including ALPHA and GEL. Sample results shall be submitted to both the Owner and Engineer.

C. The Contractor is responsible for scheduling specified submittals and resubmittals so as to prevent delays in the Work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials and equipment shall be of suitable size, capacity, and type to dewater work areas; maintain dry and stable working surfaces; and to pump, store, manage, treat, and discharge Construction Water effluent in conformance with the requirements specified in this Section.

B. Provide secondary containment to capture spills and releases from the DETS. Dual wall piping shall be used to convey water from source areas to DETS.

C. Fractionation tanks, multi-media granular filter media, bag filters, and other treatment components shall be of sufficient size and capacity to handle the dewatering flows and reduce suspended materials and contaminants to achieve the DETS Performance Criteria at the DETS Compliance Point defined in this Section.

D. All materials and equipment shall be of appropriate type and maintained in proper operating condition at all times during the Work.

E. Fractionation tanks shall contain baffles to reduce velocities and allow sediment to settle inside the tank.

F. The Contractor shall maintain and employ adequate back-up equipment in the case of equipment break-down and power supply interruption. Contractor shall provide backup power generation and dewatering system components and devise emergency procedures for maintaining continuous, uninterrupted dewatering operations.

Provide sample ports before and after each major treatment component to enable performance evaluation.

PART 3 - EXECUTION

3.01 DEWATERING SYSTEM

A. Install the dewatering system(s) for excavations in accordance with accepted shop drawings.

B. Conduct system startup and prove-out of Construction Water treatment efficacy through collection, conveyance, treatment, storage, and testing in batch mode (no discharge of effluent) for each work area or water quality type (i.e., water quality influent exhibiting differing assemblage and/or concentration of constituents). Assume a minimum two (2) batch mode treatment efficacy verification events occur during the Work (an initial event and one other time during the Work). Pending test results that demonstrate efficacy of treatment to the DETS Performance Criteria defined herein and approval by the Owner, discharge successfully treated Construction Water to the effluent discharge point indicated on the Drawings.

C. The Contractor will obtain samples, submit for testing, and report results in conjunction with monitoring DETS attainment of the applicable DETS Performance Criteria defined herein. Contractor shall provide (and allow Engineer access to) sampling ports at the influent and effluent of each major treatment system component. The Contractor may at their discretion collect additional samples at the Contractor's own expense to assess treatment performance.

D. Operate and maintain equipment, immediately ceasing and repairing defective equipment and system components.

E. Contain and clean up releases.

F. Provide all collection, pumping, and sedimentation control to reduce suspended solids in effluent prior to discharge.

G. Control the inflow of water, including surface water and seepage, into the excavation at all times during construction and to permit all work to be performed in the dry.

H. Continuously operate the dewatering and DETS system to:

   1. Maintain dry undisturbed excavation subgrades for execution of subsequent construction operations in the dry.

   2. Maintain and control the water level within the excavation to a minimum of 2-ft below subgrade during all excavation, construction, and backfilling operations beneath proposed structures (including but not limited to areas where proposed Gabion Boxes are shown on the Drawings). In other areas without proposed structures, maintain, and control the water level within the excavation to a minimum of 1-ft below subgrade during all excavation, construction, and backfilling operations.

   3. Result in no damage to adjacent buildings, properties, structures, utilities, and completed work.

   4. Prevent fugitive release/runoff of Construction Water.

5. Remove any water accumulating in the excavation or backfill areas, soil stockpiles areas, and other areas collecting Construction Water; convey, treat, and discharge in conformance with this Section.

6. Treat Construction Water to the DETS Performance Criteria.

7. Discharge successfully treated Construction Water to the leach field located below the North Parking Lot.

8. Maintain the leach field components to ensure it can accept the flow volume/rate from the DETS.

I. Perform sampling to verify compliance with treatment requirements specified herein.

J. Inform the Owner and Engineer in writing of any changes made to the system(s) to accommodate field conditions. Notification shall be provided no less than 24 hours prior to implementing the changes.

K. In the event of a release from the DETS or conveyance systems, immediately shut down the system and notify the Owner and Engineer. Perform cleanup and system repair in a timely manner to resume operations in compliance with this Section upon approval by the Owner.

L. Provide, install, maintain, and operate pumps, wells, and related equipment, including standby equipment, in accordance with system/equipment manufacturer's recommendations and of sufficient capacity to adequately dewater excavations until the required construction, installation, backfilling, and other elements are completed.

M. Modify dewatering procedures which cause or may cause, in the opinion of the Engineer, damage to new or existing facilities, utilities, or other site features. Modifications to dewatering system(s) shall be made at no additional cost to the Owner.

N. Maintain continuous and complete effectiveness of all systems throughout the conduct of the Work.

O. Permanent utilities, piping, and existing infrastructure shall not be used as part of Construction Water management system(s) unless specifically indicated (e.g., leach field components as shown on the Drawings).

P. Remove dewatering sump materials and other equipment upon completion of Construction Water management to facilitate site restoration unless otherwise indicated. In the event sumps cannot be removed, temporary dewatering sumps are to be backfilled and sealed with cement grout or low permeability compacted soils.

END OF SECTION

SECTION 03 40 00

PRECAST CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Attention is directed to the GENERAL CONDITIONS OF THE CONTRACT and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

E. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 RELATED SECTIONS

A. SECTION 011100 – Summary of Work

B. SECTION 020000 – Existing Conditions

C. SECTION 310000 – Earthwork

D. Drawings

E. Other Sections of the Specifications, not referenced above, shall also apply to the extent required for the proper performance of the Work.

1.3 SUBMITTALS

A. The following shall be submitted in accordance with Section 013300 - Submittal Procedures.

1. Shop Drawings: Submit complete shop drawings for all items diameters and classes of reinforced concrete pipe, manholes, and fittings, and related items showing dimensions, strength and materials specifications and standards, joint details and reinforcement position for approval prior to manufacture. Include the following information on the shop drawings:
   a. Dimensions of pipe and manhole structure
   b. Integrated shop drawing details from third party component suppliers, including but not limited to manhole hatch.
   c. Indicate plan, location, and inverts of connecting pipe
   d. Joint design details, including length, thickness, and shape of joint
   e. Manufacturer, size, and type of gasket and sealing materials, manhole hatch, steps
   f. Manufacturer's recommendations for gap dimension and tolerance for a properly installed joint
   g. Signature and title of authorized representative
2. Materials and Product Compliance: Submit notarized affidavits of all materials compliance with ASTM C913 and these specifications.
3. Joint Compliance: Submit notarized affidavit of joint compliance with ASTM C990 and these specifications for each pipe size and manhole type/size. The statement shall include date of test.
4. Concrete Quality Control: Test concrete in accordance with ASTM C913 using method ASTM C39. Minimum of one test from each concrete batch representative of the days production run that produces the precast concrete products for this project. Submit certified results of all shop tests for approval.
5. Retain plant records and quality control program used during production of precast concrete and make such records and test results available to Engineer if requested.
6. Manufacturer’s Installation Instructions.
7. Warranty information.
8. Product Data: Provide manufacturer’s product data for all materials in this specification.
9. Shop Drawings: Show profiles, accessories, location, and dimensions.
10. Vault access door manufacturer shall provide the manufacturer’s Warranty. Materials shall be free of defects in material and workmanship for a period of (10) ten years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

1.4 DESCRIPTION OF WORK

A. Abbreviated Summary of Work

1. The Work of the Contract is indicated by the Contract Documents.
2. The Contract includes coordination of all Work indicated by the Contract Documents.
3. The Contract is unavoidably affected by governmental regulations, weather and natural phenomena, an access agreement with one or more landowners, and other forces and conditions not described in the Contract Documents.
4. Work includes any pre-cast structures as indicated on drawings or determined by Engineer.

B. General Description

1. Submittal preparation.
2. Subgrade and other preparation to facilitate installation of precast components.
3. Installation, where indicated on the Drawings, foundation system to support precast structures.
4. Furnish and install precast concrete components as per the Drawings and the specifications.
5. Installation of reinforced cast-in-place concrete components such as but not limited to the drainage features and other items necessary to properly install and support precast concrete components.
6. Ensuring proper coordination and integration of the components integrated into precast features shown on the Drawings and approved shop drawings.
7. Such other activities needed to execute the work of this specification section.

1.5 DEFINITIONS AND REFERENCES

A. AASHTO - Standard Specifications for Highway Bridges

B. American Concrete Institute:

1. ACI 318 - Building Code Requirements for Structural Concrete

C. ASTM International (from ASTM C913)

1. A82/A82M Specification for Steel Wire, Plain, for Concrete Reinforcement
2. A185/A185M Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
3. A416/A416M Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
4. A421/A421M Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
5. A496/A496M Specification for Steel Wire, Deformed, for Concrete Reinforcement

6. A497/A497M Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
7. A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
8. A706/A706M Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
9. C33 Specification for Concrete Aggregates
10. C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
11. C94/C94M Specification for Ready-Mixed Concrete
12. C150 Specification for Portland Cement
13. C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
14. C260 Specification for Air-Entraining Admixtures for Concrete
15. C330 Specification for Lightweight Aggregates for Structural Concrete
16. C494/C494M Specification for Chemical Admixtures for Concrete
17. C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
18. C595 Specification for Blended Hydraulic Cements
19. C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
20. C685/C685M Specification for Concrete Made by Volumetric Batching and Continuous Mixing
21. ASTM C877 - Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
22. C890 Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
23. C913 Standard Specification for Precast Concrete Water and Wastewater Structures
24. C990 Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

1.6 QUALITY ASSURANCE

A. Design Criteria

1. Manhole structure, v-ditch, and any other components indicated on the Drawings shall conform to ASTM C890, ASTM C913 and ACI 318.
2. Manhole sections shall be capable of withstanding AASHTO H-20 loading without failure or leakage.
3. Manhole base and walls shall be a minimum of 6 inches thick.
4. Joint: sealed, watertight design as per ASTM C990.
5. Reinforcing steel: Grade 60 (ASTM A615).
6. Concrete:

   a. As Per ACI 318 and ASTM C913. Concrete testing as per ASTM C39.
   b. Minimum compressive strength of 4,000 psi at 28 days.
   c. Freeze/Thaw protection with air entrainment admixture conforming to

ASTM C260 consisting of 5.5% +/- 1.5% by volume as measured by ASTM C231.

d. Water-Cementitious Ratios of 0.45 or less.

7. Handling: Incorporate embedded lifting devices designed for this purpose with minimum safety factor of 4 and in conformance with ASTM C890.
8. Steps designed and tested according to ASTM C497.

B. The quality of all materials, the process of manufacture and the finished sections shall be subject to inspection by the Engineer. Such inspection may be made at the place of manufacture, and/or on the work site after delivery. Sections shall be subject to rejection due to failure to meet any of the Specification requirements, even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the site shall be marked for identification and shall be removed from the site at once. All sections that have been damaged after delivery will be rejected, or if already installed, shall be repaired or removed and replaced entirely at the Contractor's expense as directed by the Engineer.

C. All sections shall be inspected for general appearance, dimensions, soundness, etc. The surface shall be dense, close-textured and free of blisters, cracks, roughness and exposed reinforcement.

D. Imperfections may be repaired, subject to acceptance by the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final acceptance. Concrete grout shall be used for repairs. Epoxy grout may be used for repairs, subject to acceptance by the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Precast manhole sections shall not be shipped until the concrete has attained a compressive strength of 3,000 psi or until 5 days after fabrication and/or repair, whichever time is longer.

B. Transport and handle precast concrete units with equipment designed to protect units from damage. Lift and support manhole sections from lifting points using lifting or handling devices.

C. Do not place concrete units in position to cause overstress, warp or twist.

D. Conform to manufacturer's instructions for delivery and handling.

E. Protect edges of manhole and rings to prevent chipping or spalling.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Specification includes references to designated manufacturers in select cases to illustrate minimum acceptable requirements for products.

B. Substitutions: Products of equal or better quality, detail, function, and performance may be proposed for substitution by following the procedures in the specifications.

2.2 PRECAST MARKINGS

A. All precast concrete manhole, rings, and pipe sections shall have 1) the date of manufacture; 2) name or trademark of the manufacturer; 3) initials or symbols to indicate intended use of the structure indelibly marked on the inside of the wall.

2.3 PRECAST

A. Concrete Mixes:

1. Portland Cement: ASTM C150, Type II.
2. Coarse Aggregates: ASTM C33; Graded 1 inch to No. 4 Sieve.
3. Sand: ASTM C33; 2.35 fineness modulus.
4. Water: Potable; clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.
5. Air-Entraining Admixtures: ASTM C260.
6. Reinforcing Steel:
   a. Deformed Bars: ASTM A615/A615M, Grade 60.
   b. Welded Wire Fabric: ASTM A185.
7. Design concrete mix to produce homogeneous mixture exhibiting required concrete strength, air-entrainment, watertight properties, and loading requirements.

B. Joint “O” Rings”

1. Confined rubber “O” ring gasket as per ASTM C443.

C. Joint Sealant:

1. In Joint: Butyl rubber as per ASTM C990.
2. Surface Sealing Band: Type III Butyl Rubber as per ASTM C877.
   a. Manhole: 6-inch (minimum) wide band
   b. 24-inch by 24-inch box culvert: 9-inch (minimum) wide band

D. Mortar:

1. Masonry Cement: ASTM C91.
2. Mortar for Unit Masonry: ASTM C270, Type S.

3. Premixed Materials: ASTM C387.

E. Concrete Grout:

1. Concrete grout shall be premixed, prepackaged nonshrink cement based grout such as Five Star Grout manufactured by Five Star Products, Inc.
2. Nonshrink when tested in accordance with ASTM C827.
3. Minimum compressive strength of 5000 psi at 28 days when tested in accordance with ASTM C109.

F. Manhole Hatch Vault Door Frame and Covers:

1. Manufacturers
   a. Model JAL-H20-series - The BILCO Company, P.O. Box 1203, New Haven, CT 06505; 1-203-934-6363, Fax: 1-203-933-8478, Web: www.bilco.com
   b. Model THS–series - U.S.F. Fabrication, Inc., 3200 West 84 Street, Hialeah, FL 33018, Phone: (800) 258-6873, Fax: (305) 882-1577, Web: www.usffab.com
2. Integrated into the Precast structure by the precast Manufacturer as per the approved shop drawings.
3. Furnish and install where indicated on plans vault access door measuring clear opening width (30 inch) x length (36 inch). Length denotes hinge side. The vault access door shall be single leaf. The vault access door shall be pre-assembled from the manufacturer. Door shall open and be sized as per the Drawings and the approved shop drawing.
4. Performance characteristics:
   a. Heavy duty, single door aluminum door rated for off-street locations that may occasionally experience AASHTO H-20 loading. Cover: Shall be reinforced to support AASHTO H-20-wheel load with a maximum deflection of 1/150th of the span. Manufacturer to provide structural calculations stamped by a registered professional engineer upon request. (Note: For installation in an off-street location where not subject to high-density, fast moving traffic.)
   b. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
   c. Operation of the cover shall not be affected by temperature.
   d. Entire door, including all hardware components, shall be highly corrosion resistant.
5. Cover: Shall be 1/4” (6.3 mm) aluminum diamond pattern.
6. Frame: Channel frame shall be 1/4” (6.3mm) extruded aluminum with bend down anchor tabs around the perimeter.
7. Provide frame skirts for casting into precast structure.
8. Incorporate recessed padlock hasp/staple for locking.
9. Drain Coupling: Provide a 1-1/2” (38mm) drain coupling located in the right front corner of the channel frame.
10. Lifting mechanisms: Manufacturer shall provide the required number and size of enclosed stainless steel horizontal springs (bolt-on variety) or compression

spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe fastened to a formed 1/4” gusset support plate. Mechanisms must be capable of being integrated into precast concrete structure.

11. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the cover and the latch release shall be protected by a flush, gasketed, removable screw plug.
12. Hardware:
    a. Hinges: Heavy forged Type 316 stainless steel hinges, each having a minimum 1/4” (6.3 mm) diameter Type 316 stainless steel pin, shall be provided and shall pivot so the cover does not protrude into the channel frame. Shall be specifically designed for horizontal installation and shall be through bolted to the cover with tamperproof Type 316 stainless steel lock bolts and shall be through bolted to the frame with Type 316 stainless steel bolts and locknuts.
    b. Cover shall be equipped with a hold open arm which automatically locks the cover in the open position.
    c. Cover shall be fitted with the required number and size of compression spring operators. Springs and spring tubs shall be Type 316 stainless steel.
    d. A Type 316 stainless steel snap/slam lock with fixed handle shall be mounted on the underside of the cover.
    e. Provide stainless steel safety chain with aluminum support posts.
    f. Shall be Type 316 stainless steel throughout.
13. Finishes: Factory finish shall be mill finish aluminum with bituminous coating applied to the exterior of the frame contacting concrete.

G. Access Steps:

1. Manhole rungs shall comply with all dimensional and structural requirements of the Occupational Safety and Health Standards, U.S. Department of Labor (OSHA) most recent publication.
2. Setting: 12 inches center to center vertical distance, unless otherwise indicated on the Drawings.
3. Integral foot stops and nonslip treads. Steel reinforced copolymer polypropylene meeting the following specifications:
    a. ASTM C478, Section 16.
    b. ASTM C497, Method of test.
        1) Horizontal pullout load 400 lbs
        2) Vertical load 800 lbs
    c. ASTM D4104, copolymer polypropylene.
    d. ASTM A615/A615M, Grade 60, 1/2" reinforced rod.

H. Bedding material shall consist of dense grade crushed stone as specified in Section 31 00 00 – Earthwork and as per the Drawings.

I. Substitutions – See Section 01 60 00 - Product Requirements.

PART 3 – EXECUTION

3.1 MANHOLE VAULT ACCESS DOOR (HATCH) OR MANHOLE COVER

A. Submit product design drawings for review and approval to the Engineer before fabrication.

B. The installer shall check as-built conditions and verify the manufacturer's vault access door details for accuracy to fit the application prior to fabrication. The installer shall comply with the vault access door manufacturer's installation instructions.

C. The installer shall furnish mechanical fasteners consistent with the vault access door manufacturer's instructions.

D. Verify that other trades with related work are complete before installing vault access door(s).

1. Mounting surfaces shall be straight and secure; substrates shall be of proper width.
2. Refer to the construction documents, shop drawings, and manufacturer's installation instructions.

3.2 SPECIAL FOUNDATION REQUIREMENTS

A. MANHOLE VAULT ACCESS DOOR (HATCH) OR MANHOLE COVER

3.3 INSTALLATION OF MANHOLE BASES AND SECTIONS AND CULVERT PIPE

A. Lifting apparatus: meet or exceed OSHA requirements.

B. Lift and handle precast structures to minimize contact with tongue and groove area of sections. Care shall be taken in loading, transporting, and unloading to prevent injury to the manhole, pipe, or fittings and the joint surfaces. Manhole, pipe, or fittings shall not be dropped. All material shall be examined before laying and no piece shall be installed which is found to be defective.

C. Precast manholes and culvert pipe shall be placed on a layer of compacted bedding material except where subgrade conditions require special foundation system. Refer to related specifications and Drawings for installation under special foundation conditions. The excavation shall be properly dewatered to allow placing of bedding material and setting the manhole base and culvert pipe on drained subgrade. Manhole sections and culvert pipe shall be placed using manufacturer's recommended procedure for sealing the horizontal joints, as well as other tongue and groove connections. Manhole sections shall be set vertical with sections in true alignment within 1/4-inch maximum tolerance.

D. Blocking under the pipe will not be permitted.

E. Apply In Joint butyl rubber sealant (ASTM C990) as per manufacturer's recommendations.

F. Inlet and outlet pipes shall be connected and sealed in accordance with the manufacturer's recommended procedure, and as shown on the Drawings.

G. Grouting or placing mortar in and around flexible compression connectors/joints shall be avoided unless conditions dictate use as approved by the Engineer.

H. A leakage test shall be made as described below in this Section.

I. Non-woven geotextile shall be placed on the bedding before installation of the culvert pipe to facilitate wrapping.

J. A depression shall be left in the supporting bedding at the joint to prevent contamination of the gasket immediately before engaging the joint. Before the pipe is lowered into the trench, the joints shall be cleaned and free from dirt. Gasket ("O" Ring if used) and joint shall be lubricated by a vegetable lubricant which is not soluble in water, furnished by the pipe manufacturer and harmless to the gasket. The pipe shall be properly aligned in the trench to avoid any possibility of contact with the side of the trench and fouling the gasket. As soon as the male and female joints are centered in the previously laid pipe, the joint shall be engaged with jacks or come-alongs. After the gasket is compressed and before the pipe is brought fully home, each gasket shall be carefully checked for proper position around the full perimeter of the joint. Steel inserts shall be used to prevent the pipe from going home until the feeler gauge is used to check the final position of the gasket. The jacks or come alongs shall be anchored sufficiently back along the pipeline (a minimum of five lengths) so that the pulling force will not dislodge the pieces of pipe already in place. Only a jack or come along shall be employed to force the pipe home smoothly and evenly and hold the pipe while backfilling is in progress. Under no circumstances shall crowbars be used nor shall any of the motor driven equipment be used.

K. Install sealing band around joint as per the manufacturer's recommendations. Apply sealant band to all exposed joint connections except for the bottom joint of the precast box culvert.

L. Place fill in bedding depressions used for joint sealing.

M. As soon as the pipe is in place and before the come along is released, backfill shall be placed as indicated on the Drawings and compacted for at least one half the length of pipe. Not until this backfill is placed shall the come along be released. If any motion at joints can be detected, a greater amount of backfill shall be placed before pressure is released. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by a watertight plug or other approved means.

N. Carefully regulate the equipment and construction operations such that the loading of the pipe does not exceed the loads for which the pipe is designed and manufactured. Any pipe damaged during construction operations shall promptly and satisfactorily be repaired or replaced at the Contractor's expense.

O. Backfill equally around the structure to prevent tipping and disturbance.

P. The manhole hatch shall be closed when not in use.

Q. Comply with OSHA confined entry requirements.

3.4 LEAKAGE TEST (WATER TEST)

A. Leakage tests shall be made by the CONTRACTOR and observed by the ENGINEER on each manhole. The test shall be an exfiltration test or vacuum test made as described below.

B. The test shall be conducted before backfilling around the manholes. After the manhole has been assembled in place, all lifting holes shall be filled with nonshrinking concrete grout. If the ground water table has been allowed to rise above the bottom of the manhole, it shall be lowered for the duration of the test. All pipes and other openings into the manhole shall be suitably plugged and the plugs braced to prevent blowout.

C. The manhole shall then be filled with water to the top. A period of time may be permitted if the Contractor so wishes to allow for absorption. At the end of this period, the manhole shall be refilled to the top of the cone, if necessary, and the measuring time of at least 6 hours begun. At the end of the test period, the manhole shall be refilled to the top of the cone, measuring the volume of water added. This amount shall be extrapolated to a 24-hour rate and the leakage determined on the basis of depth. The leakage for each manhole shall not exceed 1 gallon per vertical foot for a 24-hour period. If the test fails this requirement, but the leakage does not exceed 3 gallons per vertical foot per day, repairs by approved methods may be made to bring the leakage within the allowable rate of 1 gallon per vertical foot per day. Leakage due to a defective section or joint or exceeding the 3 gallons per vertical foot per day, shall be cause for the rejection of the manhole. It shall be the Contractor's responsibility to disassemble, reconstruct or replace it as directed by the Engineer at no additional cost to the Owner (SDs). The manhole shall then be retested and, if satisfactory, the manhole exterior backfilled.

D. If the Contractor elects to backfill prior to testing, it shall be at the Contractor's risk and it shall be incumbent upon the Contractor to determine the reason of any failure of the test. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorption, etc., i.e., it will be assumed that all loss of water during the test is a result of leaks through the concrete. The Contractor shall take any steps necessary to assure the Engineer that the water table is below the bottom of the manhole throughout the test.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. See Section 003000 – Measurement and Payment for relevant information.

END OF SECTION

SECTION 31 00 00

EARTHWORK

PART 1 – GENERAL

1.1 SUMMARY

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

E. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 REFERENCES

A. See specification Section 01 11 00 – Summary of Work for references of acronyms and definitions applicable to this Section.

B. ASTM C127-12 – Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

C. ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

D. ASTM D421-85(2007) – Standard practice for Dry Preparation of Soil Samples by Particle-Size Analysis and Determination of Soil Constants

E. ASTM D422-63(2007) – Standard Test Method for Particle-Size Analysis

F. ASTM D1140-00(2006) – Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75-um) Sieve

G. ASTM D1556-07 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

H. ASTM D1557-12 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 lbf/ft3 (2,700 kN-m/m3))

I. ASTM D6938-10 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

J. Method 8260B – Volatile Organic Compounds by Gas Chromotography / Mass Spectrometry (CG/MS)

K. Method 8270C – Semi-volatile Organic Compounds by Gas Chromotography / Mass Spectrometry (GC/MS)

L. Method 8081A – Organochlorine Pesticides by Gas Chromotography

M. Method 8082 – Polychlorinated Biphenyls (PCBs) by Gas Chromotography

N. Method 6010B – Inductively Coupled Plasma-Atomic Emission Spectrometry

O. Method 7470A – Mercury in Liquid Waste (Manual Cold-Vapor Technique)

P. Method 7471B – Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique)

Q. Massachusetts Department of Transportation – Highway Division, “Supplemental Specifications to the Standard Specifications for Highways and Bridges”, 15 June 2012.

1.3 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. SECTION 01 33 00 – Submittal Procedures

C. SECTION 01 56 00 – Temporary Barriers and Enclosures

D. SECTION 01 57 00 – Temporary Erosion and Sediment Controls

E. SECTION 01 57 19 – Environmental Controls

F. SECTION 01 70 00 – Execution and Closeout Requirements

G. SECTION 02 21 00 – Surveys

H. SECTION 02 61 00 – Waste Management

I. SECTION 32 30 00 – Site Restoration

J. SECTION 02 70 00 – Construction Dewatering and Water Management

K. SECTION 31 36 00 – Gabions

L. Drawings

M. Other Sections of the Specifications, not referenced above, shall also apply to the extent required for proper performance of the Work.

1.4 DESCRIPTION OF WORK

A. Abbreviated Summary of Work

1. The Work of the Contract is indicated by the Contract Documents.
2. The Contract includes coordination of all Work indicated by the Contract Documents.
3. The Contract is unavoidably affected by governmental regulations, weather and natural phenomena, an access agreement with one or more landowners, and other forces and conditions not described in the Contract Documents.

B. General for All Work Areas

1. Contact "Dig Safe": Comply with Massachusetts General Laws, Chapter 82, Section 40 and all applicable codes, rules, regulations. Do not begin any excavation without complying with the law. Ensure that all utilities have been located and marked prior to beginning any excavation work.
2. Submittal preparation.
3. Where applicable, coordinating work with the radiation safety officer, including training staff as required by radiation safety protocols for the site.
4. Where applicable, coordinating work with utility owners.
5. Site clearing and grubbing, including chipping of all above-grade woody plant materials and containerizing for off-site management. Segregate, stockpile, and containerize grubbed root balls for disposal by others.
6. Performing the required excavation and grading to establish access and material staging areas in the various Work Areas. Rough grading of onsite fill may be required.
7. Perform excavation, temporary filling, grading, and compaction as required to construct the temporary access roadways as indicated on the Drawings and as needed to facilitate material handling. Maintain access roads throughout the work.

Remove earth materials placed for temporary access roadways when work is complete unless indicated otherwise.

8. Excavating material unsuitable as a bearing surface for the overlying or adjacent construction, to lines and grades determined in the field and acceptable to the Engineer.
9. Performing localized dewatering as required.
10. On-site material handling to and from temporary stockpiles.
11. Loading material into trucks and other suitable containers for off-site disposition.
12. Compacting fill as described herein and shown on the Drawings.
13. Excavating, stockpiling, and backfilling with onsite soils, as required during construction.
14. Placing fill soils, previously excavated soils, aggregate, riprap, erosion control blankets, geotextiles and other materials as shown on the Drawings.
15. Providing approved fill, as necessary, from off-site sources.
16. Installing and maintaining erosion and sedimentation controls.
17. Dust and odor control.
18. Performing final grading as required to achieve the elevations and lines indicated on the Drawings.
19. Protection of existing utilities, monitoring wells, and other site features.
20. Protection of completed work.
21. Performing other earthwork operations that are incidental to the Work and general items required by the Contract Documents.

C. Site-wide Sediment and Soils (SSS) Remedial Activity Excavation Areas

1. General items including installation of erosion controls.
2. Installing and maintaining a stabilized construction entrance and existing site entrance improvement, and a wheel wash decontamination pad. Construction of existing access road improvements.
3. Earthwork to facilitate installing and maintaining temporary surface water diversions (e.g., removal of drainage pipe and catch basin and install new drainage structures), as needed.
4. Installation of water treatment system for dewatering as needed (e.g. for Cooling Pond Work) in accordance with Section 02 70 00 Construction Dewatering and Water Management.
5. Installation of support of excavation as required for areas of deep excavation (e.g. the Courtyard area).
6. Construction of a temporary excavated soil stockpiles and grubbed material stockpile areas. Removing earth materials placed for the areas when work is complete.
7. Excavate the limits of soil or sediment excavation to the lines and grades as shown within SSS drawings. Layout the grid for confirmatory sampling or install demarcation layer prior to temporary restoration, such that confirmatory sampling can be completed during the site wide sediment and soils remediation. There may be the need for additional erosion controls as directed by the Engineer to allow the

excavation to remain open for an extended period of time due to laboratory turnaround times being longer than normal.

8. Finish grading to facilitate temporary or permanent site restoration per discussions with Engineer.
9. All other work indicated.

1.5 EXISTING CONDITIONS

A. See Specification Section 01 11 00 – Summary of Work for information regarding site conditions.

B. Below-grade debris and obstructions may be present onsite. Debris and obstructions may include bricks, metal scraps, piping, tools, concrete, wood, and boulders.

C. Contaminated soils exist on site. The Contractor shall be responsible for the health and safety of all workers engaged in excavation, backfilling, grading, and other associated operations. Work shall be performed in accordance with the Contractor's Health and Safety Plan. See Section 01 35 29 – Health and Safety Requirements.

D. Contractor shall conduct the Work in a manner that is protective of public health and safety. The Contractor shall control public access to the Work Areas and shall control the concentration of dust and odors at the Limit of Work perimeter. See Sections 01 57 19 – Environmental Controls for more information.

E. Contractor shall conduct the Work in a manner that is protective of surface water quality and wetlands. Contractor shall control erosion as specified in Section 01 57 00 – Temporary Erosion and Sedimentation Controls.

F. The excavations when complete and after confirmatory samples are collected may remain open for over 2-months. It may be necessary to construct temporary berms around the areas to minimize runoff from flowing into the excavation. Temporary erosion control mats may be necessary to protect the soils.

1.6 QUALITY ASSURANCE

A. The Contractor’s quality control of earthwork operations will be monitored by the Engineer. During final stages of excavation, foundation construction, subgrade preparation, placement of working mats, and controlled filling operations, the Contractor shall provide sufficient notice to the Engineer prior to work and shall cooperate with the Engineer in all respects to facilitate any testing or observations required. The Contractor shall not place a layer of fill or foundations until the Engineer has approved the underlying subgrade surface (and underlying geotextile, where required). The Engineer will make such tests, in accordance with the methods specified below, as are deemed necessary to determine compliance with these Specifications. The Engineer will determine the suitability of earth materials for use in backfill.

1. Methods of Testing

a. Moisture-Density Relationship: ASTM D1557
b. In-Place Density: ASTM D1556 or D6938.
c. Sieve Analysis: ASTM D421 or D422
d. Percent Passing No. 200 Sieve: ASTM D1140

2. Tolerances
   a. For grading in areas not included in (a) and (b), construct soil and backfill surfaces to plus or minus 1/10-ft of the elevations indicated on the Drawings, unless otherwise indicated.
   b. Maintain the moisture content of fill material as it is being placed within plus or minus two percent of the optimum moisture content of the material determined by the laboratory tests specified herein.

B. The Engineer will observe other aspects of construction including dewatering, installation of the temporary diversion structures, wetlands restoration, and erosion control.

C. All costs related to testing or replacement of non-conforming materials shall be paid for by the Contractor at no additional cost to the Owner, and the costs thereof will be deducted by the Owner from that due the Contractor.

D. All Work shall conform to the Drawings and Specifications and shall comply with applicable codes and regulations.

1.7 COORDINATION

A. As construction proceeds, the Contractor shall be responsible for notifying the Engineer at least three working days prior to the start of earthwork operations requiring monitoring and/or testing.

B. Contractor shall cooperate with the Engineer in obtaining field samples and conducting field testing. Furnish incidental labor, if necessary, in connection with the required sampling and testing.

C. Contractor shall control dust and odors such that perimeter air action levels are not exceeded (see Section 015719 – Environmental Controls). Contractor shall modify Work practices, including (if necessary) stopping dust- or odor-producing activities, to control dust/odors and ensure air action levels are not exceeded at the request of the Engineer.

1.8 LINES AND GRADES

A. The Contractor shall be responsible for layout and survey control and establishing all elevations required based on the benchmarks indicated on the Drawings or other points acceptable to the Engineer. Layout and survey control requirements associated with the Work, as shown on the Drawings and described in these specifications, is described in Section 01 70 00 – Preparation and Closeout Requirements.

1.9 SUBMITTALS

A. Submit to the Engineer the following information on the proposed source of imported fill materials

1. Location of the borrow source site. Include street (if applicable), city, state, and contact telephone number for source site information.
2. Present and past usage of source site and material;
3. Any existing site assessment reports evaluating the presence of oil and hazardous material at the source site.
4. Any change in source throughout the Work requires prior approval by the Engineer.
5. Design calculations and drawings for temporary excavation support prepared by a professional engineer licensed in Massachusetts. **Submit three weeks before work is scheduled to begin.**
6. Proposed schedule, sequence, procedures and equipment for all earthwork including descriptions of all methods, operations and equipment proposed for excavation, sheeting and shoring, subgrade preparation, backfilling and compaction.
7. Contractor shall sample and submit for chemical testing at the Project Chemical Testing Laboratory the suite of chemical tests listed in this section on all proposed fill materials from off-site sources, with the exception of stone, riprap, and submit results at least two weeks prior to delivery to the site to confirm the borrow source is acceptable. The cost for sampling is at the Contractor's expense. The cost for testing one candidate borrow source by material type at the Project Chemical Testing Laboratory shall be by the Owner. In the event test results for the first borrow source fails to meet the project requirements or additional borrow sources for a particular material type are needed, the cost of additional sampling as well as testing source quality will be by the Contractor. The Contractor shall provide the Project Chemical Testing Laboratory's final reports to the Engineer for review. At a minimum, laboratory reports/deliverables shall include sample chain of custody forms, analytical results, QC summaries and supporting raw data from instrument printouts sufficient to support validation of the analytical data as described in the Quality Assurance Project Plan (QAPP) included with the Remedial Action Work Plan (RAWP) and 100% Remedial Design. The testing suite shall consist of the following:
   a. Record of Decision (ROD) Contaminants of Concern (COCs) including: Uranium, (U-238, U-235 and U-234), thorium (Th-232);
   b. Volatile Organic Compounds SW-846 Method 8260B;
   c. Semi-Volatile Organic Compounds SW-846 Method 8270C;
   d. MADEP Extractable Petroleum Hydrocarbons (EPH), (adjusted carbon ranges only); and TPH by EPA Method 8015
   e. Pesticides SW-846 Method 8081A;
   f. Polychlorinated Biphenyls (PCBs) SW-846 Method 8082;
   g. Trace Metals, including RCRA 8 Metals by SW-846 Method 6010B (plus Copper);
   h. Ignitability, corrosivity, reactivity (Hazard ID); and
   i. Mercury SW-846 Methods 7470/7471.

For each type of off-site soil material, one suite of the above tests with Massachusetts RCS-1 reporting limits shall be performed at least two weeks prior to delivery to the site, and thereafter for each 5,000 cubic yards of the material imported to the site.

B. For each type and source of proposed imported fill or crushed stone, the Contractor shall deliver to the Engineer one 5-gallon pail with secured lid - sample for quality control testing. For each type and source of riprap, the Contractor shall deliver to the Site an approximate 150-lb sample. All samples shall be clearly labeled as to the project, source of the material, intended use and date of sample delivery.

C. Record Drawings

1. The Contractor shall submit to the Owner and Engineer a set of as-built drawings in accordance with Section 01 70 00 – Execution and Closeout Requirements.

D. Product Information

1. For Specialty Material, provide manufacturer cut sheet, handling, installation, manufacturer certification of the material as defined herein, and related product information.

PART 2 – PRODUCTS

2.1 EARTH MATERIALS

A. Common Fill: Common Fill shall be naturally occurring mineral soil, well-graded and free of trash and all organic soils and materials, weak, compressible, and frozen materials. It shall be of such nature and character that it can be readily spread and compacted and shall be free of expansive materials (such as highly plastic clays), and of materials subject to decay, decomposition, or dissolution. Common fill shall contain no stone larger than three (3) in. in maximum dimension.

B. Onsite Fill: Onsite Fill shall be existing onsite fill including rubble and topsoil, organic soil, and miscellaneous material.

C. Processed Gravel (MHD M1.03.1): Processed gravel shall consist of inert material that is hard durable stone and coarse sand, free from loam and clay, surface coatings and deleterious materials. The material shall be the result of processing by mechanical means and shall be stockpiled in such a manner to minimize segregation of particle sizes. All processed gravel shall come from approved stockpiles. The gradation shall meet the following requirements:

Sieve Designation	Percent Passing
3 in.	100
1-1/2 in.	70-100
3/4 in.	50-85
No. 4	30-60

No. 200	0-10

D. Granular Fill for general use: shall consist of clean, gravelly sand or sandy gravel free of organic material, loam, trash, snow, ice, frozen soil, or other objectionable material. This material should be well graded within the following limits:

Sieve Size	Percent Finer by Weight
6 in.	100
No. 4	30 - 80
No. 40	10 - 50
No. 200	0 - 8

E. Granular Fill for Holding Basin surface grading: shall consist of clean, gravelly sand or sandy gravel free of organic material, loam, trash, snow, ice, frozen soil, or other objectionable material. This material should be well graded within the following limits:

Sieve Size	Percent Finer by Weight
3-in.	100
No. 4	20-90
No. 40	10-80
No. 200	0-30

F. Dense-graded Crushed Stone: Dense-graded crushed stone shall conform to MHD M2.01.7. Dense-graded Crushed Stone shall consist of a well-graded material produced by combining crusher run coarse aggregate and fine aggregate consisting of natural or crushed sand. The coarse aggregate shall consist of angular fragments of hard, durable stone, produced by crushing solid or shattered rock. The composite material shall be free from clay, loam, and other deleterious materials, and shall conform to the following requirements:

Sieve Designation	Percent Passing
2 in.	100
1-1/2 in.	70-100
3/4 in.	50-85
No. 4	30-55
No. 50	8-24
No. 200	3-10

G. Sand Borrow shall be as specified in MHD M1.04.0, Type a. Sand Borrow shall consist of clean, inert, hard, durable grains of quartz or other hard durable rock, free from loam or clay, surface coatings, fly ash, and deleterious materials. The allowable amount of material passing the No. 200 sieve as determined by ASTM D422 shall not exceed 10 percent by weight. The maximum particle size for Sand Borrow shall be 1/4 inch.

H. Crushed Stone: Crushed Stone shall consist of one or the other of the following materials:

1. Durable crushed rock consisting of the angular fragments obtained by breaking and crushing solid or shattered natural rock, and free from a detrimental quantity of thin, flat, elongated, or other objectionable pieces. A detrimental quantity will be considered as any amount in excess of 15 percent of the total weight.
2. Durable crushed gravel stone obtained by artificial crushing of boulders or fieldstone with a minimum diameter before crushing of 8 in.

   The Crushed Stone shall be reasonably free from clay, loam and deleterious material. Not more than 1.0 percent of satisfactory material passing a No. 200 sieve will be allowed to adhere to the Crushed Stone. The Crushed Stone shall be uniformly blended according to the grading requirements for the respective stone sizes shown in the following table:

	2-in. Crushed Stone (No MHD spec)	3/4-in. Crushed Stone (MHD M2.01.4)	1/2-in. Crushed Stone (MHD M2.01.5)	1/4-in. Crushed Stone (MHD M2.01.5)
Sieve Designation	Percent Passing			
2-1/2 in.	100			
2 in.	95-100			
1-1/2 in.	35-70			
1 in.	0-25	100		
¾ in.	0-5	90-100		
5/8 in.			100	
1/2 in.		10-50	85-100	100
3/8 in.		0-20	15-45	85-100
No. 4		0-5	0-15	20-50
No. 8			0-5	0-15
No. 16			0-5	0-5

I. Riprap: Riprap shall be hard, durable, angular shaped stones that are the product of crushing, blasting, or ripping. Rounded stone, boulders, sandstone and similar soft stone or thin slabs are not acceptable. Riprap shall be free of soil, organics and other deleterious materials, and shall have a minimum specific gravity of 2.60 as determined by ASTM C 127. Riprap shall have a maximum of 50 percent abrasion loss as determined by the methods of ASTM C 131.

1. Light Riprap shall consist of MHD M2.02.4, Modified Rockfill and shall be graded within the following limits:

Size of Stone	Percent Finer by Weight
8 in.	95 – 100
4 in.	0 – 25
2-1/2 in.	0 – 5

2. Medium Riprap shall consist of MHD M2.02.3, Stone for Pipe Ends. Each stone shall weigh not less than 50 pounds, not more than 125 pounds, and at least 75 percent of the volume shall consist of stones weighing not less than 75 pounds each. The

remainder of the stones shall be so graded that, when placed with the larger stones, the entire mass will be compact.

3. Heavy Riprap shall consist of MHD M2.02.2, Dumped Riprap and shall be graded within the following limits:

Size of Stone	Percent Finer by Weight
400 lb	100
300 lb	80
200 lb	50
25 lb*	10

* No more than 5 percent by weight shall pass a 2-in. sieve.

J. Stone Riprap for Filter Mattress Armoring. Stone for filling Filter Mattresses may be crushed stone. The stone shall be durable and of suitable quality to ensure suitable performance in the Mattresses and the climate at the work site. Stone shall be free from cracks, seams, and other defects that would tend to increase its deterioration in the Mattresses. The inclusion of objectionable quantities of dirt, sand, clay, and rock fines shall not be permitted. Stone for filling Filter Mattresses shall be a well-graded mixture with the following gradation:

Sieve Designation	Percent Finer by Weight
3 in.	100
2-1/2 in.	90-100
2 in.	35-70
1-1/2 in.	0-15
¾ in.	0-5

K. Sand and Gravel Stream Liner: Stream Liner shall consist of a mixture of gravel and coarse sand. The gravel shall be hard, durable, rounded or sub-rounded in shape and resistant to weathering. Angular shaped stones or crushed material will not be accepted. Sand and Gravel Stream Liner shall meet the gradation shown below. It is anticipated that MHD Gravel Borrow with the minus No. 10 material removed will meet the gradation for Sand and Gravel Stream Liner.

Sieve Designation	Percent Passing
3 in.	100
2 in.	50-100
1 in.	40-100
½ in.	28-65
No. 4	14-40
No. 10	0-5

L. Topsoil/Loam Borrow: Topsoil/Loam Borrow shall be as specified in MHD M1.05.0, and shall also have a pH between 5.8 and 7.0. Loam Borrow shall consist of a fertile, friable, natural topsoil, without admixture of subsoil, refuse, or other foreign materials, and shall be obtained from a well-drained arable site.

M. Wetland Organic Soil: Wetland Organic Soil shall consist of a highly decomposed organic material containing at least 12 percent organic carbon content by weight. To meet this standard, wetland soils shall be produced by amending natural loam with leaf mold at a ratio of 50 percent soil to 50 percent organic material by volume, or equal. The resulting soil mix shall be free of stones, stumps, large sticks, shrubs, the seeds and roots of exotic/invasive plants, or other litter. The Wetland Organic Soil mix shall be tested to confirm that it meets the minimum 12 percent organic carbon content. Earth materials used for wetland restoration, including but not limited to, wetland organic soil, loam, leaf mold, shall not be harvested from an area that contained invasive species plant parts (seed, rhizomes, etc.) or contain any materials with invasive plant parts present. To the extent on-site wetland organic soil is re-used on site for restoration, such on-site re-use of material shall require conformance with the composition requirements described herein.

2.2 GEOTEXTILE, GEOMEMBRANE, AND EROSION CONTROL BLANKET

A. Geotextile and erosion control blanket shall be placed within the limits indicated on Drawings or as directed by the Engineer. The limits indicated on the Drawings will be adjusted in the field by the Engineer, depending on the actual limits of excavation during construction and other field conditions.

B. Geotextile and erosion control blanket shall consist of the type and grade indicated on the Drawings, or equal products approved by the Engineer. Erosion control blankets shall be placed in accordance with Section 01 57 00 – Temporary Erosion and Sedimentation Controls

C. Geomembranes shall be furnished and installed where shown on the Drawings or otherwise specified in the Contract Documents.

D. Geotextiles shall consist of the following (see Drawings for limits of each material).

1. Mirafi 140N or approved equal
2. Mirafi 180N or approved equal
3. Mirafi 1160N or approved equal

E. Erosion control blankets shall consist of the following (see Drawings for limits of each material):

1. North American Green Bionet C125BN or approved equal
2. North American Green Bionet SC150BN or approved equal
3. North American Green Bionet S75BN or approved equal

F. Geomembrane shall consist of the following (see Drawings for limits of each material):

1. GSE Lining Technology Inc., High Performance GSE HD Textured 40 mil or approved equal

2. GSE Lining Technology Inc., High Performance GSE HD Textured 60 mil or approved equal

G. Sediment control filtration rolls shall consist of the following (see drawings for limits):

1. North American Green SediMax-FR (Filtration Rolls) or approved equal
2. North American Green Coir Rolls or approved equal
3. North American Green SediMax-SW (Straw Wattles) or approved equal

PART 3 – EXECUTION

3.1 EXCAVATION

A. General Requirements

1. The Contractor shall excavate soil in accordance with the sequence of work outlined in Section 01 11 00 – Summary of Work.
2. Excavation shall include the removal of all materials encountered including earth, organic soils, boulders, pavement, slabs, demolition debris, walls, foundations, incidental structures, and other materials.
3. Excavation of rock, as defined previously, is not anticipated to be necessary. Boulders shall be classified as rock when in excess of 3 cubic yards in general excavation, but only when removed through the use of explosives. It does not include materials that can be removed by means other than drilling and blasting or drilling and wedging, but which, for reasons of economy in excavation, the contractor prefers to remove with explosives.
4. Excavated material shall be stockpiled onsite as shown on the Drawings. The material will be screened and placed in bagged roll-off containers as described in the Transportation and Disposal Plan. Radiation safety protocols will be followed in accordance with Section 01 35 29 Health and Safety Requirements.
5. The Contractor shall control the grading such that ground is pitched to prevent water from running to excavated areas, damaging structures or leaving the work area. The Contractor shall ensure that grading is undertaken such that abutting properties are protected from flooding.
6. Where soil has been softened, eroded by flooding, or placement during unfavorable weather, frozen, or otherwise disturbed, it shall be removed and replaced with suitable material at no additional cost to the Owner.
7. Exercise care to preserve materials below and beyond the lines of excavation. Where excavation is carried out, through Contractor error, below indicated grade or beyond the lines of excavation or as directed by the Engineer, backfill to the indicated grade and compact with acceptable material at no additional cost to the Owner, and at the direction of the Engineer.
8. The Contractor shall shore, brace and/or slope excavations in compliance with OSHA requirements. The Contractor shall be solely responsible for maintaining Site safety in accordance with OSHA and other applicable regulations, including Massachusetts 520 CMR 14.00 and "Jackie's Law"

9. The responsibility for providing a site and excavation “competent person”, as defined by OSHA, shall rest on the Contractor.
10. Restore any altered wetland resource areas impacted by erosion from Contractor’s work to prior conditions at no cost to Owner.

3.2 SHEETING, SHORING AND BRACING

A. The Contractor shall shore, brace and/or slope excavations in compliance with OSHA. The Contractor shall be solely responsible for protection of existing or new facilities and for maintaining site safety in accordance with OSHA and other applicable regulations. Lateral excavation support systems (including steel sheetpiling, and soldier pile and lagging systems) shall be designed to retain and provide full support for adjacent soil, rock, structures, utilities, light fixtures, streets and other features and protect them from damage due to settlement, lateral movement, loss of ground, or any other causes related to this construction. In addition, the support system must be located to allow new construction to be completed. Lateral excavation support systems shall be designed for all temporary and permanent loading conditions to which they will be subjected.

B. Provide materials for sheeting, shoring and bracing in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down sheeting, shoring and bracing and construct temporary soil nail walls as excavation progresses.

C. Structural Steel and Lagging
   1. Structural Steel shall be new and unused and shall conform to the current edition of "AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings."
   2. Structural grade timber having a minimum allowable working stress of 1,100 psi.

D. Sheetpiles shall be in good condition and shall conform to AISC Specifications for the design.

E. Welding
   1. Welding shall conform to American Welding Society Code D1.0 69 for Welding in Building Construction.

F. Where hydrostatic pressure is not considered in design, provide suitable drainage as needed to relieve hydrostatic pressure and prevent loss of ground behind the excavation support system. Stability analyses for temporary excavation support systems shall consider the effects of groundwater levels behind and in front of such systems.

G. Contractor shall remove all elements of temporary excavation support systems to a depth of 5 ft below finished grade.

H. Wood sheeting shall not be completely withdrawn if driven below mid-diameter of any pipe, and under no circumstances shall any wood sheeting be cut off at a level lower than one foot above the top of pipe.

3.3 HAULING WITHIN LIMITS OF WORK

A. Equipment

1. Trucks transporting saturated material shall be designed to contain the material and not allow the release of materials to roadways. Truck bodies shall be as watertight as practicable by initial design or supplement modifications, such as gasketing of tail gates.
2. Trucks transporting soil, rock, or sediment shall be equipped with covers that are secured at multiple points to the vehicle body to prevent contents from becoming airborne or otherwise leaving the truck during transport.

B. Routing

1. Vehicles leaving the limits of work shall be cleaned of soil, and public roadways shall be maintained as required by Section 01 57 19 – Environmental Controls.

3.4 FILL PLACEMENT AND COMPACTION

A. Requirements

1. Place and compact fill to the limits, of the material types, and in the manner as specified herein and shown on the Drawings. Unless otherwise specified or directed by the Engineer, material used for fill and backfill shall meet the material requirements specified under Part 2 – PRODUCTS.
2. Protect functioning utilities, structures, and pipes from damage during backfilling operations. If damaged, repair at no additional cost to the Owner.
3. The Contractor shall maintain and protect all overhead, surface, and subsurface utilities during construction activity.
4. The Contractor shall maintain and protect all structures, pavements and fences during construction activity.
5. If excessive weaving or instability is observed during compaction, as judged by the Engineer, compaction efforts shall be discontinued until the subgrade is stabilized.
6. Compaction by puddling or jetting is prohibited.
7. Control groundwater and surface run-off to minimize disturbance of material being placed. Slope fill surfaces at the end of each day to provide for free surface drainage.
8. Placement of fill shall not begin before observation and approval of subgrade conditions by the Engineer.
9. All materials shall be placed in-the-dry on subgrades acceptable to the Engineer. The Contractor shall dewater excavated areas as required to perform the work in such a manner as to preserve the undisturbed state of the approved subgrade and maintain proper moisture content of the fill soils.

10. Do not place fill on frozen ground unless approved by the Engineer.
11. Do not place frozen fill unless approved by the Engineer.
12. In freezing weather, a layer of fill shall not be left in an uncompacted state at the close of a day's operations.

B. Compaction Equipment and Lift Thickness

1. Compaction equipment used in open areas where space permits shall consist of single or double drum vibratory rollers weighing at least 14,000 pounds, or similar equipment approved by the Engineer. Place fill in loose lifts not exceeding 12 in. when using vibratory drum compactors. The Contractor will be given the option of demonstrating to the satisfaction of the Engineer in the field the ability to compact lift thickness up to 18 inches, loose measure.
2. In confined areas, compaction equipment shall consist of hand-guided equipment such as vibratory plate or vibratory drum compactors. Place fill in loose lifts not exceeding 6 in. when using hand guided equipment.
3. A minimum of four (4) systematic passes of the approved compaction equipment is required, unless otherwise indicated herein.
4. If the required compaction is not achieved, the Contractor shall apply additional passes, use heavier equipment, reduce lift thickness, and/or adjust moisture content as needed to achieve the minimum specified compaction.
5. The Engineer reserves the right to disapprove compaction equipment being used if it is judged to be unsuited or inadequate to compact materials to the specified densities and within a reasonable length of time.

C. Compaction Requirements:

1. All compaction requirements are based on ASTM D1557.

2. Additional compaction requirements for specific areas are as follows:

Area	Materials	Minimum Number of Coverages	Minimum Percent Compaction
Subgrade for Drainage structures, paved roadways or any Building footprint., and any other structure	Dense Graded Crushed Stone, or Existing Soils if Suitable	5	98%
Granular Fill for grading, Stone backfill surrounding temporary water diversion structure or for bedding layers at Sediment Management Areas and Construction Entrances	Granular Fill, Granular Fill for Grading Holding Basin, Crushed Stone	4	95%
Along steel sheet piles or down gradient of pipe outlets	Light Riprap	No compaction required	---
Wetland restoration areas, other loamed areas	Wetland organic soil, loam borrow	No compaction required	---
Permeable Cover, Holding Basin Fill – below 3 ft. from grade	Common Fill	4	92%
Existing Access Road Improvement and Temporary Access Roads	Dense Graded Crushed Stone	4	95%

If not otherwise indicated on the Drawings or in the Specifications, the minimum percent compaction shall be 92 percent of ASTM D1557 with a minimum of four (4) coverages, unless otherwise required by the Engineer.

3. Moisture Control
    a. If the fill is too dry for proper compaction, water shall be added to increase the moisture content, as necessary for proper compaction. If the fill is too wet for proper compaction, the material shall be processed or conditioned so that it can be compacted.
    b. No fill material shall be placed, spread, or rolled during weather conditions that prevent the Contractor from maintaining the moisture content of the fill such that the minimum compaction requirements are achieved.

c. All corrective work or operations necessary to achieve and maintain proper moisture control of fill materials shall be at the sole expense of the Contractor.

4. Protection of Fill

a. The Contractor shall take the steps necessary to avoid disturbing subgrade soils and previously placed fill during excavation and filling operations. Methods of excavation and filling operations shall be revised as necessary to avoid disturbing of subgrade and previously placed fill, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials, dewatering, and other acceptable control measures.

b. All excavated or filled areas distorted during construction, all loose or saturated soil, and other areas that do not meet compaction requirements as specified herein shall be removed and replaced with suitable materials. Costs of removal of these materials and replacement shall be borne by the Contractor.

D. Excavation, Trenching, Pipe Bedding, and Backfill

1. The Contractor shall provide temporary support to existing subsurface utilities as approved by the respective utility companies and to other facilities adjacent to or crossing through excavation at no additional cost to the Owner.
2. Trenches shall be of sufficient width for installation of pipe and utilities, and compaction of backfill materials.
3. The bottoms of trenches shall be shaped to provide uniform bearing and support of pipes and utilities.
4. Install dewatering systems, as necessary, such that the trench is continually and effectively drained.
5. Loose, saturated, or otherwise unsuitable material in the bottom of the trench shall be removed and replaced with suitable fill if required by the Engineer.
6. Open trenches shall advance no more than 50 ft ahead of installed pipe. All open trenches shall be backfilled at the end of each working day.
7. Place all bedding, filter fabric, and backfill in accordance with the Drawings and these Specifications. Compact all bedding and trench backfill materials to the specified density. All pipe bedding and backfill shall be placed in dry conditions.
8. Do not backfill trenches until tests and observations have been made and backfilling authorized by the Engineer. Use care in backfilling to avoid damage or displacement of pipe system.

E. Wetland Restoration/Replacement Areas

1. Wetland Organic Soil shall be placed within the wetlands restoration areas to the lines and grades shown on the Drawings or as determined by the Engineer during construction in accordance with Section 32 30 00 – Wetlands and Upland Restoration.

F. Riprap Installation

1. Place riprap on filter fabric using methods that will not damage the fabric.
2. Dumping of the riprap at the top of the slopes and rolling or pushing into place, or other means of placement which may result in damage to the filter fabric or segregation of the various sizes of stone, will not be permitted.
3. Should damage occur to the fabric during Riprap placement, carefully remove the Riprap and make repairs to the fabric in accordance with the manufacturer's recommendations. Make such repairs at no additional cost to the Owner.
4. Large stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified. Finished riprap shall be free from pockets of small stones and clusters of larger stones.

G. Armor Mattress and Gabion Installation

1. Refer to specification Section 31 36 00 – Armor Mattress, Gabions, and Specialty Armoring, if applicable.

3.5 DECONSTRUCTION OF TEMPORARY STRUCTURES

A. Unless otherwise indicated, at the conclusion of the Project, deconstruct the temporary access roadways, sediment dewatering areas, and temporary Dewatering Effluent Treatment System (DETS) areas. Remove fill soils and temporary structures as shown on the Drawings and in accordance with Section 01 56 00 – Temporary Barriers and Enclosures. Removing temporary shoring and bracing, and sheeting. Place and compact previously excavated soils or imported fills in order to achieve finished grades as indicated on the Drawings or to restore the area to pre-construction grades for site restoration (where applicable).

3.6 STOCKPILE MANAGEMENT

A. Soils shall be stockpiled and dewatered in accordance with the Drawings.

3.7 MANAGEMENT OF CONSTRUCTION EQUIPMENT

A. Construction equipment shall be removed from Work Areas that are adjacent to or formerly were resource areas at the end of each workday. Equipment shall be staged at the location indicated on the Drawings.

END OF SECTION

SECTION 31 36 00

GABIONS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the Work of this Section.

C. Coordinate work with that of all other trades affecting or affected by Work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Provide all facilities, labor, material, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the work specified in this Section, and as shown on the Drawings.

E. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 DESCRIPTION OF WORK

A. The work to be performed under this Section includes, but is not limited to, the following items including all labor, materials, equipment, and services incidental to mobilizing equipment, and performing gabion installation.

B. This specification covers the furnishing and installation of new wire mesh gabions. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

C. This specification also covers the removal and reuse of existing gabions, where indicated on the Drawings. Unless otherwise indicated, installation procedures for reused gabions shall be in accordance with the product manufacturer's recommendations for new gabion baskets furnished to the project. Demolition and removal of materials shall be as required to support the work.

D. Description: Gabion units shall consist of compartmented rectangular basket containers filled with stone. The required sizes of the gabion units are as shown on the Drawings or approved shop drawings submittal. Twisted or welded wire mesh shall be used. Baskets shall be fabricated from galvanized steel wire formed into a non-raveling mesh.

1.3 REFERENCE STANDARDS

A. ASTM A90: Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

B. ASTM A239: Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.

C. ASTM A641: Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire.

D. ASTM A975: Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with PolyVinyl Chloride (PVC) Coating).

E. ASTM B6: Standard Specification for Zinc.

1.4 SUBMITTALS

A. Submit the following list of documents for Owner's Representative’s review and acceptance prior to material supply.

B. Product Data: Submit manufacturer's product technical specifications, and product installation instructions.

C. Sample: Submit wire mesh samples at least 12 inches by 12 inches.

D. Certificate of Compliance: Submit written manufacturer's certificate of compliance. Manufacturer's Certificate of Compliance shall be signed by person authorized to bind the manufacturer's certifications and must have Manufacturer's name and product manufacturing location.

E. Preapproved product under these specifications is manufactured by Maccaferri Inc. (https://www.maccaferri.com/).

F. Equivalent products or any value engineering proposal using alternate product is acceptable. Submit equivalent products or any value engineering proposal using alternate product, in addition to above listed documents to the Owner and Engineer at least 14 days prior to subcontractor bid letting.

G. Test reports from a third-party test laboratory in USA to verify the product compliance with ASTM A975.

H. Mill certifications of the wire used in manufacturing the product.

I. Submit Manufacturer's Quality Control Manual along with certificate signed by person authorized to bind the manufacturer's certifications.

J. List of at least five projects where the product has been successfully installed.

K. Manufacturer shall demonstrate at least 10 years of continuous experience in manufacturing gabions, and at least 3.0 million cubic yards of gabions.

L. Shop drawings and design calculations along with test reports, signed and sealed by the Professional Engineer registered in the Commonwealth of Massachusetts.

M. The following tests shall be carried out on minimum three randomly selected field samples of lacing wire:

1. Wire thickness.
2. Tensile strength.
3. Zinc coating thickness.
4. Ring fastener individual pull apart strength.

N. Samples: Stone fill material submitted for approval prior to delivery.

O. Procedure for removing and reusing the existing gabion baskets as shown on the Drawings.

1.5 QUALITY ASSURANCE

A. A manufacturer's representative to provide reasonable installation support.

B. The Contractor shall have personnel with at least 3 years of experience installing gabions and have installed a minimum of 10,000 CY of gabions within the last three years. In case the Contractor does not meet the qualifications based on the above requirements, acquire necessary onsite training from manufacturer prior to construction or the services of a qualified gabion/mattress subcontractor must be utilized.

1.6 SITE PREPARATION

A. Elements of the work to be performed under this Section, as listed below:

1. Excavate and prepare subgrade as shown on Drawings.
2. Install geosynthetics as shown on the Drawings and approved shop drawings.
3. Prepare aggregate base to receive gabion baskets as shown on Contract Documents.

PART 2 – PRODUCTS

2.1 STEEL TWISTED WIRE MESH GABIONS

A. Gabion basket units shall be of non-raveling construction and fabricated from a double twisted hexagonal wire mesh. The size of mesh openings shall be approximately 3-1/4 in. by 4-1/2 in. (80 by 115 mm). The gabion mesh wires shall be wrapped around the selvage wire no less than 1 1/2 times and shall interconnect with adjacent mesh wires. All steel wire used shall be galvanized prior to fabrication into mesh. All gabion diaphragm and frame wire shall equal or exceed ASTM A 641 and possess soft tensile strength of 60,000 psi (415 Mpa) with a tolerance of minus 2,000 psi (14 Mpa). The galvanized wire shall have a Finish 5, Class 3, zinc coating, as indicated in ASTM A 641. The weight of coating shall be determined by ASTM A 90. The grade of zinc used for coating shall be High Grade or Special High Grade as prescribed in ASTM B 6, Table 1. The uniformity of coating shall equal or exceed four 1-minute dips by the Preece Test, as determined by ASTM A 239.

B. Steel Welded Wire Mesh Gabions: Gabion basket units shall be of non-raveling construction and fabricated from a welded square wire mesh. The size of mesh openings shall be approximately 3 in. by 3 in. (75 by 75 mm). The welded joints of the wire mesh shall conform to ASTM A 185 except that the weld shears shall be at least 600 lbs (2700 N). All gabion diaphragm and frame wire shall equal or exceed ASTM A 641 and possess soft tensile strength of 60,000 psi (415 Mpa) with a tolerance of minus 2,000 psi (14 Mpa). The galvanized wire shall have a Finish 5 Class 3 zinc coating, indicated in ASTM A 641. The weight of coating shall be determined by ASTM A 90. The grade of zinc used for coating shall be High Grade or Special High Grade as prescribed in ASTM B 6, Table 1. The uniformity of coating shall equal or exceed four 1-minute dips by the Preece Test, as determined by ASTM A 239.

C. Mesh wire shall be minimum 0.120-in. (3.05 mm) diameter after coating with 0.85 oz/sq ft (240 g/sq m) zinc coating.

D. Selvage wire shall be minimum 0.150-in. (3.80 mm) diameter after coating with 0.85 oz/sq ft (240 g/sq m) zinc coating.

E. Wire used for lacing or as internal connecting wire within basket cells shall be minimum 0.087-in. (2.21 mm) diameter after coating with 0.70 oz/sq ft (220 g/sq m) zinc coating and may have soft tensile strength designation.

2.2 FABRICATION

A. Gabions shall be manufactured and shipped with all components mechanically connected at the production facility. The front, base, back and lid of the gabions shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base. All perimeter edges of the mesh forming the basket and top, or lid, shall be selvedged with wire having a larger diameter.

B. The gabion shall be divided into cells by means of diaphragms positioned at approximately 3 ft (1 m) centers. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite.

2.3 ROCK

A. The rock used in gabions shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Gabion rocks shall range between 4 in. (0.10 m) and 8 in. (0.20 m). The range in sizes shall allow for a variation of 5% oversize and/or 5% undersize rock, provided it is not placed on the gabion exposed surface. The size shall be such that a minimum of three layers of rock must be achieved when filling the gabions. Refer to Section 31 00 00 Earthwork for additional requirements related to the import of soil and aggregates for earthwork. Existing rock inside the Gabions currently in-place on site is acceptable rock to be reused in new Gabions.

PART 3 – EXECUTION

3.1 DISASSEMBLY AND REUSE

A. For gabions proposed for reuse on the Drawings, develop and execute work plan prepared by Contractor as reviewed and accepted by the Engineer.

3.2 ASSEMBLY

A. Gabions are supplied folded flat and packed in bundles. The units shall be assembled individually by erecting the sides, ends, and diaphragms, ensuring that all panels are in the correct position, and the tops of all sides are aligned. The four corners shall be connected first, followed by the internal diaphragms to the outside walls. All connections should use lacing wire or fasteners as previously described in Paragraph 2.1.D and Paragraph 2.1.E.

B. The procedure for using lacing wire shall consist of cutting a sufficient length of wire, and first looping and/or twisting to secure the lacing wire to the wire mesh. Proceed to lace with alternating double and single loops through every mesh opening approximately every 6 in. (150 mm), pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting. The use of fasteners shall be in accordance with the manufacturer’s recommendations and as specified in Paragraph 2.1.E.

3.3 INSTALLATION

A. After initial assembly, the gabions shall be carried to their final position and securely joined together along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described in Paragraph 3.2. Whenever a structure requires more than one layer, the upper empty baskets shall also be connected to the top of the lower layer along the front and back edges of the contact surface using the same connecting procedure(s) described in Paragraph 3.2.

3.4 FILLING

A. Gabions shall be filled with rock meeting the requirements specified in Paragraph 2.3. During the filling operation some manual stone placement is required to minimize voids. The exposed faces of vertical structures shall be carefully hand placed to give a neat, flat, and compact appearance. Care shall be taken when placing fill material to ensure that baskets are not damaged.

B. The cells shall be filled in stages so that local deformation is minimized. That is, at no time shall any cell be filled to a depth exceeding 1-foot (0.30 m) higher than the adjoining cell. Overfill baskets as necessary to allow for rock settlement. Behind gabion walls, compact the backfill material simultaneously to the same level as the filled gabions.

3.5 INTERNAL CONNECTING WIRES

A. Internal Connecting Preformed Stiffeners (e.g., MacTie) or lacing wire shall be used as internal connecting wires when a structure requires more than one layer of gabions to be stacked on top of each other. Internal Connecting Wires with lacing wire shall connect the exposed face of a cell to the opposite side of the cell. Internal Connecting Preformed stiffeners shall connect the exposed face of a cell to the adjacent side of the cell. Preformed stiffeners shall be installed at 45° to the face/side of the unit, extending an equal distance along each side to be braced (approximately 1 ft. (300 mm)). An exposed face is defined as any side of a gabion cell that will be exposed or unsupported after the structure is completed.

B. 3 feet (1 m) high gabions: 3 feet (1 m) high gabions shall be filled in three layers, 1 foot (300 mm) at a time. Connecting wires/bracings shall be installed after the placement of each layer, that is, at 1 foot (300 mm) high and 2 feet (600 mm) high.

C. 1.5 feet (0.5 m) high gabions: 1.5 feet (0.5 m) high gabions do not require connecting wires/bracings unless the baskets are used to build vertical structures. In some cases, these units shall be filled in two layers, 9 in. (230 mm) at a time. Connecting wires shall be installed after the placement of the first layer, which is at 9 in. (230 mm) high.

3.6 LID CLOSING

A. Once the gabion baskets are completely full, the lids shall be pulled tight until the lid meets the perimeter edges of the basket. A tool such as a lid closer may be used. The lid shall then be tightly laced and/or fastened along all edges, ends and tops of diaphragm(s) in the same manner as described in Paragraph 3.2.

3.7 MESH CUTTING AND FOLDING

A. Where shown on the Drawings or otherwise directed by the Owner, the gabions shall be cut, folded, and fastened together to suit site conditions. The mesh must be cleanly cut and surplus mesh either folded back or overlapped so that it may be securely fastened together with lacing wire or fasteners in the manner described in Paragraph 3.2. Any reshaped gabions shall be assembled, installed, filled, and closed as specified in the previous sections.

END OF SECTION

SECTION 32 30 00

WETLANDS AND UPLAND RESTORATION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Coordinate work with that of all other trades affecting or affected by the Work of this Section. Cooperate with such trades to assure the steady progress of work under the Contract.

D. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

E. The Work described in the Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.2 REFERENCES

A. See Specification Section 01 11 00 – References for acronyms and definitions applicable to this Section.

1.3 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. SECTION 01 33 00 – Submittal Procedures

C. SECTION 01 57 00 – Temporary Erosion and Sediment Controls

D. SECTION 01 57 19 – Environmental Controls

E. SECTION 02 21 00 – Surveys

F. SECTION 02 22 00 – Existing Conditions

G. SECTION 31 00 00 – Earthwork

H. Drawings

I. Other Sections of the Specifications, not referenced above, shall also apply to the extent required for proper performance of the Work.

1.4 DESCRIPTION OF WORK

A. The Work of this Section includes, but is not limited to:

1. Furnishing and installing new wetland and upland areas including, without limitation: fabric materials, stones, soils, grading, plantings, erosion control measures, seeding, and structural habitat features.
2. Protection, maintenance, replacement of defective work, and certification and approval of finished products.

1.5 EXISTING CONDITIONS

A. See Specification Section 01 11 00 – Summary of Work and SECTION 02 22 00 – Existing Conditions for information regarding site conditions.

1.6 QUALITY ASSURANCE

Not Used

1.7 COORDINATION

A. Coordinate earthwork and erosion controls to determine when wetland replacement and restoration, as described in the section, may proceed.

B. Assure erosion control measures are in place as described in Section 01 57 00 -Temporary Erosion and Sedimentation Controls, prior to commencing work.

C. The timing and sequence of seeding is dependent on a number of factors, including the type of seed, hydrologic regime, and the construction schedule, as described in Section 1.8.C, below.

1.8 CONSTRUCTION SEQUENCE

A. Place erosion control measures around the wetland and upland work area to be reconstructed, as required.

B. Follow the construction sequencing in the Contractor's approved Construction Sequence Plan. In general, construction will proceed from upstream to downstream for the project Work Areas if applicable.

C. Each Work Area has its own construction sequence and the scope of wetland (if applicable) and upland restoration varies as shown on the Drawings.

D. The window of time available for wetland seeding is dependent on the type of seed, hydrologic conditions such as the elevation of the water in wetlands adjacent to the Work Areas, and the construction schedule. Preferred and alternate seeding times are provided in these Specifications and/or the Drawings. These planting seasons are subject to modifications, based on the construction schedule and/or hydrologic conditions. Therefore, the Contractor shall coordinate with the Engineer and Owner to determine if seeding is done following construction or the following spring season.

E. The Contractor's construction sequence shall eliminate the need to travel (by pedestrian, vehicle, and equipment) across the finish surface materials of the seeded sections of wetland or upland areas except for hand tools and personnel as may be necessary for seeding purposes, repair, and maintenance.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Materials:

1. Deliver packaged materials to the site in original, unopened containers, showing weight, manufacturer's name, and guaranteed analysis.
2. Store materials in a manner that their effectiveness and usability will not be diminished or destroyed. Materials shall remain uniform in composition, dry, unfrozen and free flowing. Any material that has become caked or otherwise damaged or does not meet the specified requirements will be rejected.

B. Plants:

1. The plants required for specific locations are shown on the Drawings.

1.10 SUBMITTALS

A. Submit results of tests verifying that the Wetland Soil Mixture contains at least 12 percent by weight of organic material and other tests and submittals required for earth materials as per Section 31 00 00 - Earthwork.

B. Submit manufacturers' material specifications for seed, fertilizer, and hydroseed mixture as appropriate.

C. Certificates of Compliance:

1. Submit manufacturer's Certificate of Compliance to the specifications with each shipment of each type of seed. The certificates shall include the guaranteed

percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. Seed shall not be sown prior to submittal of the certificates.

2. Submit a certified statement for the hydroseed mix to be used to include the amounts of seed and processed fiber per 100 gallons of water. The statement shall also include the amounts and type of seed mixture used.

PART 2 - PRODUCTS

2.1 EARTH MATERIALS

A. Wetland Organic Soils: As defined in Section 31 00 00 - Earthwork.

B. Loam: As defined in Section 31 00 00 - Earthwork.

C. Leaf Mold: Leaf mold shall be a highly organic dark brown to black spongy residue resulting from the well aerated composting of deciduous tree parts, free of plants and their roots, debris or other extraneous matter and shall be uncontaminated by foreign matter and substances harmful to plant growth. The organic matter shall not be less than 85 percent by weight.

D. Earth materials used for wetland restoration, including but not limited to, wetland organic soil, loam, leaf mold, shall not be harvested from an area that contained invasive species plant parts (seed, rhizomes, etc.) or contain any materials with invasive plant parts present that are capable of reproducing.

2.2 FERTILIZER

A. Fertilizer may be used for upland planting but not in wetlands areas. Fertilizer used for seeding shall contain the following percentage of available plant food by weight: 12 percent nitrogen, 6 percent potash, or similar concentrations as approved.

B. For all fertilizers, at least 50 percent of available nitrogen shall be in a slow-release form as is found in certain urea-formed products, or natural organic forms, or a combination of both. Exact percentages of the fertilizer components may vary in accordance with the soil test report.

2.3 FABRIC MATERIALS AND STAKES

A. Coir Logs shall be North American Green Sedimax – FR (Filter Rolls) as described in Section 01 57 00 - Temporary Erosion and Sedimentation Controls.

B. Wood stakes. Pine, oak or fir, 1 in. by 1 in. by 3 ft long, used for marking limits of planting areas.

2.4 PLANT MATERIALS

A. Wetland Seed Mix:

1. The Wetland Seed Mix shall conform at a minimum to the New England Wetland Plants, Inc. New England Wetmix (Wetland Seed Mix).

2. Seed mix shall be fresh, clean, dry, new-crop seed. Weed seed content shall not exceed 1 percent. The Seed Mix shall be as follows:

- The seed mix will be New England Wetmix (New England Wetland Plants, Inc.)
- Seed mixture to be applied throughout the entire wetland restoration area at rate of 1 pound per 2,500 square feet (18 pounds per acre)

B. Upland Seed Mix:

1. Seed mix shall conform to seed mix shown on Drawings.

C. Plantings

1. Provide plant, shrub, tree, and other vegetation types as listed on the Drawings, and listed below:

Herbaceous Plug Plantings:

- Plug plantings will be installed as 2-inch plugs within Area A.
- A total of 750 plug plantings will be planted with an average spacing of approximately 3 feet on center.
- Plug plantings will be selected from the species listed below based on availability at the time of planting. A minimum of four species will be used for the plug plantings.

Common Name	Scientific Name
Lurid Sedge	*Carex lurida*
Broom Sedge	*Carex scoparia*
Tussock Sedge	*Carex stricta*
Canada Rush	*Juncus canadensis*
Soft Rush	*Juncus effusus*
Northern Arrowhead	*Sagittaria latifolia*
Arrow Arum	*Peltandra virginica*

Common Name	Scientific Name
Green Bulrush	*Scirpus atrovirens*
Woolgrass	*Scirpus cyperinus*
Broad-leaved Cat ail	*Typha latifolia*

Woody Plantings:

- Woody plantings will be planted as 18-24” specimens (at minimum).
- A total of 130 shrubs will be planted, with an average spacing of approximately 10 feet on center in Area A and 8 feet on center in Area B.
- Shrub species will be selected from the species listed below based on availability at the time of planting. A minimum of four (4) species will be used for the shrub plantings.

Common Name	Scientific Name
Black Chokeberry	*Aronia melanocarpa*
Highbush Blueberry	*Vaccinium corymbosum*
Sheep Laurel	*Kalmia angustifolia*
Rhodora	*Rhododendron cana-dense*
Leatherleaf	*Chamaedaphne calycu-lata*
Red maple	*Acer rubrum*

2. Substitutions for species described on the Drawings must have Engineer’s approval.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Equipment to be used shall be in clean condition prior to entering the work area such that no mud containing invasive seeds or other plant parts capable of reproducing are inadvertently brought onto the site.

3.2 PLACEMENT OF COIR ROLLS

A. Following earthwork activities, place and anchor Coir (Coconut fiber) Rolls as shown on Drawings and in accordance with manufacturer's recommendations.

B. Where indicated on the Drawings, backfill areas upslope of the Coir Rolls with Wetland Organic Soil.

3.3 APPLY WETLAND ORGANIC SOIL TO SUBGRADE

A. Wetland Organic Soil. Apply Wetland Organic Soil to subgrade in thickness as shown on the Drawings.

1. Preserve any "pit and mound" topography of the subgrade into the finish grade of the Wetland Organic Soil.
2. Lightly spread the soil mixture into place, but do not compact.
3. Once placed, do not traverse the soil with equipment or vehicles.
4. Place the Wetland Organic Soil on the slopes to the lines shown on the Drawings, preserving the subgrade elevations between the various wetland sections identified on the Drawings.

3.4 APPLY LOAM TO SUBGRADE IN UPLAND AREAS

A. Apply loam to subgrade in a thickness as per the Drawings.

3.5 STRAW WATTLES AND BALES

A. Straw wattles and bales shall be in accordance with Section 01 57 00-Temporary Erosion and Sedimentation Controls. No invasive plant parts shall be used in the straw wattles and bales.

3.6 SEEDING

A. Wetland areas specified on Drawings shall be seeded after initial planting. Seeding shall be performed between April 15 and May 31, or August 31 and October 15. No seeding is permitted when flooded or inundated conditions exist.

B. Where the seedbed has become compacted, it shall be scarified to a depth of 3 in. prior to fine raking. No seeding will be permitted on areas where the seedbed has not been properly prepared or where the soil is compacted.

C. Seed mixture shall be spread directly on the surface of the Wetland Organic Soil prior to placement of erosion control blankets, using the methods described below.

D. The application rate shall conform to the recommended guidelines published by the manufacturer (or as provided in the Drawings). Because the wetland seed is very fine, a bulking material such as vermiculite may be mixed with this seed to achieve the application rate. A Culti-packer or approved equal equipment may be used to cover the seed and to form the seedbed in one operation. Otherwise, seed shall be lightly raked into the soil to a depth of between 1/8 in. to 1/4 in., and the entire seeded area shall be rolled with a light roller. In upland areas having slopes of 3:1 or steeper, and in drainage swales, the Contractor shall overseed immediately after sowing the specified seed mix. Overseeding shall be sown at the rate of 3 pounds per 1,000 sq ft.

E. Hydroseeding slurry shall contain seed at the recommended application rates published by the manufacturer, or as provided in the Drawings. Wood cellulose fiber mulch shall be included in the hydroseeding slurry to achieve an application rate of 2 tons per acre. The hydroseeding slurry for upland seeding shall contain fertilizer at a rate of 850 pounds per acre. The slurry shall be mixed and kept in an agitated state so the materials are uniformly suspended in the water. The slurry shall be applied evenly over the area to be seeded by an operator thoroughly familiar with this type of seeding operation.

3.7 PLANTING

A. Planting materials in each area shall be as shown on the Drawings.

B. Prior to commencing plantings, provide plant materials to Engineer or Owner for inspection and approval.

C. Planting Season:

1. Between May 1 and June 15; OR
2. Between September 1 and October 15.

D. Planting Holes.

1. Holes shall be of sufficient width and depth to allow easy placement of the plant at a depth that is one inch deeper into the soil than it was grown at the nursery.
2. If the root system is container bound, the roots shall be carefully freed, separated, and spread out such that the roots can grow without further constriction.
3. Backfill the plant hole with the excavated soil by layer type and tamp firmly to remove large air pockets and soil voids.
4. If a soil depression is formed up slope of or adjacent to the planting, slough and tamp enough soil from the surrounding area into the depression to leave a level surface with the surrounding area.

3.8 MAINTENANCE

A. Begin maintenance immediately after planting is completed.

B. Maintenance shall include, but may not be limited to, watering, weeding, re-seeding, pruning, disease and pest control, protection from herbivory, re-mulching, removal of dead and dying plantings, resetting to proper grades and upright positions, repair of erosion damage, repairing structural habitat features, replacing unacceptably growing plants, and any other procedures consistent with good horticultural practice required to ensure normal, vigorous, and healthy growth of wetland plantings.

C. Wetland restoration areas shall be protected at all times against trespassing and damage of all kinds for the duration of the maintenance period. If any plants become damaged or injured, they shall be treated or replaced as directed at no additional cost to the Owner.

D. Replace damaged and non-growing plantings as soon as they are discovered, provided it is within the planting season.

E. Water plantings as needed to promote growth and vitality.

F. Maintenance period shall be a minimum of sixty (60) days from date of completion of all plantings, or until conditional approval of all plants, whichever is greater.

3.9 FINAL WETLAND RESTORATION APPROVAL AND ACCEPTANCE

A. Final acceptance criteria for wetland restoration areas are a minimum 75 percent overall vegetative growth coverage within two (2) years. This vegetative coverage may be achieved as a result of seeding installed under this section of the specifications.

B. As-built plans shall be generated by the Contractor following the completion of the construction of the wetland. These plans must show any construction modifications that were approved by the Engineer or Wetland Scientist. If there were no such modifications, then original plans and specifications should be labeled "AS-BUILT – NO MODIFICATIONS – CONSTRUCTED AS DESIGNED AND SPECIFIED."

C. The Contractor shall not request a final inspection of the wetland replacement and restoration activities before one (1) year from the date of conditional approval. The request shall be made in writing at least ten (10) days prior to the anticipated date.

D. After inspection, the Contractor will be notified in writing of any deficiencies of the requirements for completion of the work. If any plant materials are found dead or not in a healthy flourishing condition, they shall be replaced at no additional cost to the Owner. Plants shall be replaced at no additional cost to the Owner. Plants shall be replaced during the normal planting season. Replacement plant materials shall be of the same size and species. The Wetland Scientist shall be given sufficient notice of the installation of the replacement plants to allow an inspection of the plant material.

E. If additional seeding is required, the Contractor will be notified in writing of the nature and location of the deficiency. Acceptance shall be given for the entire portion of the seeded areas; no partial acceptance will be given. Seeded areas shall exhibit a uniform, thick, well-developed stand of herbaceous cover. Bare spots shall not exceed 4 in. in diameter, or comprise more than 2 percent of the total area of the planting zone. Seeded areas shall not exhibit signs of damage from erosion, washouts, gullies, or other causes. Unacceptable areas shall be reseeded at no additional cost to the Owner. Reseeding shall be performed during the normal seeding season (as specified herein). Replacement seed mixtures shall be of the same size and species.

END OF SECTION

SECTION 33 29 00

WELL ABANDONMENT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Attention is directed to the GENERAL CONDITIONS OF THE CONTRACT and all sections of Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

E. The Work described in these Contract Documents will be performed at a Superfund site. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soil, sediment, surface water, groundwater, and other media (contaminated media). The Engineer should be notified of the presence of potentially hazardous conditions, if encountered.

F. The Contractor shall at times be solely responsible for exercising reasonable precaution to protect the health, safety, public welfare, and all on-site personnel, and the environment during performance of the Work described in these Contract Documents. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

1.3 RELATED SECTIONS

A. SECTION 01 11 00 – Summary of Work

B. SECTION 01 35 29 – Health and Safety Requirements

C. SECTION 31 00 00 – Earthwork

D. Drawings

1.4 SUBMITTALS

A. The following items are to be submitted:

1. Well decommissioning shall be performed by a registered well driller in Massachusetts or a person knowledgeable with the installation of wells. Submit the name and experience of qualified well abandonment subcontractor or, if self-performed by the Contractor, the personnel, qualifications, and description of their prior well abandonment experience.
2. Schedule for completing the work described in this specification. Schedule must indicate the timing in relation to other construction activities planned in the work area.
3. Documentation in the form of purchase records or similar for the materials, including but not limited to cement, bentonite, admixtures, used in well abandonment.
4. Submit complete well abandonment/decommissioning records.

1.5 DESCRIPTION OF WORK

A. Decommission or abandon groundwater monitoring wells to permanently decommission the subsurface monitoring device designed for abandonment in Table 332900-1.

B. Protect in place subsurface monitoring devices designated for protection in Table 332900-1. If wells are damaged during construction, then the Contractor is responsible for replacing them.

C. The work for abandoning select site groundwater monitoring wells generally consists of:

1. Preparing submittals
2. Removing Protective casing and existing surface seal
3. Pulling Well casing material where possible
4. Tremie pressure grouting well borehole
5. Installing cement-bentonite surface seal
6. Containerizing debris from abandonment activities
7. Coordinating disposal of debris

PART 2 – PRODUCTS

2.1 MATERIALS

A. Cement-Bentonite Grout (smooth cement/bentonite/water mixture). Mixture must be free from lumps and uniform throughout. A thick viscous mix consisting of 5 to 7.5 gallons of water per 94-lb bag Type I Portland cement and 2% to 10% powdered bentonite (percent addition based on dry weight of cement). The use of potentially hazardous materials to decrease or increase grout viscosity (e.g., kerosene) is prohibited.

B. Portland Cement (Type I)

C. Powdered Bentonite (pulverized bentonite 200-mesh screen)

D. Water, potable

E. Concrete for surface seal

PART 3 – EXECUTION

3.1 GENERAL

A. Monitoring wells within excavation or other work areas that are designated for abandonment in Table 332900-1 shall be abandoned in accordance with the procedure in Section 3.3 prior to the work. For wells in excavation areas, the concrete plug during abandonment shall be established 2 to 4 feet below the depth of excavation at that location. For wells outside of excavation areas, the concrete plug will be established at 2 to 4 ft below ground surface.

B. Monitoring wells within excavation or other work areas that are designated for protection in Table 332900-1 shall be protected with cones, concrete blocks, or other measures managed by the Contractor prior to the work. If wells are damaged during construction, then the Contractor is responsible for replacing them.

Table 332900-1

Well Identification	Bedrock or Overburden	AOI or Area	Surface Completion	Total Depth (feet below ground surface)	Casing Riser Diameter (inches)	Casing/Riser Material	Abandon or Protect	Notes
MW-S20	Overburden	Landfill	Standpipe	29	2	PVC	Protect-Medium Priority	Not a priority if HA-CMT-5S/5I and HA20-CMT-6S are retained
MW-S19	Overburden	Landfill	Standpipe	49	2	PVC	Protect-Medium Priority	Not a priority if CMT-6S and MWS21 are retained
PW-6	Overburden	South of Holding Basin	Standpipe	55	2.5	Steel	Protect – Low Priority	Not a priority if CMT-1S/I and CMT-6S are retained
HA-10	Overburden	South of Holding Basin	Flushmount	48	2	PVC	Abandon	Not usable for Geosyntec monitoring
HA-10A	Overburden	South of Holding Basin	Flushmount	47.6	2	PVC	Protect – Low Priority	Not a priority if MW-S12 is retained
PZ-RI-S03	Overburden	Cooling Pond	Unknown	Unknown	Unknown	Unknown	Protect – Low Priority	Geosyntec does not have records of well

Well Identification	Bedrock or Overburden	AOI or Area	Surface Completion	Total Depth (feet below ground surface)	Casing Riser Diameter (inches)	Casing/Riser Material	Abandon or Protect	Notes
TW-4	Overburden	Cooling Pond	Standpipe	Unknown	3	Steel	Abandon	Not usable for Geosyntec monitoring
PW-4	Overburden	Cooling Pond – Bog Area	Standpipe	6	2.5	Steel	Protect – Low Priority	
TPZ-RI-02	Overburden - Unknown	Southern Cooling Pond	Unknown	Unknown	Unknown	Unknown	Protect if Existing	Suspected to be temporary Piezometers, could be used to delineate DU plume if existing
TPZ-RI-01	Overburden - Unknown	Southern Cooling Pond	Unknown	Unknown	Unknown	Unknown	Protect if Existing	
PZ-RI-S05	Overburden - Unknown	Southern Cooling Pond	Unknown	Unknown	Unknown	Unknown	Protect if Existing	
PZ-RI-S06	Overburden - Unknown	Southern Cooling Pond	Standpipe	64	Unknown	Unknown	Protect if Existing	Not monitored to knowledge of Geosyntec, last water level measurement record from 2013
MW-S07	Overburden	Northern Courtyard	Flushmount	69	2	PVC	**Protect – Highest priority**	Bounds DU plume to the north
MW-S17	Overburden	North of Building D	Flushmount	66	2	PVC	**Protect – Highest priority**	Directly outside of Building D Work Area
MW-SD17	Overburden	North of Building D	Flushmount	86	2	PVC	**Protect – Highest priority**	Directly outside of Building D Work Area
MW-BS17	Bedrock - Shallow	North of Building D	Flushmount	109.8	2	PVC	**Protect – Highest priority**	Directly outside of Building D Work Area
MW-S27	Overburden	West of Building D	Flushmount	134	2	PVC	Protect – Low Priority	Should be utilized as a concentration as <RL for future 1,4-D plume contours even if not replaced moving forward
MW-SD27	Overburden	West of Building D	Flushmount	82	2	PVC	Protect – Low Priority	
MW-SD30	Overburden	West of Building D	Flushmount	82	2	PVC	**Protect – Highest priority**	Needed to bound 1,4-dioxane plume and uranium sampling
MW-S30	Overburden	West of Building D	Flushmount	62	2	PVC	**Protect – Highest priority**	

Well Identification	Bedrock or Overburden	AOI or Area	Surface Completion	Total Depth (feet below ground surface)	Casing Riser Diameter (inches)	Casing/Riser Material	Abandon or Protect	Notes
MW-S23	Overburden	South of B Buildings	Standpipe	50	2	PVC	Protect – Low Priority	
MW-S09	Overburden	In between Buildings B and E	Flushmount	61	2	PVC	Protect – Low Priority	
MW-T10	Overburden	Southeast of Building E	Standpipe	80	2	PVC	**Protect – Highest Priority**	Needed for 1,4-dioxane bounding
MW-SD10	Overburden	Southeast of Building E	Standpipe	64.3	2	PVC	**Protect – Highest Priority**	Needed for 1,4-dioxane bounding
MW-BS10	Bedrock - Shallow	Southeast of Building E	Standpipe	108.5	2	PVC	**Protect – Highest Priority**	For monitoring of bedrock pumping
SW-2A	Bedrock - Deep	Southeast of Building E	Standpipe	537	Unknown	Unknown	**Protect – Highest Priority**	Very deep, could be expensive to replace
MW-S16	Overburden	Courtyard/ Pump House area	Flush-mount	78.8	2	PVC	Protect – High Priority	
MW-S60	Overburden	Courtyard/ Pump House area	Flush-mount	63	Unknown	Unknown	Protect – Medium Priority	
MW-SD60	Overburden	Courtyard/ Pump House area	Flush-mount	79	Unknown	Unknown	Protect – Medium Priority	
MW-BS7-2	Bedrock	Courtyard/ Pump House area	Unknown	Unknown	Unknown	Unknown	Protect – High priority	
GZW-7-1	Overburden	Courtyard/ Pump House area	Standpipe	122	1.5	BarCad	Protect – High Priority	
GZW-7S	Overburden	Courtyard/ Pump House Area	Flush-mount	71	2	PVC	Protect – Low Priority	
MW-S62A	Overburden	Courtyard Restricted Area for Excavation	Standpipe	68	Unknown	Unknown	Protect – Medium priority	
MW-SD62A	Overburden	Courtyard Restricted Area for Excavation	Standpipe	83	Unknown	Unknown	Protect – Medium priority	
MW-8A	Overburden	Courtyard Restricted Area for Excavation	Flush-mount	70	2.5	PVC	**Protect – Highest priority**	

Well Identification	Bedrock or Overburden	AOI or Area	Surface Completion	Total Depth (feet below ground surface)	Casing Riser Diameter (inches)	Casing/Riser Material	Abandon or Protect	Notes
MW-SD61	Overburden	Courtyard Restricted Area for Excavation	Standpipe	82	Unknown	Unknown	Protect – High priority	
MW-S63	Overburden	Courtyard Restricted Area for Excavation	Flushmount	70	2” PVC, 8” casing	PVC	Protect – Low priority	
MW-SD63	Overburden	Courtyard Restricted Area for Excavation	Flushmount	83	2” PVC, 8” casing	PVC	Protect – Low priority	
MW-S05	Overburden	Courtyard Area	Flush-mount	73	2	PVC	Protect – High priority	
BEW-1	Bedrock	Courtyard Area	Standpipe	175.4	Unknown	Unknown	**Protect – Highest priority**	
MW-S24	Overburden	Courtyard/ Pump House Area	Flush-mount	65	2	PVC	**Protect – Highest priority**	
MW-SD24	Overburden	Courtyard/ Pump House Area	Flush-mount	95	2” PVC, 6” casing	PVC	Protect – High priority	
MW-T24	Overburden	Courtyard/ Pump House Area	Flush-mount	91	2	PVC	Protect – High priority	
HB-12	Overburden	Western Holding Basin Area	Flush-mount	57	2	PVC	Protect – High priority	
HBPZ-2R	Overburden	Western Holding Basin Area	Flush-mount	52.5	2	PVC	Protect – High priority	
HB-07	Overburden	Western Holding Basin Area	Standpipe	75.3	1.5	PVC	Protect – Low priority	
HB-620	Overburden	Western Holding Basin Area	Flush-mount	55	2	PVC	Protect – High priority	
MW-11	Overburden	Western Holding Basin Area	Standpipe	65	2	PVC	Protect – Low priority	
HB-10	Overburden	Eastern Holding Basin Area	Standpipe	65	2	PVC	Protect – High priority,	If CMT-6 is kept, HB-10 can be abandoned
HB-10S	Overburden	Eastern Holding Basin Area	Flush-mount	42	2.5	PVC	Protect – Low priority	
MW-S18	Overburden	Eastern Holding Basin Area	Standpipe	30	2	PVC	Protect – Low priority	
HA20-CMT-1	Bedrock	Southern Holding	Standpipe	94.8	6	Steel	Protect – High	

Well Identification	Bedrock or Overburden	AOI or Area	Surface Completion	Total Depth (feet below ground surface)	Casing Riser Diameter (inches)	Casing/Riser Material	Abandon or Protect	Notes
		Basin Area					priority	
HA20-CMT-2	Bedrock	Southern Holding Basin Area	Standpipe	135.6	6	Steel	Protect – High priority	
HA20-CMT-3	Bedrock	Western Holding Basin Area	Standpipe	143.4	6	Steel	Protect – High priority	
HA20-CMT-4	Bedrock	Northern Holding Basin Area	Standpipe	111.4	6	Steel	Protect – High priority	
HA20-CMT-5	Bedrock	Eastern Holding Basin Area	Standpipe	129.6	6	Steel	Protect – High priority	
HA20-CMT-6	Bedrock	Northern Holding Basin Area	Standpipe	126.5	6	Steel	Protect – High priority	
HB-9	Overburden	Northern Holding Basin Area	Flush-mount	76.5	2	PVC	Abandon	
HB-11	Overburden	Northern Holding Basin Area	Flush-mount	57	2.5	PVC	Abandon	
HB-13	Overburden	Central Holding Basin Area	Standpipe	40	2	PVC	Protect – Low Priority	
MW-S02	Overburden	Building A Area	Flush-mount	67	2	PVC	Protect – High Priority	
MW-SD02	Overburden	Building A Area	Flush-mount	95	2	PVC	Protect – High Priority	
MW-BS02	Bedrock	Building A Area	Flush-mount	127.5	2	PVC	**Protect – Highest Priority**	
BEW-2	Bedrock	Building A Area	Steel Casing Standpipe, Royer Locking Cap	227	7	Steel Casing	**Protect – Highest Priority**	
MW-S03	Overburden	Building A Area	Flush-mount	60.5	2	PVC	Protect – High Priority	
MW-BS03	Bedrock	Building A Area	Flush-mount	140.5	2	PVC	**Protect – Highest Priority**	
MW-BM03	Bedrock	Building A Area	Flush-mount	167	2	PVC	**Protect – Highest Priority**	

3.2 EQUIPMENT

A. Drill rig equipped with pump, grout tub, various hand tools, hoses, tremie wands etc.

B. Mixer, cement, or grout plant

C. Ruler, engineer's 6 ft. folding

D. Scale, engineer's

E. Graduated Tape, 100 ft. length, with weighted end

F. Water Level Indicator, Slope Indicator brand or equivalent

G. Logs & Forms

H. Site Plan Drawing(s), Maps, Boring and Well Installation Logs

I. Calculator

J. Sample jars and labels

3.3 PROCEDURE

A. Locate Well. Locate the subject well in the field, using Drawings, sketches, fixed references or other available documentation. Verify well designation, particularly individual wells located in closely spaced well clusters or well nests. If necessary, verify and document the location of the well to be decommissioned, referenced by taped distance to three fixed features, or acquire coordinates using global positioning system (GPS) methods or by instrument survey.

B. Evaluate Well Integrity and Construction.

1. Evaluate and document condition of protective well casing and surface seal (padlock missing/broken, well cap missing, staining on well riser observed, concrete surface seal cracked, surface runoff entering well, etc.). Record well construction material (stainless-steel, PVC, fiberglass, galvanized steel, black carbon steel, etc.). Measure well diameter, depth to water, and depth to bottom of well using water level indicator and a weighted graduated tape (the water-level indicator should not be used to sound the depth of the well as the electric probe can be damaged over time if it is repeatedly submerged). Verify information on the respective well record, if available, and note any discrepancies. If well logs are not available, determine screen length and depth, if possible, to determine whether the well construction will provide useful data.
2. Evaluate obstructions present within the well or material accumulated in bottom of well. The presence of an obstruction or a significant amount (0.5 ft. or greater) of accumulated materials (i.e., silt) in bottom of well shall be removed prior to sealing or over-drilling to remove the obstruction and well materials.
3. Remove and discard any dedicated groundwater sampling devices, including

dedicated pump tubing and foot valves, if present.

C. Calculate Volume of Cement-Bentonite Grout Needed. To assure the well is properly plugged and sealed, calculate the estimated volume of cement-bentonite grout required to fill or exceed the volume of hole to be plugged. For wells in excavation areas, the well shall be grouted at 2 to 4 feet below the depth of excavation at that location. For wells outside of excavation areas, the well shall be grouted at 2 to 4 ft below ground surface.

D. Remove Protective Casing. Remove and either properly dispose protective casing or set aside for re-use (where applicable).

E. Remove Riser and Screen. Attempt to remove well screens and risers by pulling. If not possible, tremie grout the well from the bottom up according to the procedure below.

F. Tremie Pressure Grouting

1. Prepare smooth cement/bentonite/water mixture (Cement-Bentonite Grout).
2. Obtain a representative sample of the cement-bentonite grout mix. Label sample container appropriately, indicating date, project number, work area, boring/well designation, water/cement ratio and additives. Provide grout sample to Engineer.
3. Visually inspect grout tremie hose and ensure it is equipped with a side discharge end pipe (tremie “wand”). Overly flexible hoses that kink, are unable to reach the bottom of the well, or constrict grout flow are not acceptable.
4. Lower grout pipe or tremie hose into the well riser until the bottom is reached, and pump the grout mix down into the well. Continue to pump grout mix into the borehole until the water present in the well riser is evacuated and the grout mix is flowing out at the ground surface. In no circumstances is the grout to be placed by pouring or dumping down the well riser or open borehole (i.e., in cases where the well materials can be pulled from the borehole).
5. Groundwater displaced from the borehole requires containment due to its water quality. If an on-site water treatment system capable of treating the extracted groundwater is available or otherwise part of the Contractor’s work scope, containerize and treat groundwater in the on-site treatment system unless indicated otherwise by the Engineer. If no on-site treatment system is available or as directed by the Engineer or SD Representative, containerize the water for proper off-site disposal.
6. If the well screen and riser was not pulled (or over-drilled, if applicable), expose and remove the upper three (3) to (4) feet of well riser at the ground surface. Remove existing protective casings or guard pipes and concrete surface seal, if not previously removed.
7. Additional grout batches may be required. Each additional batch shall be consistent with the original grout batch. Document total quantity of grout used in decommissioning.
8. Remove the grout pipe (or the tremie hose). Immediately top off the borehole or split well screen and riser with additional grout to approximately 2 to 4 ft below the depth of excavation for wells in excavation areas. For wells outside of excavation areas, the well shall be grouted at 2 to 4 ft below ground surface.

9. Clean and flush all equipment used in the grouting/sealing procedure with clean water, including grout mixer, grout tub, pump, hoses, tremie wand, hollow stem augers or other drilling tools.
10. Top off decommissioned well borehole with a minimum of two (2) ft thick concrete plug installed and tamped at a depth of approximately 2 to 4 feet below the depth of excavation within excavation areas. For wells outside of excavation areas, the plug shall be established at 2 to 4 ft below ground surface. Grade disturbed soils to promote rainwater runoff away from decommissioned well location.
11. Check the grouted borehole during the subsequent 24-hour period for signs of settlement, and top off with additional cement to ground surface.
12. Restore surface.
13. Complete documentation, including but not limited to well decommissioning records.

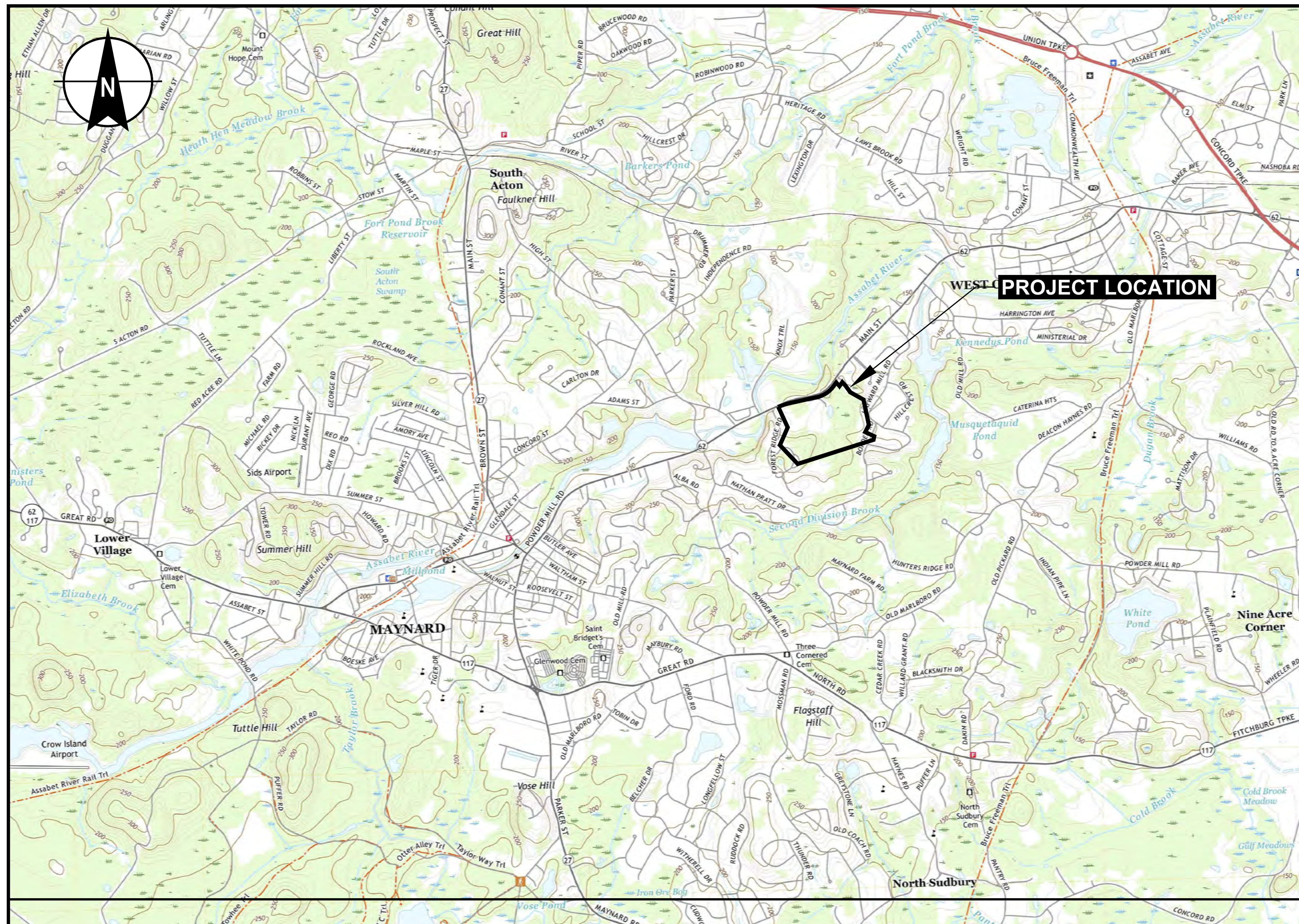
PART 4 – MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

ATTACHMENT A2

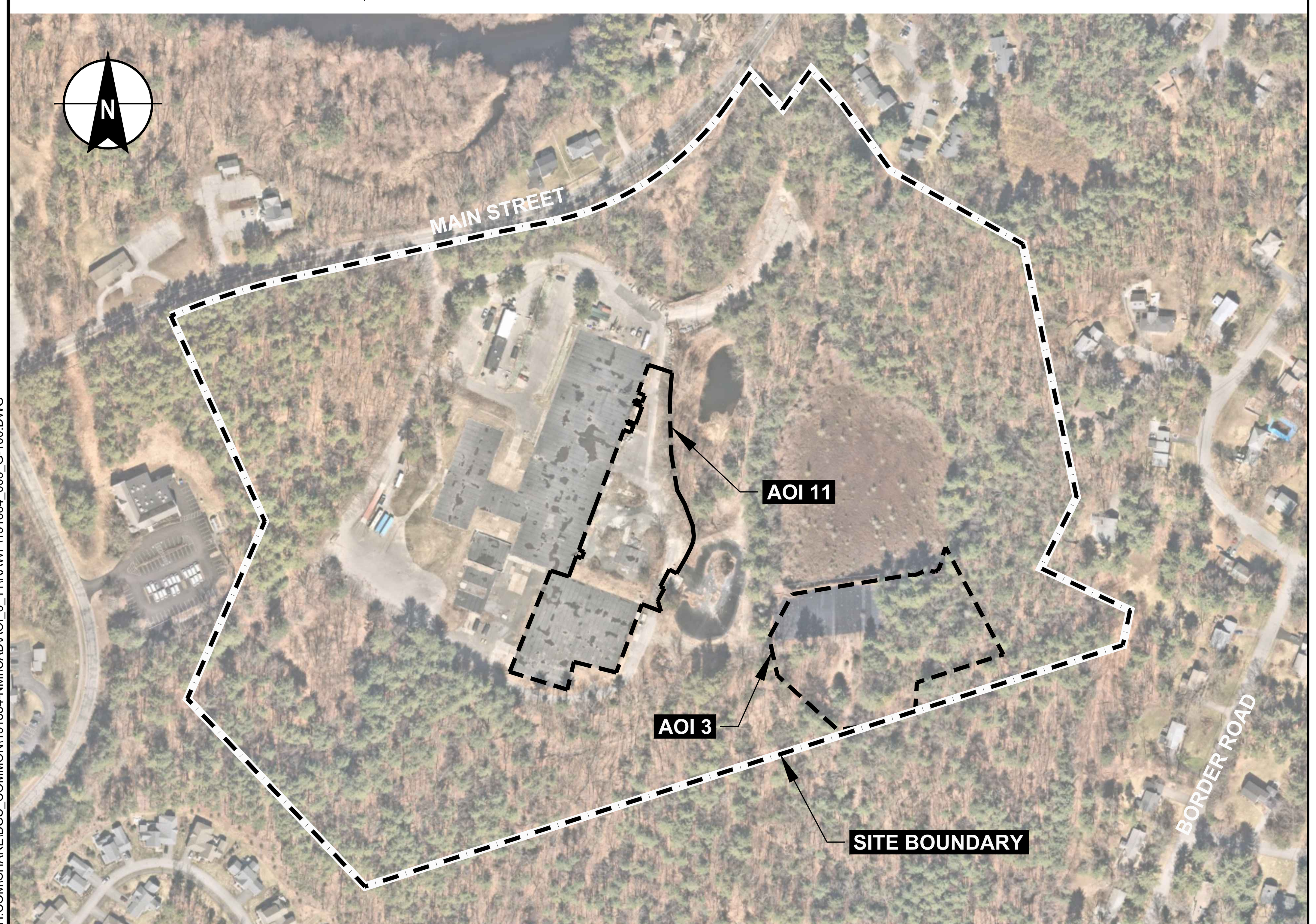
Courtyard, Landfill, and Cooling Pond Drawings



SITE LOCUS

TOPO SOURCE: BASE MAP DEVELOPED FROM THE CITY OF COLUMBUS, IN NORTH USGS TOPOGRAPHIC QUADRANGLE MAP, DATED 2016.

0 2500 5000
SCALE IN FEET



SITE AERIAL

MAP SOURCE: IMAGERY © 2022 NEARMAP, HERE

0 200 400
SCALE IN FEET

NUCLEAR METALS, INC. COURTYARD, LANDFILL, SPHAGNUM BOG, AND COOLING POND RAWP REMEDIAL DESIGN

100% SITEWIDE SEDIMENT AND SOILS REMEDIAL DESIGN PHASE 1

CONCORD, MASSACHUSETTS

APRIL 2024

DRAWING INDEX

SHEET NO.	SHEET TITLE	DESCRIPTION
1	G-100	TITLE SHEET AND DRAWING INDEX
2	G-101	NOTES
3	G-102	LEGEND
4	C-100	EXISTING CONDITIONS SITE OVERVIEW
5	C-101	EXISTING CONDITIONS LANDFILL
6	C-102	EXISTING CONDITIONS COURTYARD AND COOLING POND
7	C-200	SITE PREPERATION AND EROSION CONTROL OVERVIEW
8	C-201	SITE PREPARATION AND EROSION CONTROLS LANDFILL
9	C-202	SITE PREPARATION AND EROSION CONTROLS COURTYARD AND COOLING POND
10	C-300	COURTYARD PRE-EXCAVATION DRAINAGE IMPROVEMENTS AND GRADING
11	C-301	PRE-EXCAVATION PLAN FOR SPHAGNUM BOG SEDIMENT EXCAVATION
12	C-302	PRE-EXCAVATION PLAN COOLING POND
13	C-400	EXCAVATION PLAN LANDFILL
14	C-401	COLOR DEPTH PLAN LANDFILL
15	C-401-A	LANDFILL EXCAVATION AND GEOPHYSICAL DATA
16	C-402	EXCAVATION PLAN COURTYARD AND BUILDING E - PHASE 1
17	C-403	EXCAVATION PLAN COURTYARD AND BUILDING E - PHASE 2
18	C-404	EXCAVATION PLAN COURTYARD AND BUILDING E - PHASE 3
19	C-405	RESTORATION PLAN COURTYARD AND BUILDING E - PHASE 4
20	C-406	COLOR DEPTH PLAN COURTYARD AND BUILDING E
21	C-407	EXCAVATION CROSS-SECTIONS – COURTYARD AND BUILDING E
22	C-408	EXCAVATION PLAN FOR COOLING WATER POND SLOPES
23	C-409	EXCAVATION PLAN COOLING WATER POND
24	C-410	EXCAVATION SECTIONS COOLING POND
25	C-411	GROUNDWATER / SURFACE WATER INTERACTION SECTION
26	C-412	POST EXCAVATION BUILDING E FOOTPRINT
27	C-500	CONFIRMATORY SAMPLING LOCATIONS LANDFILL AND SPHAGNUM BOG
28	C-501	CONFIRMATORY SAMPLING LOCATIONS COURTYARD
29	C-502	CONFIRMATORY SAMPLING LOCATIONS COOLING WATER POND
30	C-503	CONFIRMATORY SAMPLING LOCATIONS BUILDING E
31	C-600	SITE RESTORATION PLAN LANDFILL AND BOG SEDIMENT
32	C-601	WETLAND RESTORATION PLAN
33	C-602	SITE RESTORATION PLAN COOLING POND
34	C-700	SITE PREPARATION DETAILS (1 OF 2)
35	C-701	SITE PREPARATION DETAILS (2 OF 2)
36	C-702	CONSTRUCTION DETAILS
37	C-703	TSCA EXCAVATED MATERIAL PROCESSING AREA DETAIL

HALEY ALDRICH

HALEY & ALDRICH, INC.
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Fax: 617.886.7600
www.haleyaldrich.com

Project No.:	131884
Scale:	SHOWN
Date:	APRIL 2024
Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

TITLE SHEET AND DRAWING INDEX

G-100

Sheet: 1 of 37

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GENERAL

1. THE TERM "OWNER" REFERS TO DE MAXIMIS, INC.
2. THE TERM "ENGINEER" REFERS TO HALEY & ALDRICH, INC.
3. THE TERM "CONSTRUCTION MANAGER" REFERS TO TBD.
4. THE TERM "CONTRACTOR" REFERS TO ENTITIES CONTRACTED BY THE CONSTRUCTION MANAGER TO COMPLETE THE WORK.
5. THE TERM "WORK" REFERS TO ALL CONSTRUCTION RELATED ACTIVITIES PERFORMED IN ACCORDANCE WITH CONTRACT DOCUMENTS.
6. THE TERM "CONTRACT DOCUMENTS" REFERS TO DRAWINGS, SPECIFICATIONS, CONTRACT TERMS, AND OTHER DOCUMENTS CREATED FOR THE EXPRESSED PURPOSE OF COMPLETING THE WORK.
7. MEANS AND METHODS OF CONSTRUCTION ARE THE RESPONSIBILITY OF THE CONTRACTOR AND MUST BE SUFFICIENT TO ACHIEVE THE PERFORMANCE OBJECTIVES OF THE PROJECT AS DESCRIBED IN THE SUBCONTRACTOR DOCUMENTS.
8. DETAILS TAKE PRECEDENCE OVER GENERAL DRAWINGS. WHERE NOTES CONFLICT WITH ANY DRAWING, THE MOST RESTRICTIVE SHALL APPLY. WHERE CONFLICTS EXIST, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE ENGINEER IN WRITING. NO CHANGES OR ADDITIONS TO THE SCOPE OF WORK DEPICTED HEREIN SHALL BE MADE WITHOUT PRIOR APPROVAL OF THE ENGINEER.
9. HORIZONTAL SURVEY DATUM SHALL BE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM NORTH AMERICAN DATUM OF 1927 (NAD27). VERTICAL SURVEY DATUM SHALL BE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).
10. LIMITS OF THE WORK AREA ARE INDICATED ON THE DRAWINGS. CONFINE ALL SITE ACTIVITIES WITHIN THE WORK AREAS INDICATED. ADDITIONAL CONSTRUCTION AREAS REQUIRED TO COMPLETE THE WORK, BUT NOT WITHIN THE LIMITS INDICATED, SHALL NOT BE PERMITTED.
11. ALL DESIGN EXCAVATION LIMITS AND VOLUMES ARE BASED ON REMOVAL TO MEET RECORD OF DECISION (ROD) CLEANUP STANDARDS BUT ARE NOT CONSIDERED FINAL. LIMITS OF EXCAVATION AND TOTAL VOLUMES MAY BE ADJUSTED BASED ON FUTURE REMEDIAL ACTION LEVEL (RAL) CALCULATIONS IN FUTURE DESIGN DRAWING PACKAGES.

SURVEY NOTES

1. THE BASEMAP AND ELEVATION SURVEY WERE PROVIDED BY FELDMAN LAND SURVEYORS IN THE "EXISTING CONDITIONS PLAN" DATED MAY 15, 2020.
2. BENCH MARK INFORMATION:

   TEMPORARY BENCH MARKS SET:

   TGS-1: MAGNETIC NAIL SET UP 1'ON THE SOUTHERLY SIDE OF UTILITY POLE AT THE INTERSECTION OF MAIN STREET AND THE DRIVEWAY TO #2228 MAIN STREET. ELEVATION=151.79'

   TGS-2: MAGNETIC NAIL SET UP 1' IN UTILITY POLE. ELEVATION=167.98'

   TBM PS-1: CHISEL SQUARE SET IN NORTHWEST CORNER OF LIGHT POLE BASE ELEVATION=172.60'

   TBM PS-2: CHISEL SQUARE SET IN NORTHWEST CORNER OF LIGHT POLE BASE ELEVATION=193.53'
3. ELEVATIONS WERE ESTABLISHED BY GPS OBSERVATIONS ON APRIL 17, 2020 AND CONVERTED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).
4. CONTOUR INTERVAL EQUALS ONE (1) FOOT.
5. BY GRAPHIC PLOTTING ONLY, THE PARCEL SHOWN HEREON LIES WITHIN A ZONE "X" (UNSHADED), AN AREA OUTSIDE OF THE 0.2% ANNUAL CHANCE FLOOD, AS SHOWN ON THE FEDERAL EMERGENCY MANAGEMENT AGENCY (F.E.M.A) FLOOD INSURANCE RATE MAP (F.I.R.M.) FOR MIDDLESEX COUNTY, MASSACHUSETTS, MAP NUMBER 25017C0358F, TOWN OF CONCORD COMMUNITY NUMBER 250189, PANEL NUMBER 0358F, HAVING AN EFFECTIVE DATE OF JULY 7, 2014.
6. PLANIMETRIC SITE FEATURES WERE OBTAINED BY AERIAL MAPPING AND CONTOURS FROM LIDAR PREPARED BY BLUE SKY GEOSPATIAL, LTD. RECEIVED ON JUNE 3, 2020. ADDITIONAL FEATURES WERE VERIFIED BY INSTRUMENT SURVEYS BY FELDMAN LAND SURVEYORS BETWEEN APRIL 14 TO JUNE 16, 2020.
7. WETLAND DELINEATION SKETCH PREPARED BY COMPREHENSIVE ENVIRONMENTAL, INC. (CEI) WAS PROVIDED ON APRIL 29, 2020.
8. THE SEPTIC SYSTEM, AS SHOWN HEREON, WAS SCALED FROM A PLAN ENTITLED "PARKING AND SEPTIC SYSTEM LAYOUT", BY C. E. MAGUIRE, INCORPORATED, DATED JANUARY, 1982 AND IS APPROXIMATE ONLY.
9. THE UTILITIES ON THE SITE, AS SHOWN HEREON, WERE SCALED FROM DRAWING PRSCP_POST_REMOVAL_SITE_CONDITIONS.DWG AND ARE APPROXIMATE ONLY.
10. UTILITY INFORMATION SHOWN IS BASED ON BOTH A FIELD SURVEY AND PLANS OF RECORD. THE LOCATIONS OF UNDERGROUND PIPES AND CONDUITS HAVE BEEN DETERMINED FROM THE AFOREMENTIONED RECORD PLANS AND ARE APPROXIMATE ONLY. THERE IS NO ASSUMED RESPONSIBILITY FOR DAMAGES INCURRED AS A RESULT OF UTILITIES THAT ARE OMITTED OR INACCURATELY SHOWN ON SAID RECORD PLANS, SINCE SUBSURFACE UTILITIES CANNOT BE VISIBLY VERIFIED. BEFORE PLANNING FUTURE CONNECTIONS, THE PROPER UTILITY ENGINEERING DEPARTMENT SHOULD BE CONSULTED AND THE ACTUAL LOCATION OF SUBSURFACE STRUCTURES SHOULD BE DETERMINED IN THE FIELD. CALL, TOLL FREE, THE DIG SAFE CALL CENTER AT 1-888-344-7233 SEVENTY-TWO HOURS PRIOR TO EXCAVATION.
11. ELEVATIONS AND CONTOURS SHOWN IN THE HOLDING BASIN WITHIN THIS DRAWING SET ARE CONSIDERED APPROXIMATE AND BASED ON CONSTRUCTION THAT WILL BE COMPLETED PRIOR TO THE IMPLEMENTATION OF THE 100% SSS PHASE 1 REMEDIAL ACTION.

PROJECT SCOPE

1. THE PROJECT SCOPE IS AS FOLLOWS:
   - 1.1. ESTABLISH SITE CONTROLS AND CONSTRUCTION FACILITIES.
   - 1.2. DEMOLISH SURFACE FINISHES.
   - 1.3. INSTALL PRE-GRADING DRAINAGE FEATURES.
   - 1.4. PERFORM REMEDIAL GRADING.
   - 1.5. PERFORM FINAL GRADING.
   - 1.6. RESTORATION OF WORK AREA.

HEALTH AND SAFETY

1. CONTRACTOR SHALL PREPARE A CONTRACTOR'S HEALTH AND SAFETY PLAN (CHASP) TO BE APPROVED BY THE ENGINEER AND/OR CONSTRUCTION MANAGER.
2. THE CONTRACTOR SHALL PERFORM THE WORK IN SUCH A MANNER THAT THE SAFETY OF THE WORKERS IS ASSURED. THIS SHALL INCLUDE PROVISIONS OF THE OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA).
3. CONTRACTOR SHALL COMPLY AT ALL TIMES WITH THE SITE-SPECIFIC HEALTH AND SAFETY REQUIREMENTS NOTED IN CONTRACTOR'S HASP, WITH ALL OSHA REQUIREMENTS, AND WITH THE OWNER'S SAFETY RULES.
4. CONSTRUCTION MANAGER SHALL CONDUCT DAILY SAFETY MEETINGS WHICH MUST BE ATTENDED BY ALL ONSITE CONTRACTOR PERSONNEL.
5. EXCAVATIONS SHALL BE PERFORMED IN ACCORDANCE WITH OSHA REGULATIONS AND STANDARDS. WHEN REMOVING UTILITIES OR EXCAVATING WITHIN 5 FT OF UTILITIES, AN AIR KNIFE EXCAVATION METHOD OR HAND DIGGING SHALL OCCUR. FOR MARKED UTILITIES THAT HAVE BEEN CONFIRMED TO BE INACTIVE, A HAND EXCAVATION WITHIN 1 TO 2 FT OF THE UTILITY LINE SHALL OCCUR. THE SUBCONTRACTOR IS RESPONSIBLE FOR CONTACTING DIG ALERT, AND ARE SOLELY RESPONSIBLE FOR CONFIRMING LOCATIONS OF UNDERGROUND UTILITIES.
6. WORK ON ELECTRICAL SYSTEMS MAY ONLY OCCUR AFTER THE ELECTRICAL HAZARD IS MITIGATED BY USE OF LOCK-OUT/TAG-OUT CONTROLS. SUBCONTRACTOR SHALL DE-ENERGIZE ELECTRICAL CHARGE PRIOR TO ANY MODIFICATION OR MOVEMENT OF ELECTRICAL SYSTEMS INCLUDING THOSE THAT DO NOT EXPOSE WIRING OR INTERIOR ELECTRICAL COMPONENTS.
7. THE CONTRACTOR TO MAINTAIN SAFE DISTANCE REQUIREMENTS FOR ALL THE ABOVE GROUND POWER DISTRIBUTION AND TRANSMISSION WIRES AND STRUCTURES.
8. PLACE ALL SAFETY DEVICES, CONSTRUCTION ROAD SIGNING, AND CONSTRUCTION SIGNING PRIOR TO ANY SITE MOBILIZATION, CONSTRUCTION, EXCAVATION AND DRILLING. THE SUBCONTRACTOR SHALL PROVIDE THE NECESSARY FLAG PERSONS FOR MOBILIZATION OF TRUCKS, EQUIPMENT AND PERSONNEL AS NEEDED. PROPERLY SECURE WORK AREAS AT THE END OF EACH WORKDAY.

COMPLIANCE AND STANDARDS

1. CONTRACTOR SHALL OBTAIN ANY/ALL NECESSARY CONSTRUCTION PERMITS AND SCHEDULE ANY REQUIRED INSPECTIONS. THE CONTRACTOR SHALL MAINTAIN COPIES OF ANY PERMITS AT THE JOB SITE FOR AGENCY INSPECTION AND PROVIDE A COPY TO THE ENGINEER AND/OR CONSTRUCTION MANAGER PRIOR TO BEGINNING WORK.
2. WORK SHALL COMPLY WITH ALL NATIONAL, STATE, AND LOCAL LAWS, REGULATIONS, CODES, REQUIREMENTS AND STANDARDS, INCLUDING REVISIONS TO DATE OF CONTRACT OR REVISIONS TO THE CONTRACT. UNLESS OTHERWISE SPECIFIED, THE LATEST EDITIONS OR REVISIONS OF THESE CODES AND STANDARDS SHALL BE ENFORCED:
   - 2.1. OSHA EXCAVATION REGULATIONS AND STANDARDS
   - 2.2. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
   - 2.3. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
   - 2.4. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
   - 2.5. NATIONAL ELECTRIC CODE (NEPA)

WORKING HOURS

1. CONSTRUCTION ACTIVITIES SHALL BE CONDUCTED BETWEEN 7:00 AM AND 5:00 PM MONDAY THROUGH FRIDAY UNLESS OTHERWISE APPROVED BY THE ENGINEER AND/OR CONSTRUCTION MANAGER. NIGHT OR SATURDAY WORK MAY BE APPROVED BY CONSTRUCTION MANAGER UPON REQUEST.

ENVIRONMENTAL CONTROLS

1. CONTRACTOR SHALL COMPLY WITH ALL LOCAL, STATE AND FEDERAL REQUIREMENTS TO MINIMIZE DUST, NOISE, STORMWATER IMPACTS, AND OTHER NUISANCE ACTIVITIES.
2. CONTRACTOR SHALL ESTABLISH, MAINTAIN, INSPECT AND REPAIR ALL STORMWATER AND EROSION AND SEDIMENTATION CONTROLS (BMPS) AS NEEDED TO CONTROL SEDIMENT AND RUNOFF FROM DISTURBED PROJECT AREAS, AND/OR REQUIRED BY PROJECT ENVIRONMENTAL PERMITS.
3. CONTRACTOR SHALL MONITOR THE EFFECTIVENESS OF ENVIRONMENTAL CONTROLS AND SUPPLEMENT OR MODIFY THEM AS NEEDED BASED ON SITE OPERATIONS TO MAINTAIN COMPLIANCE WITH THE PERMIT CONDITIONS AND CONTRACT DOCUMENTS.
4. CONTRACTOR SHALL PROVIDE STORM WATER RUN-ON AND RUN-OFF CONTROLS FOR OPEN EXCAVATIONS AND STOCKPILES. STOCKPILES MUST BE APPROVED IN WRITING BY THE ENGINEER AND/OR CONSTRUCTION MANAGER AND IN ACCORDANCE WITH APPLICABLE PERMITS AND CONTRACT DOCUMENTS.
5. ANY SURFACE WATER OR STORM WATER WHICH COLLECTS IN EXCAVATED AREAS SHALL BE CONTAINED, TREATED, AND DISCHARGED OR DISPOSED OF APPROPRIATELY IN ACCORDANCE WITH APPLICABLE PERMITS AND CONTRACT DOCUMENTS. CONTRACTOR SHALL SAMPLE, ANALYZE, AND BASED ON ANALYTICAL RESULTS, APPROPRIATELY MANAGE OF AT THE CONTRACTOR'S EXPENSE.
6. CONTRACTOR SHALL PROVIDE STORM DRAIN INLET PROTECTION.
7. CONTRACTOR SHALL PROVIDE DUST CONTROL AND ENSURE VISIBLE DUST DOES NOT CROSS THE PROPERTY LINE.
8. THE CONTRACTOR SHALL LEGALLY DISPOSE OF ALL MATERIALS DESIGNATED FOR REMOVAL FROM THE PROJECT SITE, UNLESS DIRECTED OTHERWISE BY THE CONSTRUCTION MANAGER.

SITE PREPARATION AND MAINTENANCE

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING ALL DIMENSIONS AND LOCATIONS SHOWN PRIOR TO COMMENCING WORK. ANY CONFLICTS WITH DETAILS AND NOTES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE ENGINEER AND/OR CONSTRUCTION MANAGER IN WRITING.
2. THE CONTRACTOR SHALL MAINTAIN AN ORDERLY AND CLEAN JOB SITE. THE CONTRACTOR SHALL REMOVE AND PROPERLY STORE OR DISPOSE OF ALL CONSTRUCTION RELATED TRASH, DEBRIS, AND EXCESS MATERIALS AT THE END OF EACH WORK SHIFT.
3. THE CONTRACTOR'S LAYDOWN AREA FOR MATERIALS SHALL BE COORDINATED WITH THE ENGINEER AND/OR CONSTRUCTION MANAGER, AND OTHER CONTRACTORS (IF APPLICABLE). SECURITY FOR CONTRACTOR'S EQUIPMENT AND MATERIALS IS THE RESPONSIBILITY OF THE CONTRACTOR.
4. TEMPORARY CONSTRUCTION UTILITY CONNECTIONS SHALL BE APPROVED AND PERMITTED BY THE LOCAL AUTHORITY HAVING JURISDICTION.
5. CONTRACTOR SHALL PREPARE THE WORK AREAS AND WORKING SURFACE IN ACCORDANCE WITH THE TEMPORARY CONTROLS AND SITE ACCESS DRAWINGS.
6. CONTRACTOR SHALL COORDINATE WITH DE MAXIMIS TO CLEAR VEGETATION WITHIN THE WORK AREA LIMITS AS REQUIRED.
7. VEHICLES AND EQUIPMENT SHALL ONLY ENTER/EXIT THE SITE BY LOCATIONS SPECIFIED ON THESE PLANS.

UTILITIES AND EXISTING INFRASTRUCTURE

1. CONTRACTOR SHALL LOCATE ALL UTILITIES AND PROTECT THEM FROM DAMAGE UNLESS OTHERWISE NOTED. THE CONTRACTOR SHALL REPAIR AND/OR REPLACE ANY UTILITIES DAMAGED BY THE CONTRACTOR AND PROVIDE FOR SERVICE CONTINUATIONS DURING REPAIRS AT NO EXPENSE TO THE ENGINEER, CONSTRUCTION MANAGER, OR OWNER.
2. UTILITY LOCATIONS DEPICTED WITHIN THE PROJECT BOUNDARIES ARE APPROXIMATE. THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING THE UTILITY LOCATIONS AND DEPTHS, AND IDENTIFYING UNDOCUMENTED UTILITIES PRIOR TO CONSTRUCTION. EXCAVATIONS SHALL BE CONDUCTED BY HAND OR AIR-KNIFE IF WITHIN FIVE FEET OF SUSPECTED UTILITIES OR WITHIN 2 FEET OF A UTILITY SATISFACTORILY EXPOSED BY POTHOLING AS DETERMINED BY THE ENGINEER AND/OR CONSTRUCTION MANAGER. UTILITIES, IF ANY, THAT ARE NOT TO BE DEMOLISHED AND ARE EXPOSED DURING EXCAVATION SHALL BE SUPPORTED BY BRACES OR OTHERWISE PROTECTED DURING CONSTRUCTION ACTIVITIES.
3. BEFORE COMMENCING WORK, THE CONTRACTOR SHALL DOCUMENT THE QUANTITY, SIZE, DIMENSIONS AND LOCATION OF ALL PRE-EXISTING LANDSCAPING, HARDSCAPE, CONCRETE SIDEWALK CRACKS, CONCRETE CULVERT CRACKS, CONDITION OF ASPHALT DIMENSIONS, STRIPING, SIGN POST LOCATIONS, FENCING, PIPING, UTILITY LINES, CURBS AND PAVING, UTILITY BOX LIDS AND OTHER EXISTING CONDITIONS WHICH THE CONTRACTOR SHALL BE REQUIRED TO RESTORE TO THEIR PRE-EXISTING CONDITION. DOCUMENTATION SHALL BE PROVIDED IN A MEMORANDUM FORMAT. USE OF TABLES AND PHOTOGRAPHS ARE ACCEPTABLE.
4. THE PROPOSED AND EXISTING UNDERGROUND AND ABOVE GROUND FACILITIES, STRUCTURES, UTILITIES, SURFACE FEATURES AND NATURAL FEATURES SHOWN HEREON ARE BASED ON FIELD SURVEYS AND RECORD DOCUMENTS. OTHER FACILITIES MAY EXIST NOT DISCOVERED THROUGH THE RECORD CHECK. THE CONTRACTOR SHALL VERIFY THE EXACT LOCATION, BOTH VERTICAL AND HORIZONTAL, OF ALL UTILITIES FROM THE APPROPRIATE UTILITY COMPANIES AND ONE CALL 811 SERVICES. THE CONTRACTOR IS RESPONSIBLE FOR DAMAGES INCURRED AS A RESULT OF UTILITIES OMITTED OR INACCURATELY SHOWN.
5. TAKE ALL NECESSARY MEASURES TO PREVENT DAMAGE TO ADJACENT AND NEARBY STRUCTURES, PAVEMENT, FENCING AND LANDSCAPING. THE CONTRACTOR IS RESPONSIBLE FOR PROTECTION OF THE ROADS, TREES AND NEARBY PUBLIC AND PRIVATE PROPERTY AND PUBLIC RIGHT OF WAYS FROM ANY SITE CONSTRUCTION/ EQUIPMENT DAMAGE CAUSED BY THE CONTRACTOR'S EQUIPMENT. ALL DAMAGE SHALL BE REPAIRED AT NO ADDITIONAL COST TO THE ENGINEER, CONSTRUCTION MANAGER, OR OWNER. REMOVE AND STORE ANY FENCING OR OTHER ITEMS NEEDED TO BE REMOVED TO PERFORM THE WORK AND RETURN TO THE ORIGINAL CONDITION AT THE COMPLETION OF ALL WORK. REMOVE AND STORE ANY CURB, FENCING OR OTHER ITEMS NEEDED TO BE REMOVED TO PERFORM THE WORK AND RETIRE TO THE ORIGINAL CONDITION AT THE COMPLETION OF ALL WORK. PERMANENT FENCING REMOVED DURING CONSTRUCTION SHALL BE REPLACED BY THE CONTRACTOR TO THE ORIGINAL LOCATION AND CONDITION TO THE SATISFACTION OF THE OWNER AND CONSTRUCTION MANAGER.

EXCAVATION AND BACKFILLING

1. ALL OPEN EXCAVATIONS SHALL BE SUPPORTED IN ACCORDANCE WITH APPLICABLE OSHA REQUIREMENTS.
2. OPEN TRENCHES SHALL BE COMPLETELY SURROUNDED BY TEMPORARY SAFETY FENCING OR COVERED BY TRAFFIC RATED STEEL PLATES AT ALL TIMES WHEN WORK IS NOT BEING DONE IN THE IMMEDIATE AREA. THE SAFETY FENCING AND/OR STEEL PLATES SHALL BE MAINTAINED UNTIL THE TRENCH IS BACKFILLED AND COMPACTED TO MATCH EXISTING GRADE.
3. THE CONTRACTOR SHALL PROVIDE TRENCH PLATES AND TRAFFIC CONTROL, AS NECESSARY TO MAINTAIN NORMAL SITE ACCESS AND TRAFFIC FLOW. A 25 FOOT WIDE EMERGENCY FIRE VEHICLE LANE MUST BE MAINTAINED AT ALL TIMES UNLESS OTHERWISE APPROVED BY ENGINEER AND/OR CONSTRUCTION MANAGER.
4. PRIOR TO BACKFILL, ANY DEVIATION FROM THE PLANNED WORK SHOULD BE CAPTURED AND NOTED ON REDLINES DRAWINGS. SURVEY DATA OR FIELD MEASUREMENTS ARE BOTH ACCEPTABLE METHODS FOR DOCUMENTING INSTALL LOCATIONS..
5. THE CONTRACTOR SHALL NOT BACKFILL THE EXCAVATIONS UNLESS WRITTEN APPROVAL IS PROVIDED BY THE ENGINEER AFTER SOIL TESTING. IF ENGINEER DETERMINES LOCAL CONDITIONS REQUIRE IMMEDIATE BACKFILL OF TRENCH, PRESSURE TESTING MAY OCCUR AFTER BACKFILLING IN THE PRESENCE OF THE ENGINEER.
6. CONTRACTOR SHALL DESIGN AND INSTALL TEMPORARY SUPPORT OF EXCAVATION (SOE) AS NEEDED FOR EXCAVATIONS DEEPER THAN 4 FEET TO PROTECT WORKERS AND/OR ADJACENT INFRASTRUCTURE. CONTRACTOR SHALL REMOVE ALL TEMPORARY SOE ELEMENTS UPON COMPLETION OF THE WORK TO THE SATISFACTION OF THE ENGINEER. A PRE-ENGINEERED TRENCH BOX MAY BE USED IN PLACE OF AN ENGINEER DESIGNED SOE SYSTEM.
7. SAFE INGRESS AND EGRESS MEASURES SHALL BE USED DURING EXCAVATION ACTIVITIES.
8. ASPHALT AND CONCRETE MATERIAL SHALL BE BROKEN DOWN INTO PIECES LESS THAN 1' ACROSS. METAL REBAR AND OTHER DEBRIS SHALL BE BROKEN DOWN INTO 1' PIECES, PER FACILITY RECEIVING REQUIREMENTS. REFER TO SPECIFICATION 02 41 00 DEMOLITION.

RESTORATION

1. SURFACES SHALL BE RESTORED TO THEIR ORIGINAL CONDITION OR AS SHOWN ON THE DRAWINGS.
2. FEATURES INCLUDING BUT NOT LIMITED TO FENCING, IRRIGATION, CURBS, SHALL BE RESTORED TO THEIR ORIGINAL CONDITION OR AS SHOWN ON THE DRAWINGS AND INDICATED IN THE SPECIFICATIONS.
3. BACKFILL EXCAVATION AND RESTORE THE WORK AREA PER THE DRAWINGS.

AS-BUILT DRAWINGS

1. CONTRACTOR SHALL PROVIDE A SET OF AS-BUILT DRAWINGS WITH REDLINE MARKUPS DEPICTING THE PRECISE LOCATION OF ALL COMPONENTS INCLUDED IN THE CONSTRUCTION DOCUMENTS AND INDICATE CLEARLY ANY FIELD ADJUSTMENTS MADE THAT DEVIATE FROM THE DESIGN PLANS.
2. CONTRACTOR SHALL SURVEY SUBGRADE ELEVATIONS FOLLOWING FINAL EXCAVATION GRADES, AND SURVEY FINISHED GRADES AFTER BACKFILLING. DETAILS OF THE RESTORED FEATURES INCLUDING MATERIAL TYPES SHALL BE INCLUDED IN THE AS-BUILT SURVEY AND SHALL BE PROVIDED IN AUTOCAD 2018 OR NEWER FORMAT AS WELL AS IN A PDF.

SUGGESTED CONSTRUCTION SEQUENCE

1. MOBILIZE.
2. INSTALL EROSION AND SEDIMENTATION CONTROLS IN THE WORK AREA INCLUDING FIBER ROLLS, SILT FENCES, CHECK DAMS, STRAW WATTLES, AND STRAW BALES. CONSTRUCT STABILIZED CONSTRUCTION ENTRANCES, EXISTING SITE ACCESS PATH IMPROVEMENT, AND WHEEL WASH. PROTECT-IN-PLACE FEATURES AS REQUIRED.
3. CONSTRUCT EXCAVATED SOIL STOCKPILE AND GRANULAR FILL MATERIAL STOCKPILE AREAS.
4. CLEAR AND GRUB THE EXCAVATION AREAS WITHIN THE AREA OF WORK INCLUDING PAVEMENT REMOVAL AS REQUIRED.
5. INSTALL POND DEWATERING TREATMENT SYSTEM PRIOR TO COOLING POND WORK
6. EXCAVATE AND PLACE SOIL AS REQUIRED AS PART OF THE PRE-GRADING DRAINAGE IMPROVEMENT.
7. EXCAVATE SOILS AS REQUIRED TO MEET THE GRADES INDICATED ON THE PLANS.
8. ALLOW FOR ENGINEER TO SAMPLE AND ANALYZE BOTTOM AND SIDEWALL OF EXCAVATION AT VARIOUS LOCATIONS AS SHOWN ON THE PLAN. ALLOW FOR UP TO 30 DAYS.
9. EXCAVATE ADDITIONAL SOIL AS REQUIRED BASED ON SAMPLE RESULTS.
10. COMPACT AND BACKFILL GRANULAR FILL AS REQUIRED TO MAKE FINAL GRADES.
11. RESTORE SITE AS INDICATED.
12. REMOVE TEMPORARY FEATURES AND FACILITIES.
13. DEMOBILIZE.

HALEY ALDRICH

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Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

NOTES

G-101

CIVIL FEATURES / SURVEY DATA

- SITE BOUNDARY
- FORMER BUILDING SLAB
- TRAILER BUILDING
- CHAIN LINK FENCE
- GUARDRAIL
- EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- STONE WALL
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- ELECTRICAL BOX
- TREE/SHRUB
- STAIRS
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- HYDRANT
- WATER/GAS SHUT OFF/GATE
- GUY WIRE
- UTILITY POLE
- BOLLARD
- POST
- GATE POST
- SIGN
- TRANSFORMER
- ELECTRIC METER
- ASPHALT
- CONCRETE
- GRAVEL

- HISTORICAL SAMPLE LOCATION
- PROPOSED SAMPLE LOCATION
- N: XXXXX.XX E: XXXXX.XX EXCAVATION CORNER COORDINATE
- LIMIT OF EXCAVATION
- 99 1 FT PROPOSED CONTOUR
- PROPOSED DRAIN PIPE
- PRE-CAST CONCRETE BLOCKS
- STRAW WATTLES
- STRAW BALES
- TRUCK ROUTE
- PROPOSED TRUCK PATH
- PROPOSED LAYDOWN / STOCKPILE AREA
- PROPOSED DEMOLITION AREA
- PRECAST CONCRETE BLOCKS
- MATERIAL PROCESSING AREA

DEFINITIONS

CI = CAST IRON
CS = COATED STEEL
PL = PLASTIC
RCP = REINFORCED CONCRETE PIPE
12" D (CL) = PIPE SIZE AND MATERIAL
BIT = BITUMINOUS
CB = CONCRETE BOUND
CC = CONCRETE CURB
CONC = CONCRETE
HP = HIGH PRESSURE
IP = IRON PIPE
IR = IRON ROD
R = RIM ELEVATION
RET = RETAINING
SB = STONE BOUND
SGC = SLOPED GRANITE CURB
VGC = VERTICAL GRANITE CURB
WF = WIRE FENCE
NMI = NUCLEAR METALS, INC.
SOE = SUPPORT OF EXCAVATION
TYP = TYPICAL
O.C. = ON CENTER
NAD83 = NORTH AMERICAN DATUM OF 1983
NGVD29 = NATIONAL GEODETIC VERTICAL DATUM OF 1929

PLAN SHEET DATA

AOI-8-1 PROFILE REFERENCE (PROFILE AOI8-1)

1 / C-700 DETAIL REFERENCE (DETAIL 1 ON SHEET C-700)

AREA OF CUT

AREA OF FILL

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11

SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

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LEGEND

G-102

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- TRAILER BUILDING
- CHAIN LINK FENCE
- GUARDRAIL
- 2 FT EXISTING GROUND CONTOUR
- 10 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.

0 80 160 240 320
SCALE IN FEET

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EXISTING CONDITIONS SITE OVERVIEW

C-100

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- TRAILER BUILDING
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 100 — 5 FT EXISTING GROUND CONTOUR
- AD — ACID DRAIN LINE
- AD — ACID WASTE LINE
- CD — COOLING DRAIN
- WW — WATER WELL LINE
- FIRE LOOP WATER LINES
- W — HYDRANT LINE
- D — STORM DRAIN LINE
- S — SANITARY SEWER LINE
- W — WATER LINE
- E — ELECTRIC LINE
- EO — OVERHEAD ELECTRICAL LINE
- C — CABLE LINE
- G — GAS LINE
- T — TELEPHONE LINE
- UNK — UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
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N

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SCALE IN FEET

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EXISTING CONDITIONS LANDFILL

C-101

GAINES, JACK Printed: 4/23/2024 10:43 AM Layout: C-101
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LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- TRAILER BUILDING
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- ACID DRAIN LINE
- ACID WASTE LINE
- COOLING DRAIN
- WATER WELL LINE
- FIRE LOOP WATER LINES
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- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.

0 40 80 120 160
SCALE IN FEET

HALEY ALDRICH

HALEY & ALDRICH, INC.
465 Medford Street, Suite 2200
Boston, MA 02129-1400
Tel: 617.886.7400
Fax: 617.886.7600
www.haleyaldrich.com

Project No.:	131884
Scale:	SHOWN
Date:	APRIL 2024
Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD, LANDFILL,SPHAGNUM BOG, AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXISTING CONDITIONS COURTYARD AND COOLING POND

C-102

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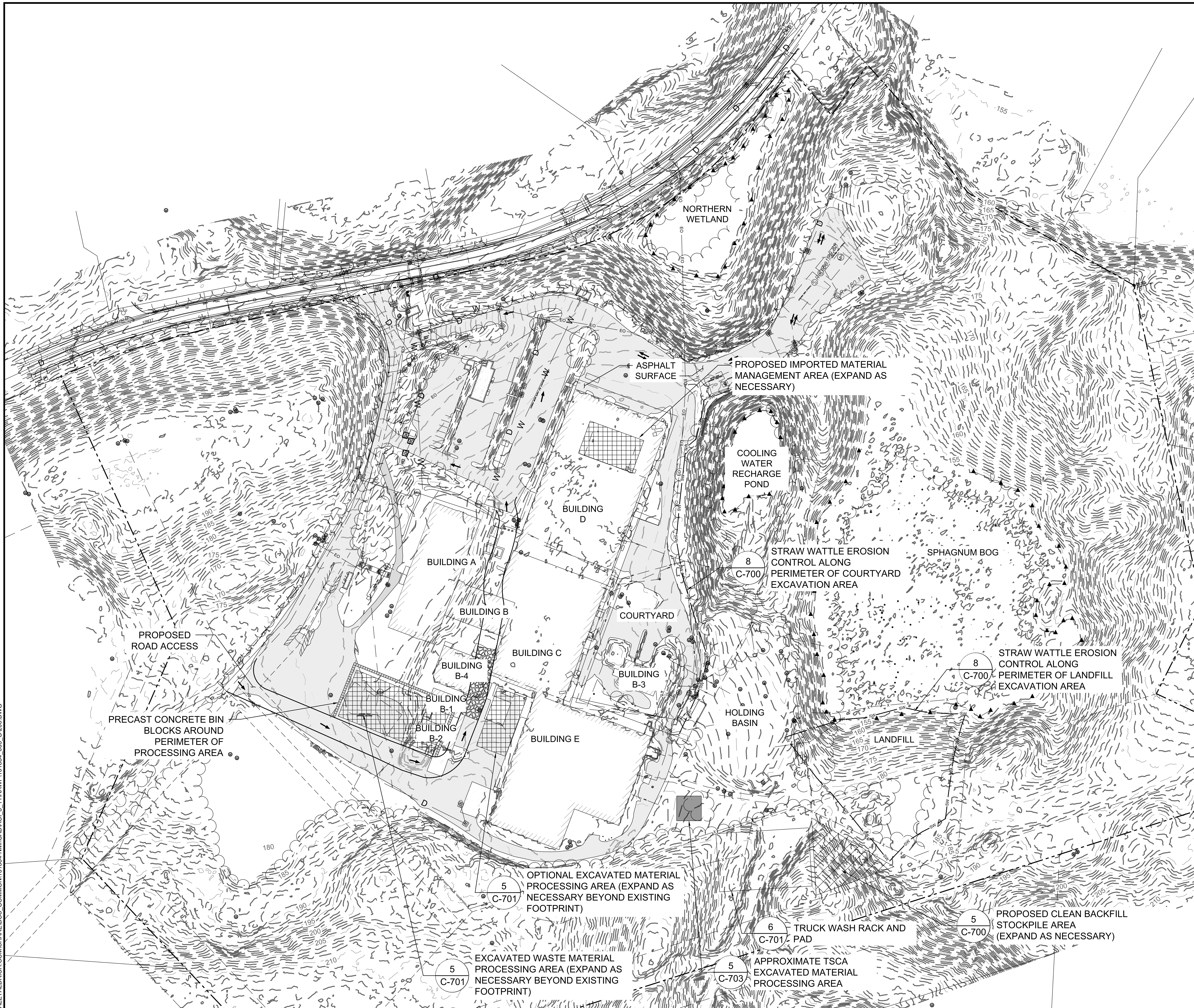

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- STRAW WATTLE
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PRE-CAST CONCRETE BLOCKS
- TRUCK ROUTE
- PROPOSED TRUCK PATH
- PROPOSED LAYDOWN / STOCKPILE AREA
- PROPOSED DEMOLITION AREA
- MATERIAL PROCESSING AREA
- TSCA EXCAVATED MATERIAL PROCESSING AREA

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-102.
2. TREE CLEARING LIMITS ARE APPROXIMATE. ADDITIONAL CLEARING MAY BE NECESSARY AS THE WORK PROGRESSES.

0 80 160 240 320
SCALE IN FEET

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CONCORD, MASSACHUSETTS

SITE PREPERATION AND EROSION CONTROL OVERVIEW

C-200

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LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PRE-CAST CONCRETE BLOCKS
- TRUCK ROUTE
- PROPOSED TRUCK PATH
- PROPOSED LAYDOWN / STOCKPILE AREA
- PROPOSED DEMOLITION AREA
- MATERIAL PROCESSING AREA
- TSCA EXCAVATED MATERIAL PROCESSING AREA
- STRAW WATTLE

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. UNLESS NOTED FOR ABANDONMENT, MONITORING WELLS SHALL BE PROTECTED IN ACCORDANCE WITH SPECIFICATION 33 29 00, MONITORING WELL ABANDONMENT AND PROTECTION.

N

0 40 80 120 160
SCALE IN FEET

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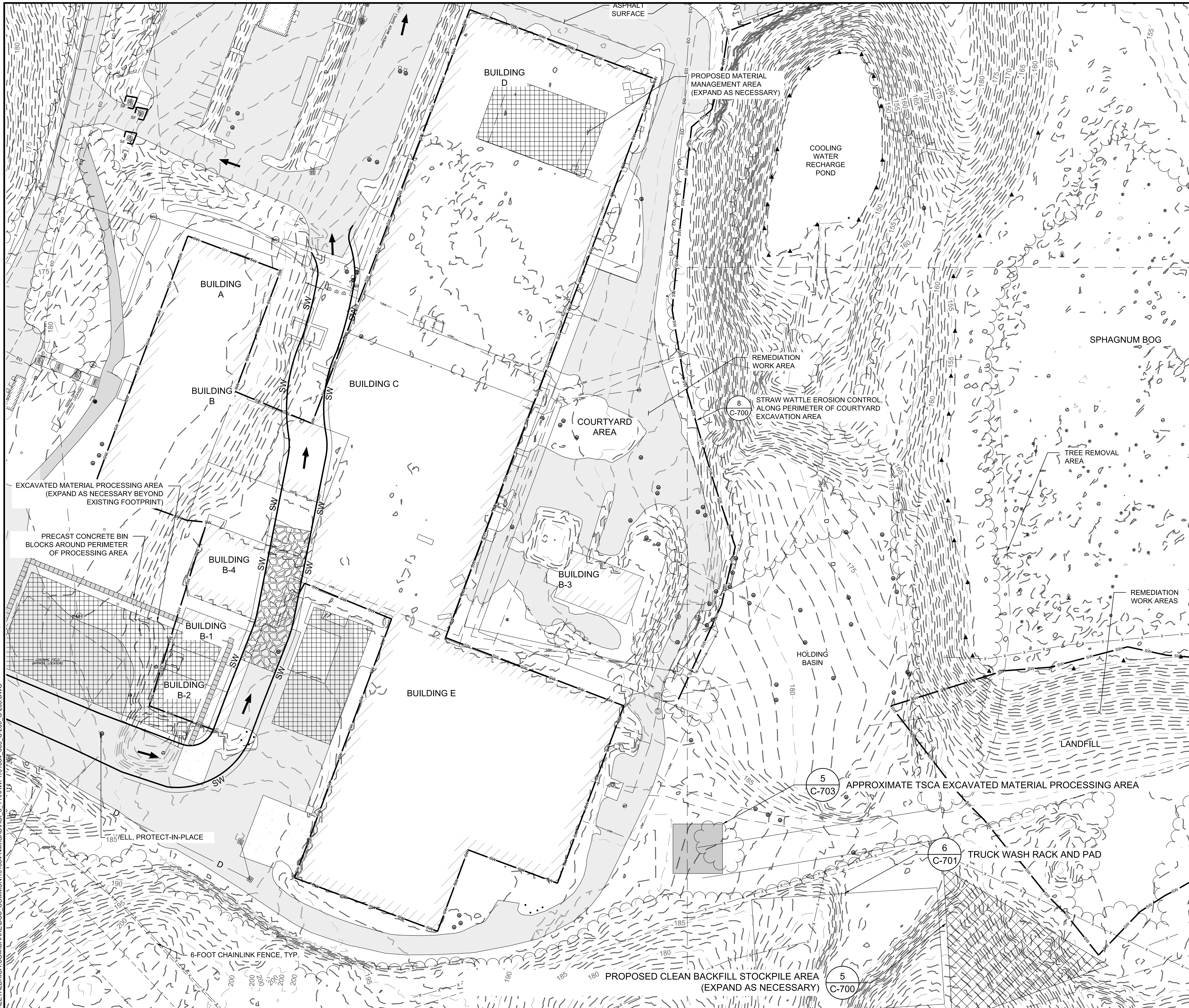
2229 MAIN STREET
CONCORD, MASSACHUSETTS

SITE PREPARATION AND EROSION CONTROLS LANDFILL

C-201



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PRE-CAST CONCRETE BLOCKS
- TRUCK ROUTE
- PROPOSED TRUCK PATH
- PROPOSED LAYDOWN / STOCKPILE AREA
- PROPOSED DEMOLITION AREA
- MATERIAL PROCESSING AREA
- TSCA EXCAVATED MATERIAL PROCESSING AREA
- STRAW WATTLE

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.

0 40 80 120 160
SCALE IN FEET

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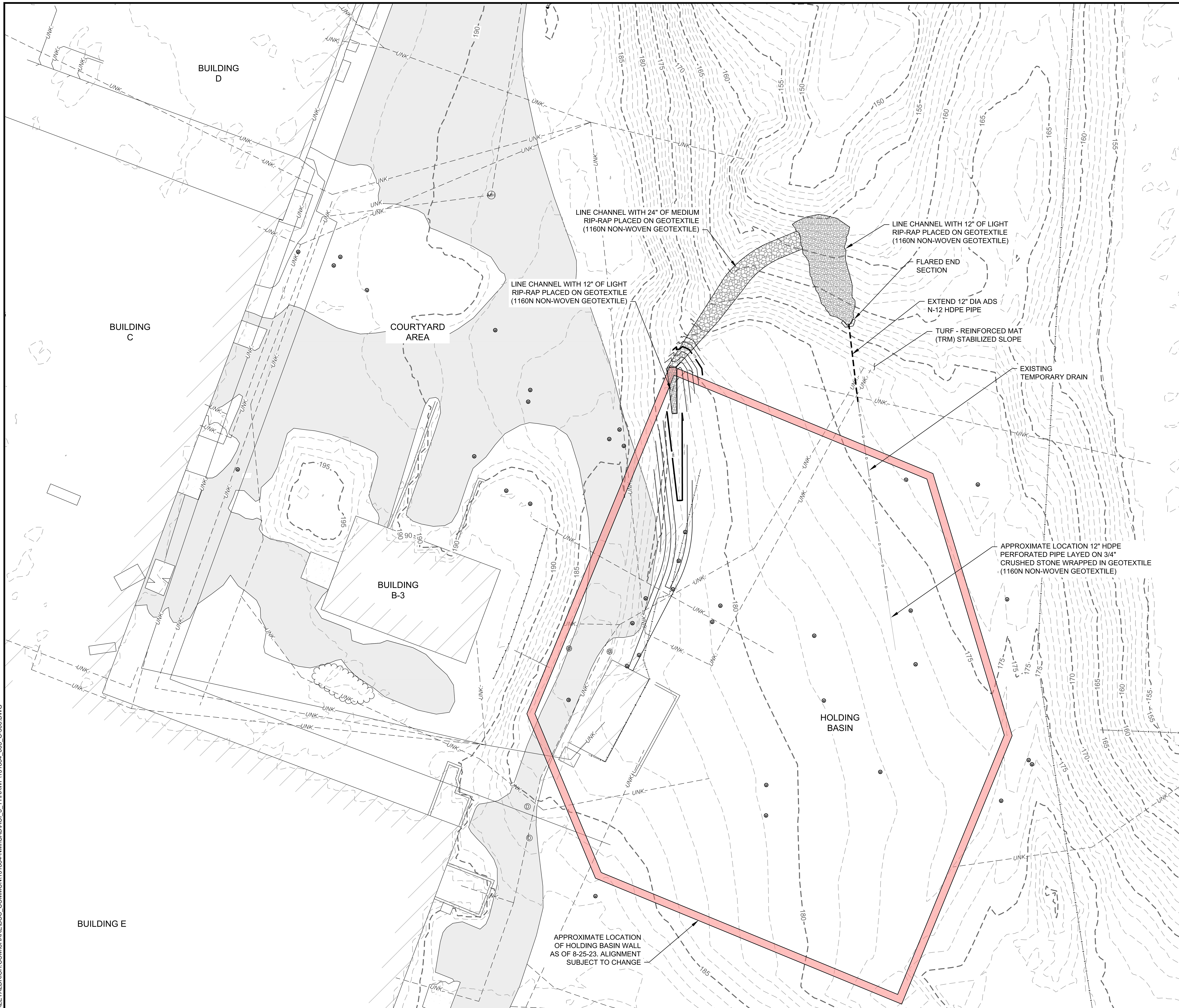
CONCORD, MASSACHUSETTS

SITE PREPARATION AND EROSION CONTROLS COURTYARD AND COOLING POND

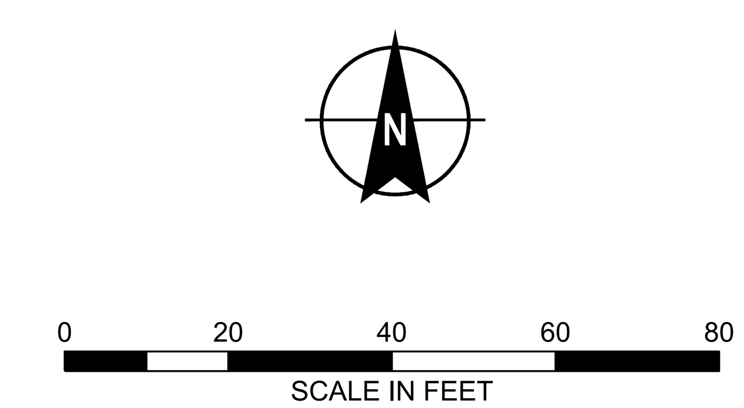
C-202

Sheet: 9 of 37



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)



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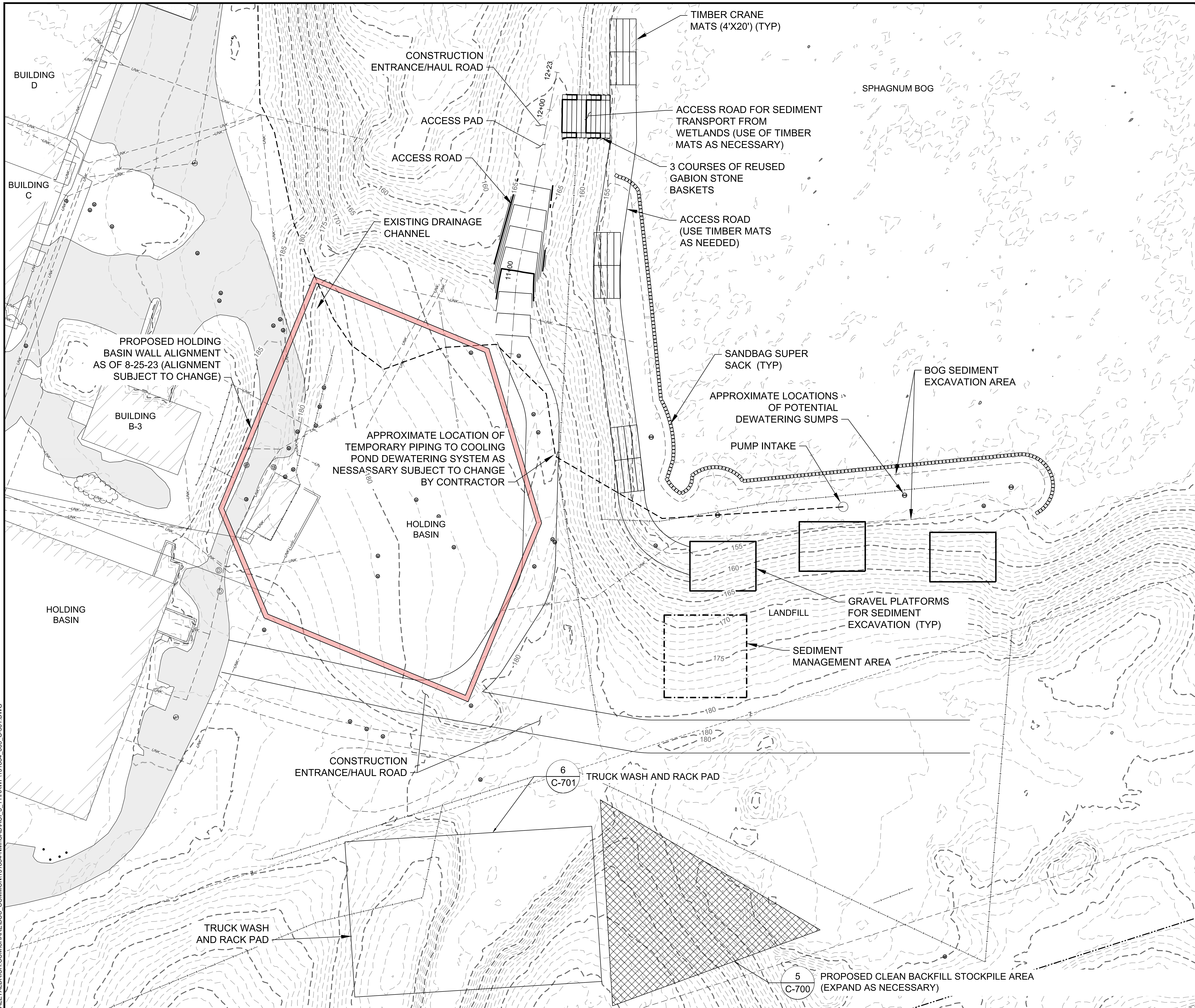
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

COURTYARD PRE-EXCAVATION DRAINAGE IMPROVEMENTS AND GRADING

C-300



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- TEMPORARY PIPING
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PRE-CAST CONCRETE BLOCKS
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- SANDBAG SUPER STACK (TYP)
- PROPOSED LAYDOWN / STOCKPILE AREA

BOG SEDIMENT EXCAVATION VOLUME:

CUT: 1,127 CY.
FILL: 0 CY.
NET: 1,127 CY. <CUT>

N

0 30 60 90 120
SCALE IN FEET

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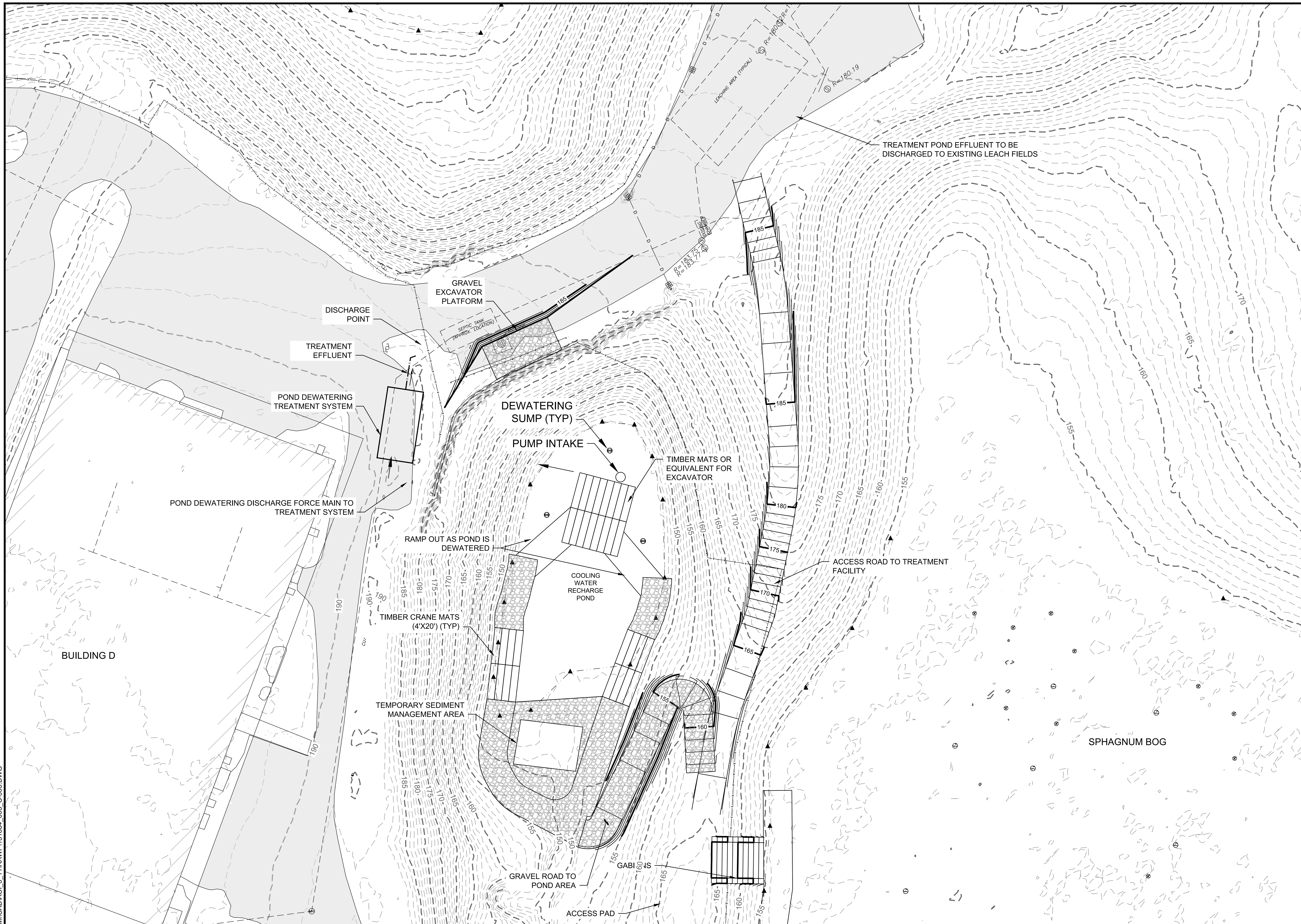
CONCORD, MASSACHUSETTS

PRE-EXCAVATION PLAN FOR SPHAGNUM BOG SEDIMENT EXCAVATION

C-301



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL

0 30 60 90 120
SCALE IN FEET

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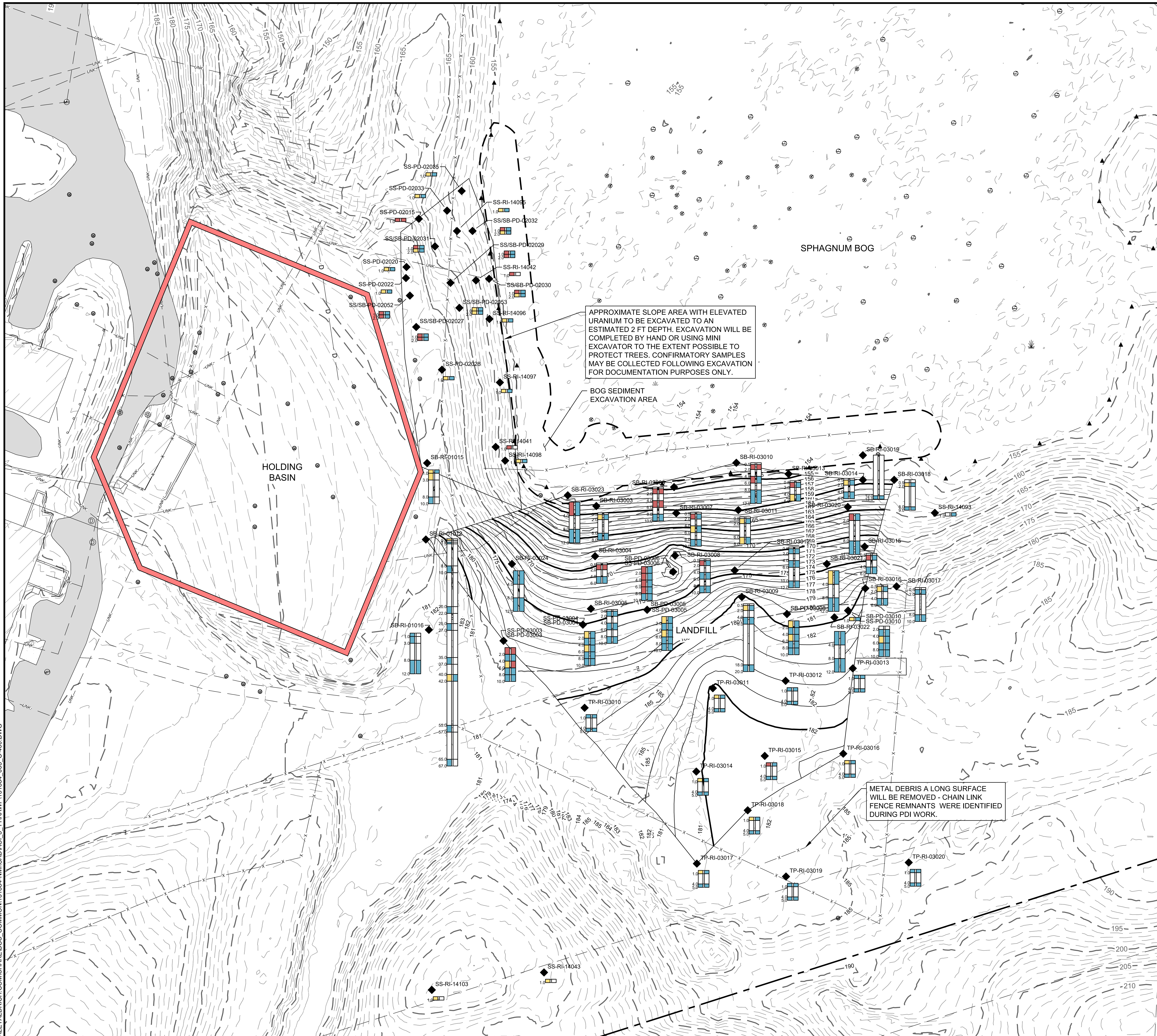
2229 MAIN STREET
CONCORD, MASSACHUSETTS

PRE-EXCAVATION PLAN COOLING POND

C-302



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- LIMITS OF EXCAVATION
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. TOTAL ESTIMATED LANDFILL EXCAVATION VOLUME = 5,975 CY. TOTAL ESTIMATED BOG SEDIMENT EXCAVATION VOLUME = 1,127 CY.
3. CONTOURS MAY BE ADJUSTED TO INCORPORATE CONSTRUCTIBILITY FEEDBACK FROM SELECTED CONTRACTOR.

0 30 60 90 120
SCALE IN FEET

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Rev.	Description	By	Date
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NUCLEAR METALS, INC.
COURTYARD, LANDFILL,SPHAGNUM BOG, AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXCAVATION PLAN LANDFILL

C-400

Sheet: 13 of 37

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EXCAVATION DEPTH TABLE

DEPTH RANGE (FEET)	COLOR
0 - 1	
1 - 2	
2 - 3	
3 - 4	
4 - 5	
5 - 6	
6 - 7	
7 - 8	
8 - 9	
9 - 10	

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- LIMITS OF EXCAVATION
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. TOTAL ESTIMATED LANDFILL EXCAVATION VOLUME = 5,975 CY. TOTAL ESTIMATED BOG SEDIMENT EXCAVATION VOLUME = 1,127 CY.
3. CONTOURS ARE SHOWN ON DRAWING C-400 AND MAYBE ADJUSTED BASED ON CONTRACTOR'S FEEDBACK.

0 30 60 90 120
SCALE IN FEET

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SSS PHASE 1
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CONCORD, MASSACHUSETTS

COLOR DEPTH PLAN LANDFILL

C-401

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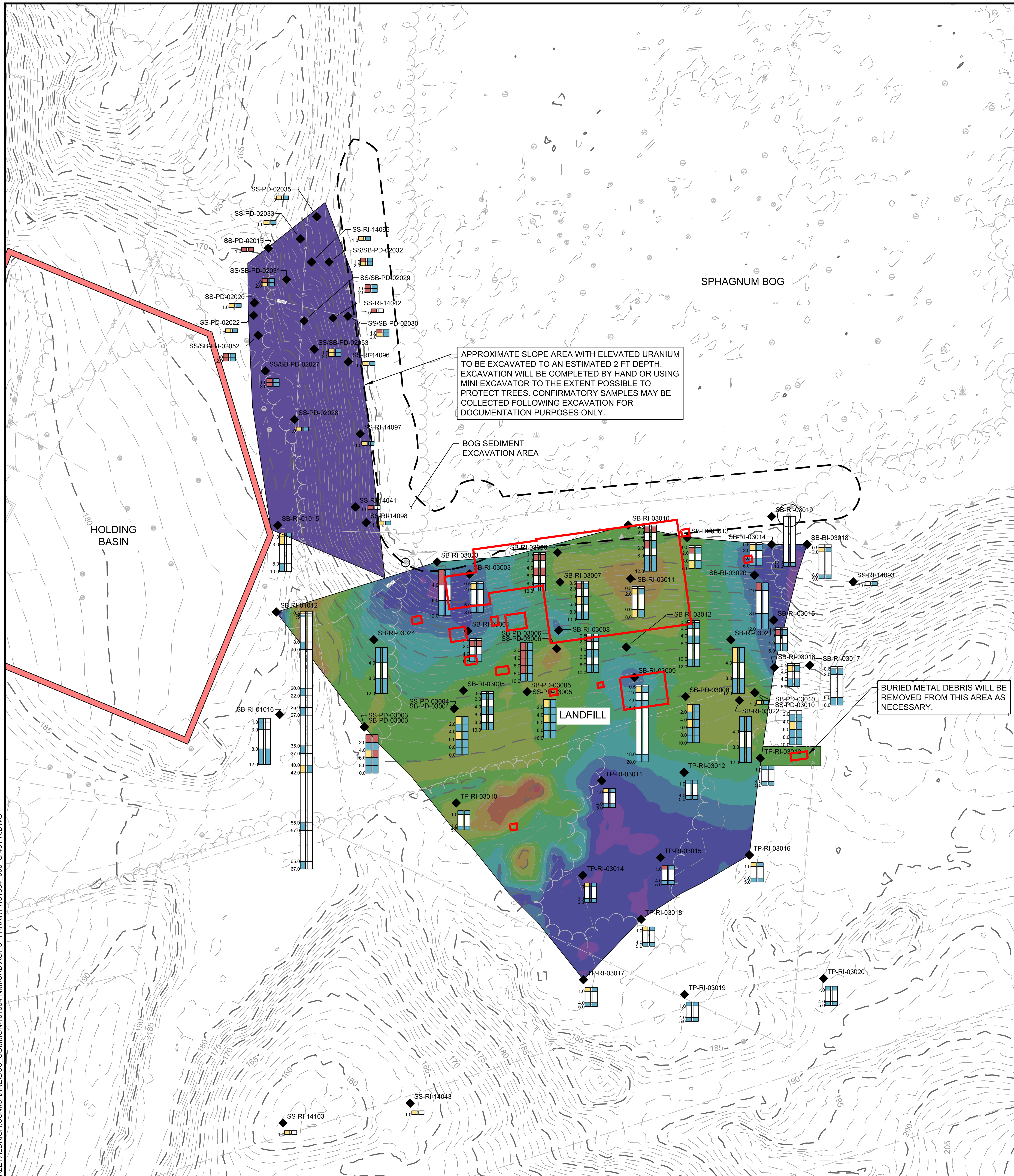

EXCAVATION DEPTH TABLE

DEPTH RANGE (FEET)	COLOR
0 - 1	
1 - 2	
2 - 3	
3 - 4	
4 - 5	
5 - 6	
6 - 7	
7 - 8	
8 - 9	
9 - 10	

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11

SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- LIMITS OF EXCAVATION
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- EM61-INFERRED SIGNIFICANT AMOUNTS OF BURIED METAL.

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. TOTAL ESTIMATED LANDFILL EXCAVATION VOLUME = 5,975 CY. TOTAL ESTIMATED BOG SEDIMENT EXCAVATION VOLUME = 1,127 CY.
3. CONTOURS ARE SHOWN ON DRAWING C-400 AND MAYBE ADJUSTED BASED ON CONTRACTOR'S FEEDBACK.
4. APPROXIMATE AREA OF EM61-INFERRED SIGNIFICANT AMOUNTS OF BURIED METAL ARE BASED ON RESULTS FROM THE NOVEMBER 2020 GEOPHYSICAL SURVEY REPORT

N

0 30 60 90 120

SCALE IN FEET

HALEY ALDRICH

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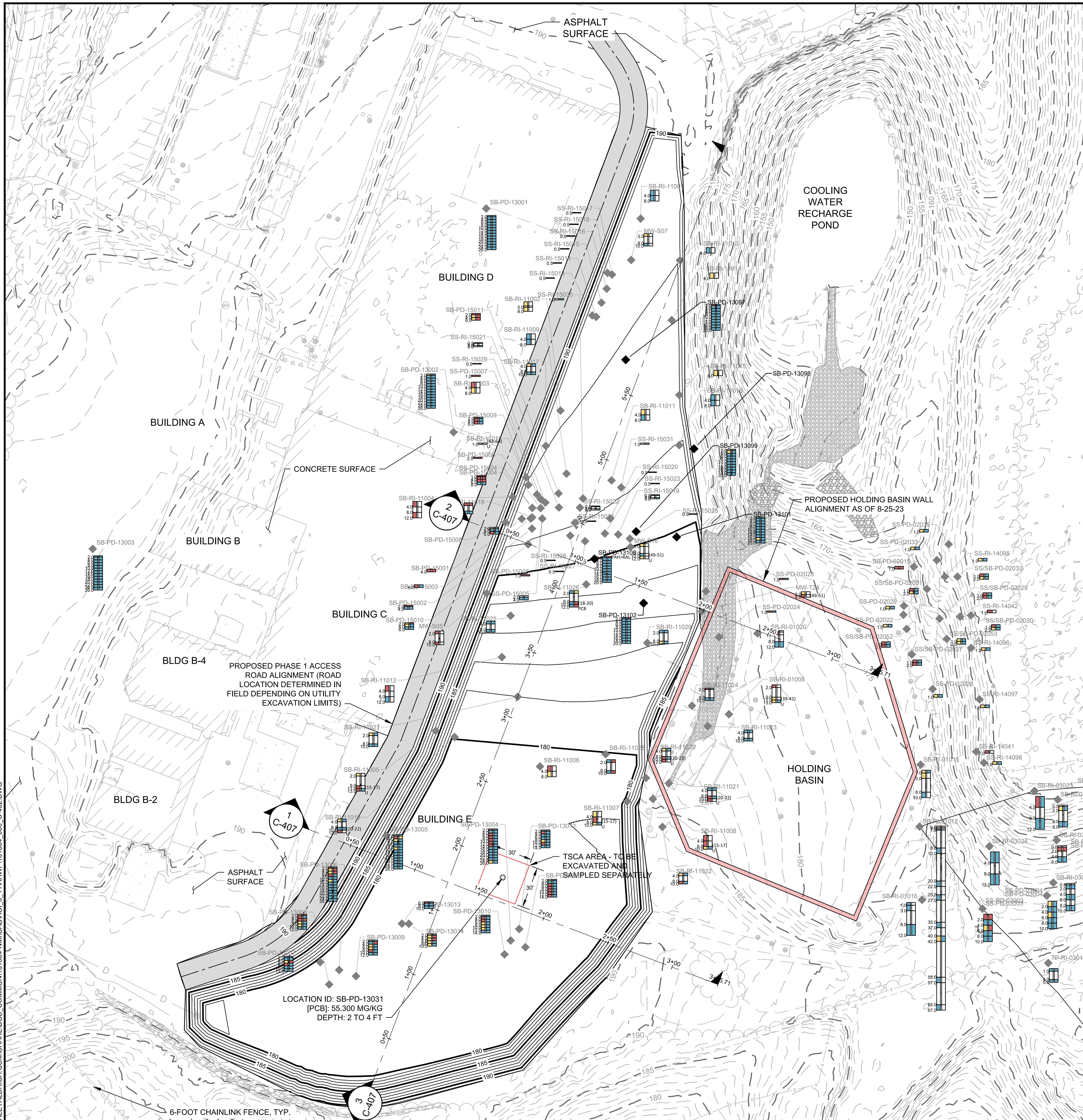
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

LANDFILL EXCAVATION AND GEOPHYSICAL DATA

C-401-A



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- HISTORICAL SAMPLING LOCATION
- 2023 PRE-CHARACTERIZATION SAMPLING LOCATION

NOTES

1. THE BASEMAP AND ELEVATION SURVEY WERE PROVIDED BY FELDMAN LAND SURVEYORS IN THE "EXISTING CONDITIONS PLAN" DATED MAY 15, 2020.
2. TOTAL ESTIMATED EXCAVATION VOLUME = 32,300 CY. (CUT)

SAMPLE LEGEND

GROUND SURFACE
0 TO 1.00
1.01 TO 2.00
2.01 TO 4.00
4.01 TO 6.00
6.01 TO 8.00
8.01 TO 10.00
>10.00
10-11

SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

N

0 40 80 120 160
SCALE IN FEET

HALEY ALDRICH

HALEY & ALDRICH, INC.
465 Medford Street, Suite 2200
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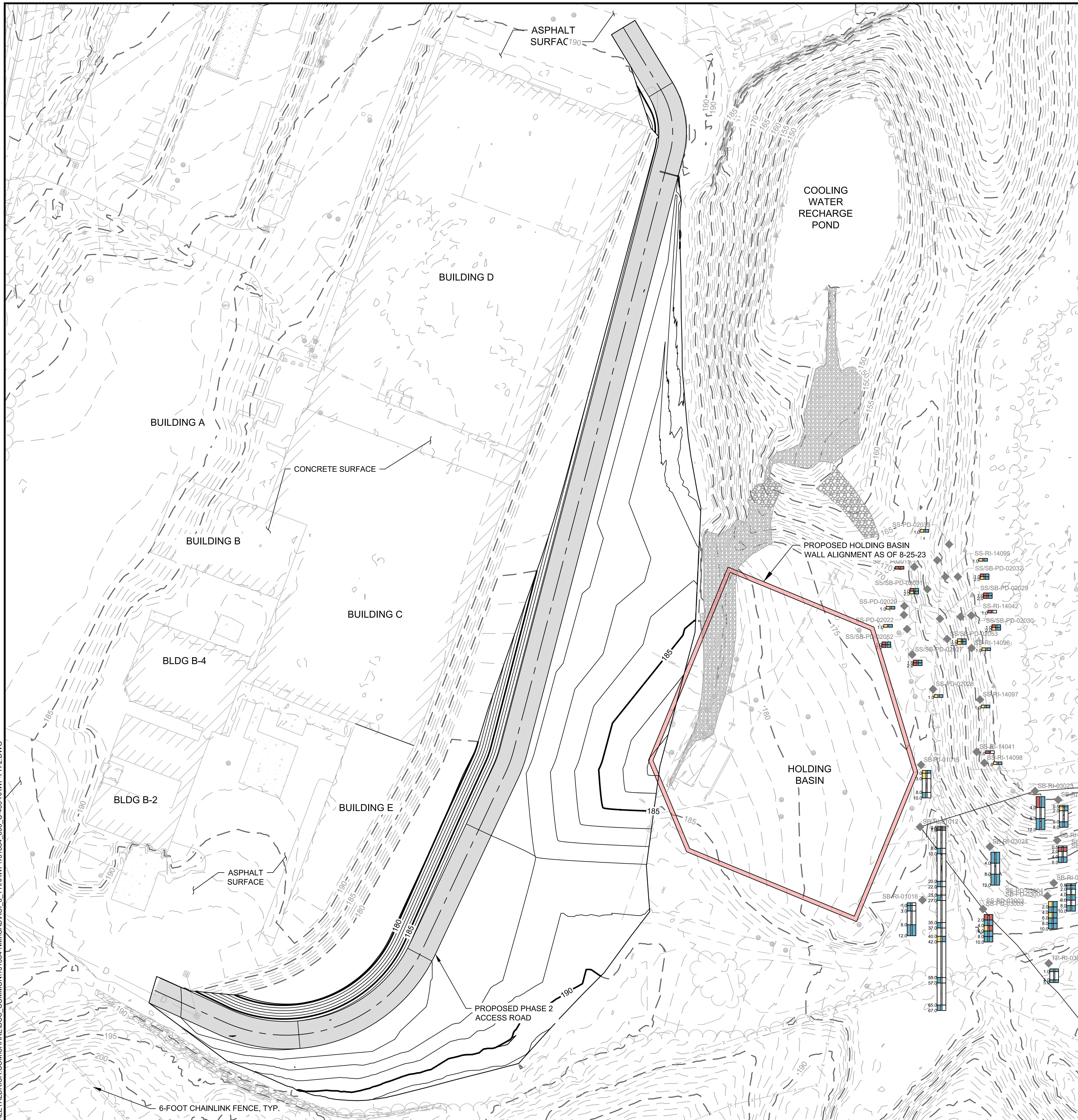
Project No.:	131884
Scale:	SHOWN
Date:	APRIL 2024
Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD, LANDFILL,SPHAGNUM BOG, AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXCAVATION PLAN COURTYARD AND BUILDING E - PHASE 1

C-402



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- HISTORICAL SAMPLING LOCATION
- 2023 PRE-CHARACTERIZATION SAMPLING LOCATION

NOTES

1. THE BASEMAP AND ELEVATION SURVEY WERE PROVIDED BY FELDMAN LAND SURVEYORS IN THE "EXISTING CONDITIONS PLAN" DATED MAY 15, 2020.
2. TOTAL ESTIMATED EXCAVATION VOLUME = 15,250 CY. (FILL)

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

0 40 80 120 160
SCALE IN FEET

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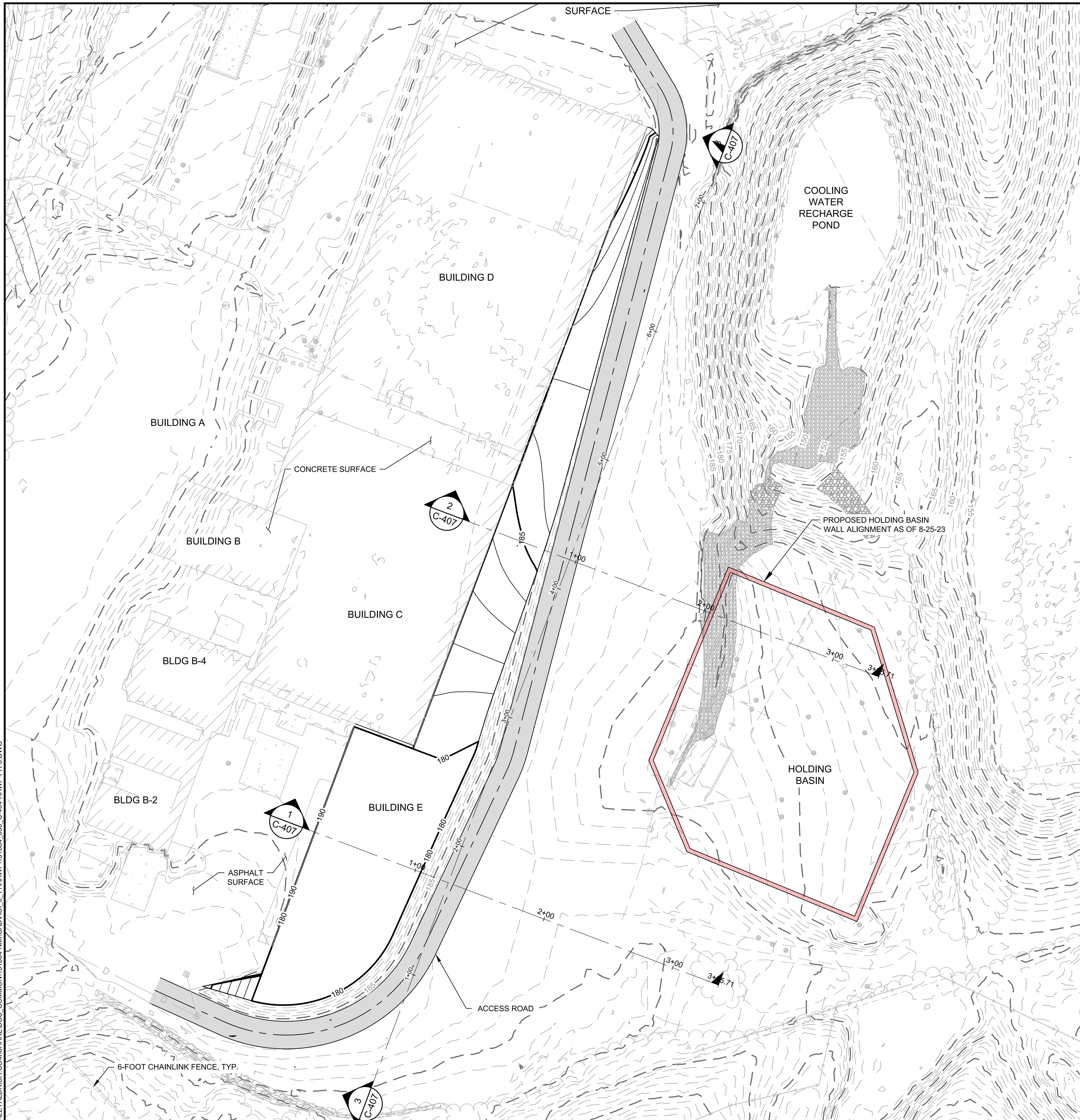
Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD, LANDFILL,SPHAGNUM BOG, AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXCAVATION PLAN COURTYARD AND BUILDING E - PHASE 2

C-403



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- HISTORICAL SAMPLING LOCATION
- 2023 PRE-CHARACTERIZATION SAMPLING LOCATION

NOTES

1. THE BASEMAP AND ELEVATION SURVEY WERE PROVIDED BY FELDMAN LAND SURVEYORS IN THE "EXISTING CONDITIONS PLAN" DATED MAY 15, 2020.
2. TOTAL ESTIMATED EXCAVATION VOLUME = 4,400 CY. (CUT)

SAMPLE LEGEND

GROUND SURFACE
0 TO 1.00
1.01 TO 2.00
2.01 TO 4.00
4.01 TO 6.00
6.01 TO 8.00
8.01 TO 10.00
>10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

N

0 40 80 120 160
SCALE IN FEET

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KEY PLAN
NOT TO SCALE

Project No.:	131884
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Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

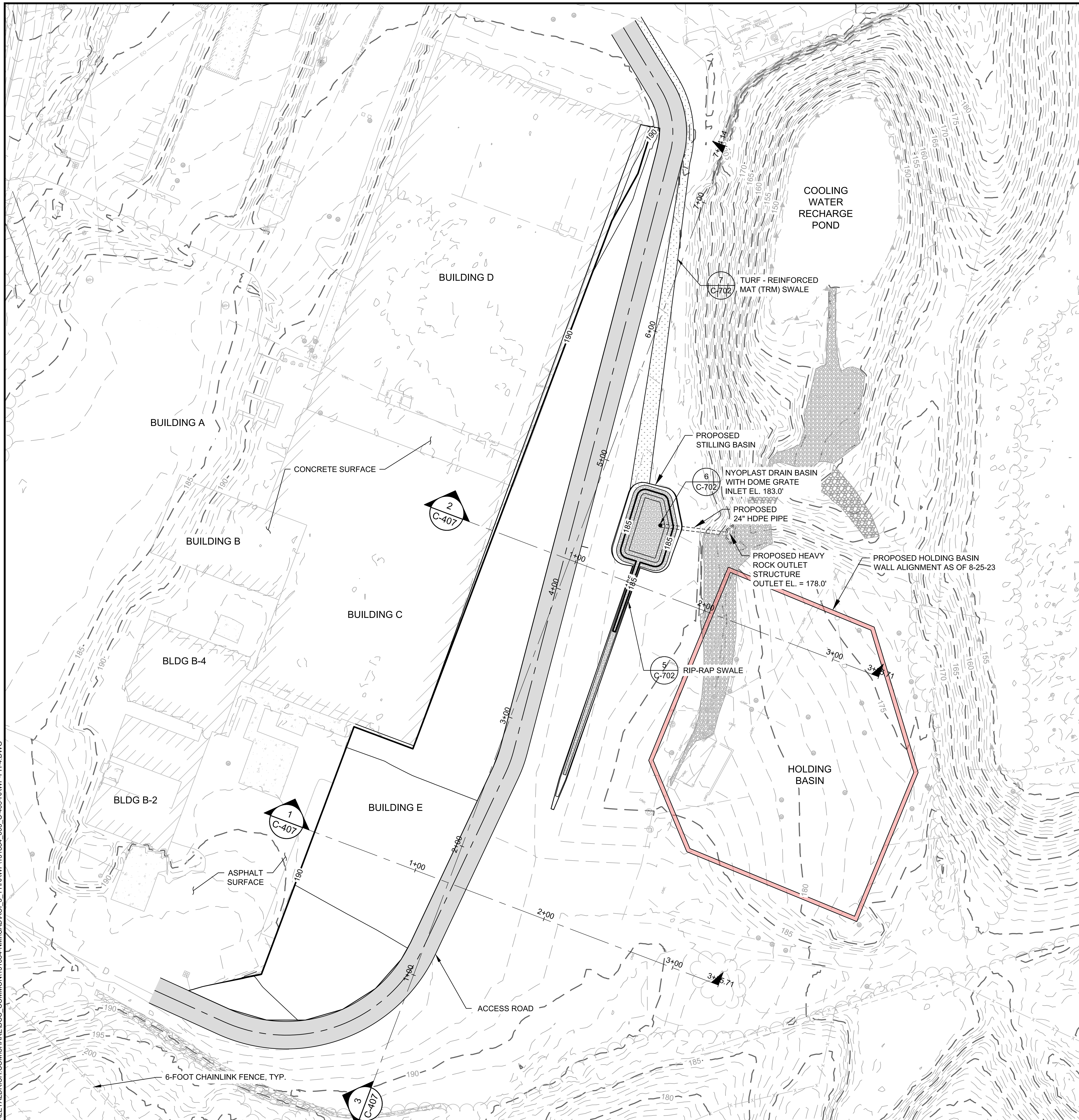
Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXCAVATION PLAN COURTYARD AND BUILDING E - PHASE 3

C-404

GAINES, JACK
\\HALEYALDRICH.COM\SHARE\BOS_COMMON\131884-NMI\CAD\AO_3_11\RAWP\131884_003_C-404-RAWP-PH-3.DWG
Printed: 4/23/2024 10:48 AM Layout: C-404



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- HISTORICAL SAMPLING LOCATION
- 2023 PRE-CHARACTERIZATION SAMPLING LOCATION

NOTES

1. THE BASEMAP AND ELEVATION SURVEY WERE PROVIDED BY FELDMAN LAND SURVEYORS IN THE "EXISTING CONDITIONS PLAN" DATED MAY 15, 2020.
2. TOTAL ESTIMATED EXCAVATION VOLUME = 7,200 CY. (FILL)

0 40 80 120 160
SCALE IN FEET

HALEY ALDRICH

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Project No.:	131884
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Checked By:	HA
Approved By:	HA

Stamp:

Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

RESTORATION PLAN COURTYARD AND BUILDING E - PHASE 4

C-405

Sheet: 19 of 37

GAINES, JACK Printed: 4/23/2024 10:49 AM Layout: C-405
\\HALEYALDRICH.COM\SHARE\BOS_COMMON\131884-NMI\CADAO_3_11\RAWP\131884_003_C-405-RAWP-PH-4.DWG

EXCAVATION DEPTH TABLE	
DEPTH RANGE (FEET)	COLOR
0 - 1	
1 - 2	
2 - 3	
3 - 4	
4 - 5	
5 - 6	
6 - 7	
7 - 8	
8 - 9	
9 - 10	
10 - 11	
11 - 12	
12 - 13	
13 - 14	
14 - 15	

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. TOTAL ESTIMATED EXCAVATION VOLUME = 32,300 CY. (CUT)
3. THE EXCAVATION GRADES SHOWN ARE THE MINIMUM CUT LINES. DRAWINGS C-402-C404 SHOW THE OVERALL CUT OF THE COURTYARD AND BUILDING E IN A SEQUENCE OF EXCAVATION AND GRADING TO MEET THE MINIMUM CUT SHOWN ON THIS DRAWING.

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11

SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- LIMITS OF EXCAVATION
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)

N

0 40 80 120 160
SCALE IN FEET

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Project No.:	131884
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Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA

Stamp:

Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

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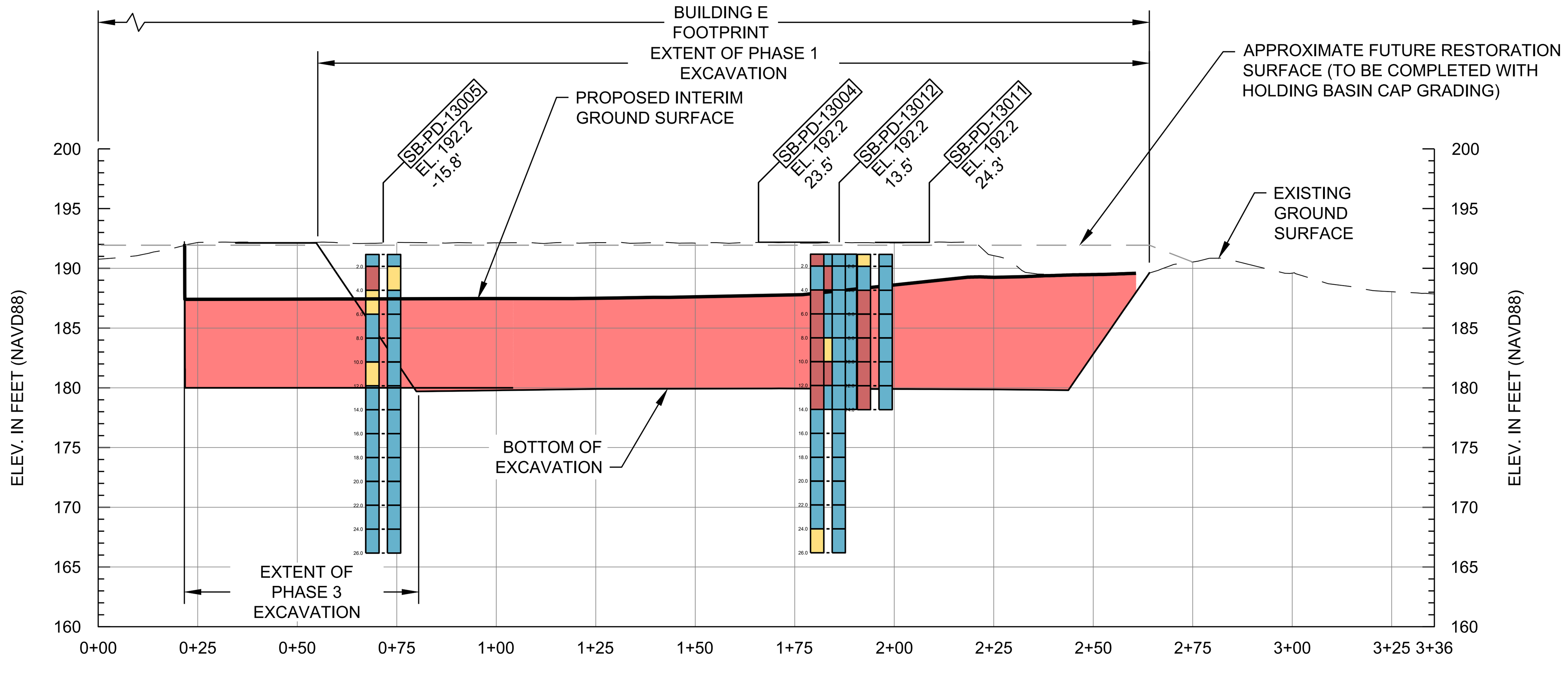
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

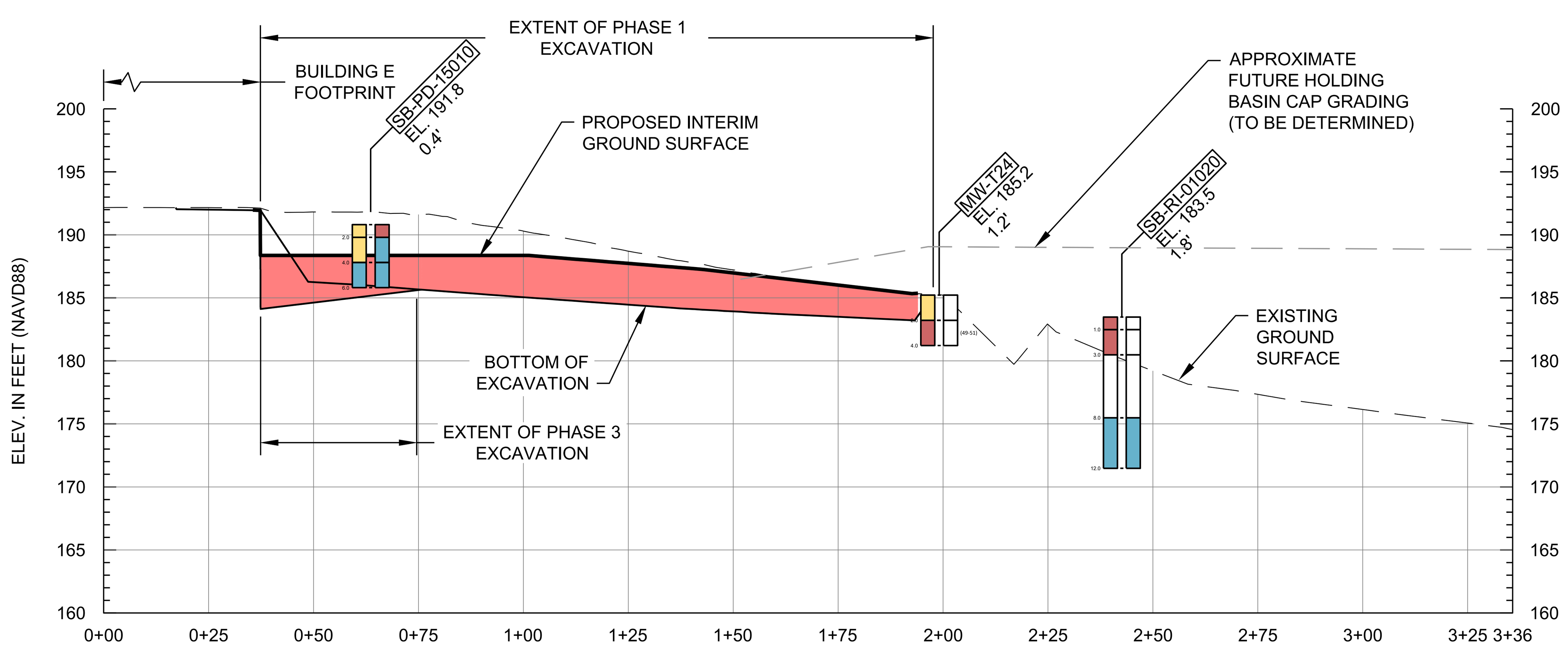
COLOR DEPTH PLAN COURTYARD AND BUILDING E

C-406

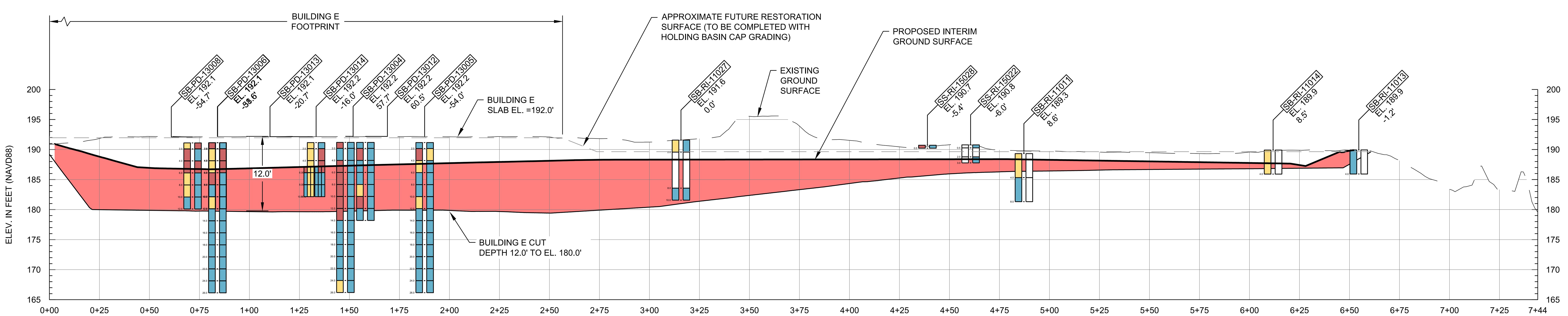
GAINES, JACK \\HALEYALDRICH.COM\SHARE\BOS_COMMON\131884-NMI\CADD\03_11\RAWP\131884_003_C-402_C-406_COLOR_MAP.DWG Printed: 4/23/2024 10:49 AM Layout: C-406



SECTION ALIGN-1-CY
SCALE AS SHOWN



SECTION ALIGN-2-CY
SCALE AS SHOWN



SECTION ALIGN-3-CY
SCALE AS SHOWN

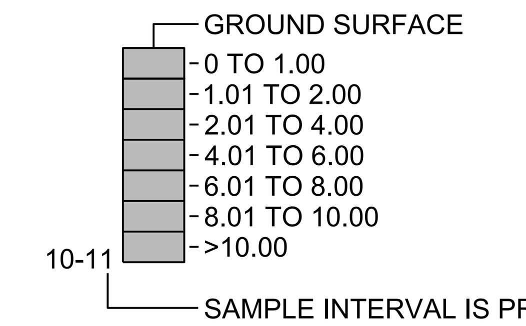
SECTION LEGEND

EXISTING GROUND SURFACE

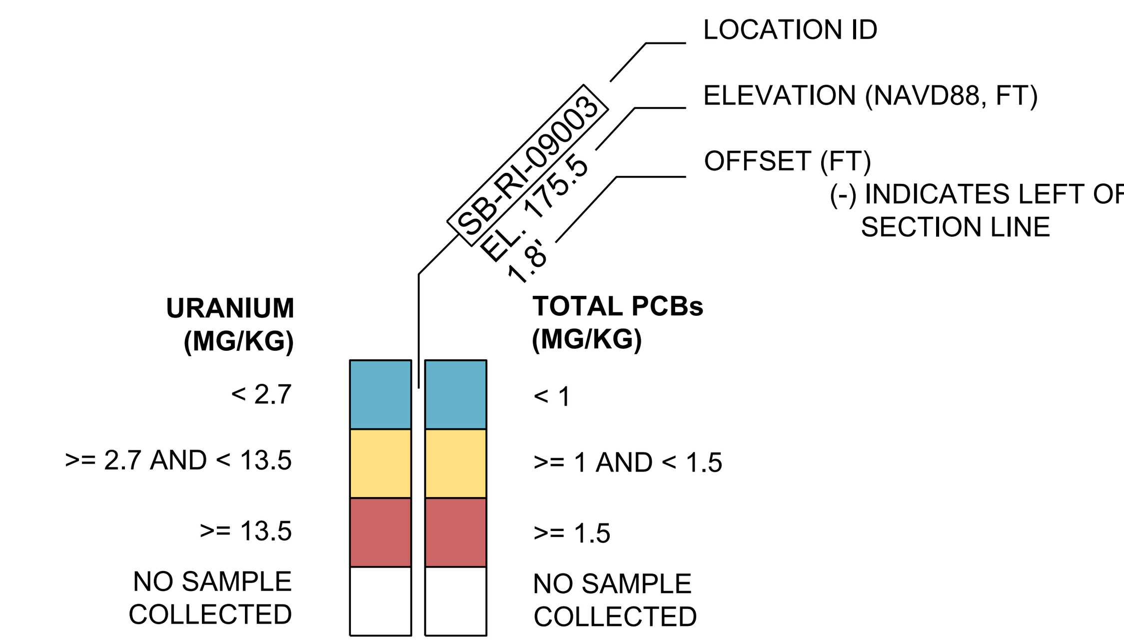
PROPOSED BOTTOM OF EXCAVATION AND ASSOCIATED CUT AREAS

PROPOSED RESTORATION

SAMPLE LEGEND



SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG



NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.

HALEY ALDRICH
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Checked By:	HA
Approved By:	HA
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Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD, LANDFILL,SPHAGNUM BOG, AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXCAVATION CROSS-SECTIONS – COURTYARD AND BUILDING E

C-407

Sheet: 21 of 37

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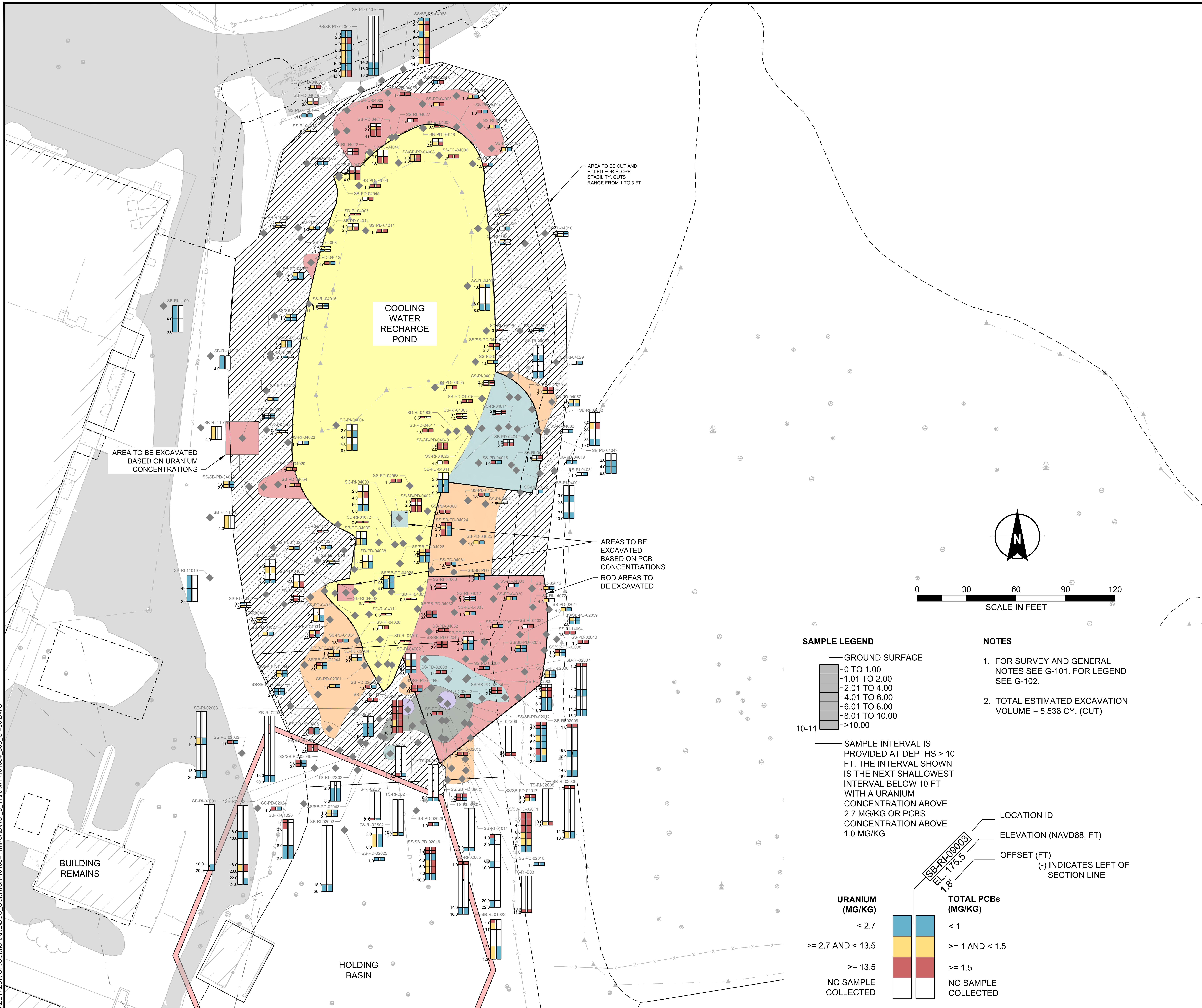
\\HALEYALDRICH.COM\SHARE\BOS_COMMON\131884-NMI\CAD\AO_3_11RAWP\131884_003_C-404.DWG



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
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- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- LIMITS OF EXCAVATION
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- HISTORICAL SAMPLING LOCATION
- AREAS TO BE CUT AND FILLED FOR SLOPE STABILITY, CUTS RANGE FROM 1 TO 3 FT.
- ADDITIONAL AREA TO BE EXCAVATED BASED ON SAMPLE CONCENTRATIONS
- ORIGINAL SITE AREA OF INTEREST (AOI) BOUNDARY
- ROD AREAS TO BE EXCAVATED

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11

SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

SB-RI-09003
EL. 175.5
1.8'

LOCATION ID
ELEVATION (NAVD88, FT)
OFFSET (FT)
(-) INDICATES LEFT OF SECTION LINE

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. TOTAL ESTIMATED EXCAVATION VOLUME = 5,536 CY. (CUT)

EXCAVATION DEPTH IN FEET

- 0.00 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 3.00
- 3.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- 11.00

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Approved By:	HA
Stamp:	

Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD, LANDFILL,SPHAGNUM BOG, AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXCAVATION PLAN FOR COOLING WATER POND SLOPES

C-408

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
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- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- LIMITS OF EXCAVATION

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. WETLAND SEDIMENT AND VEGETATIVE RESTORATION SHALL BE COMPLETED IN ACCORDANCE WITH SPECIFICATION 32 30 00, WETLAND AND UPLAND RESTORATION.
3. TOTAL ESTIMATED EXCAVATION VOLUME = 5,536 CY

N

0 30 60 90 120
SCALE IN FEET

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100% DESIGN

Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXCAVATION PLAN COOLING WATER POND

C-409

Saved by: JGAINES Printed: 4/23/2024 10:51 AM Sheet: C-409
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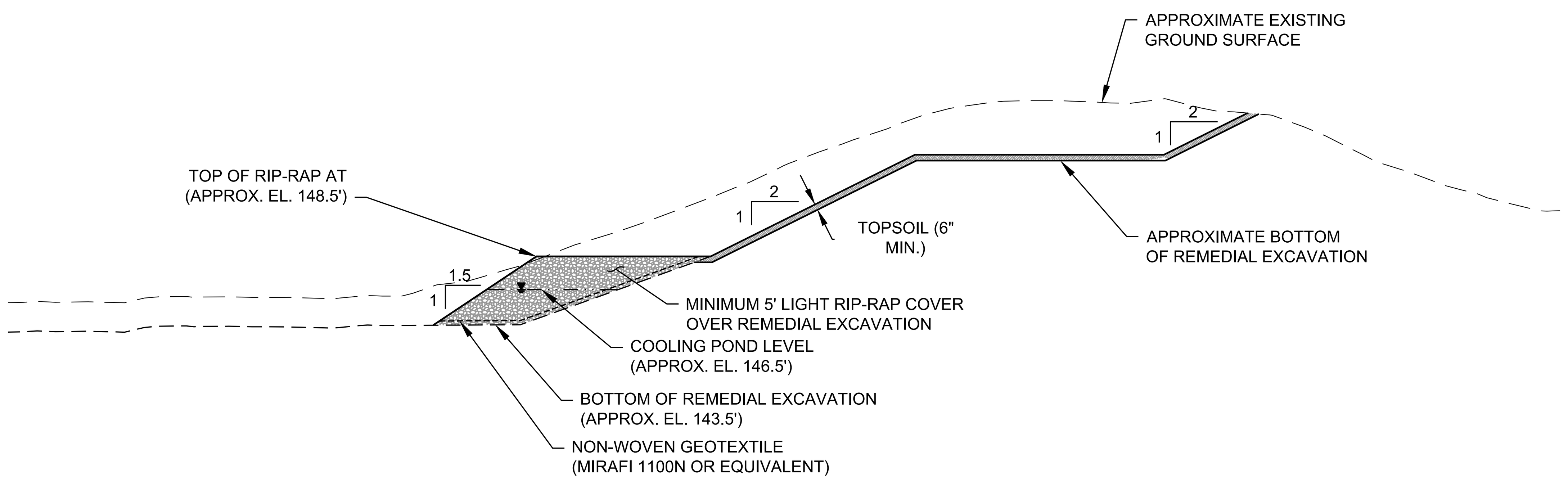
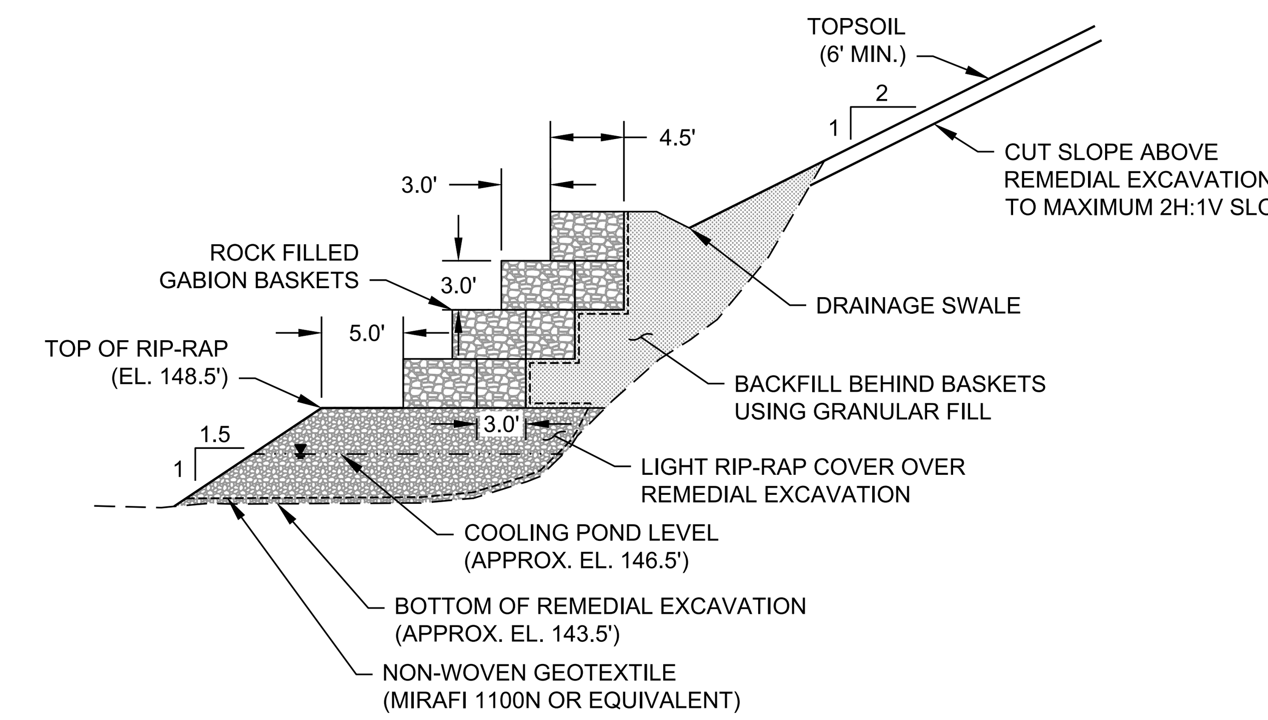
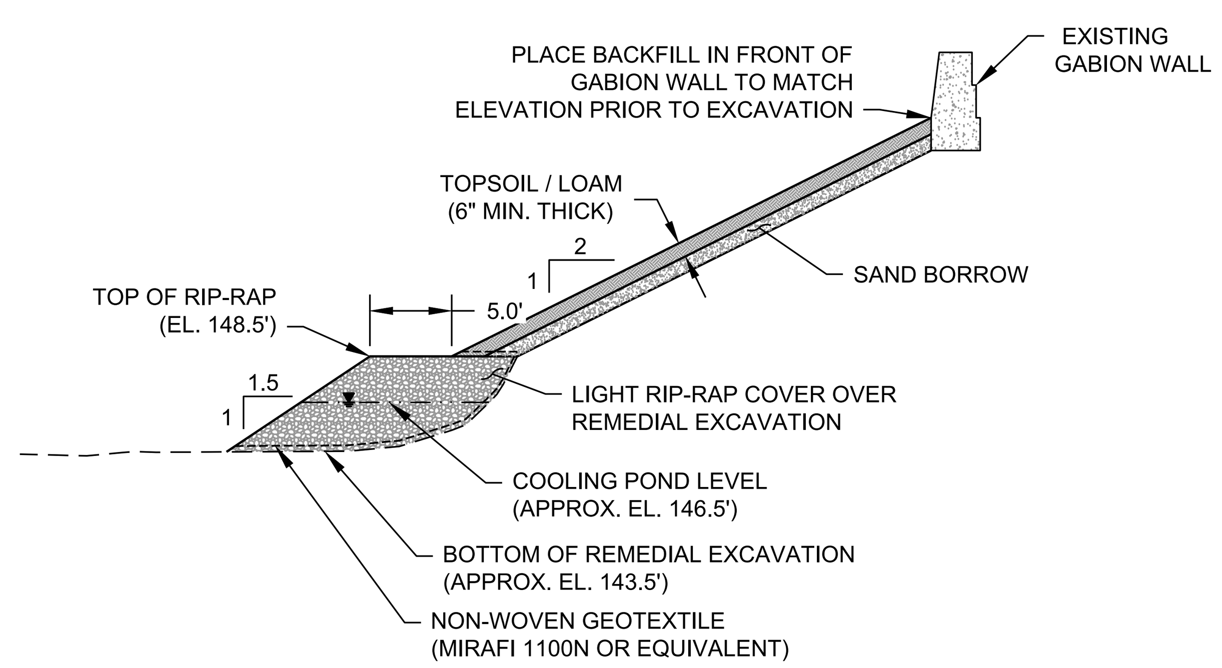


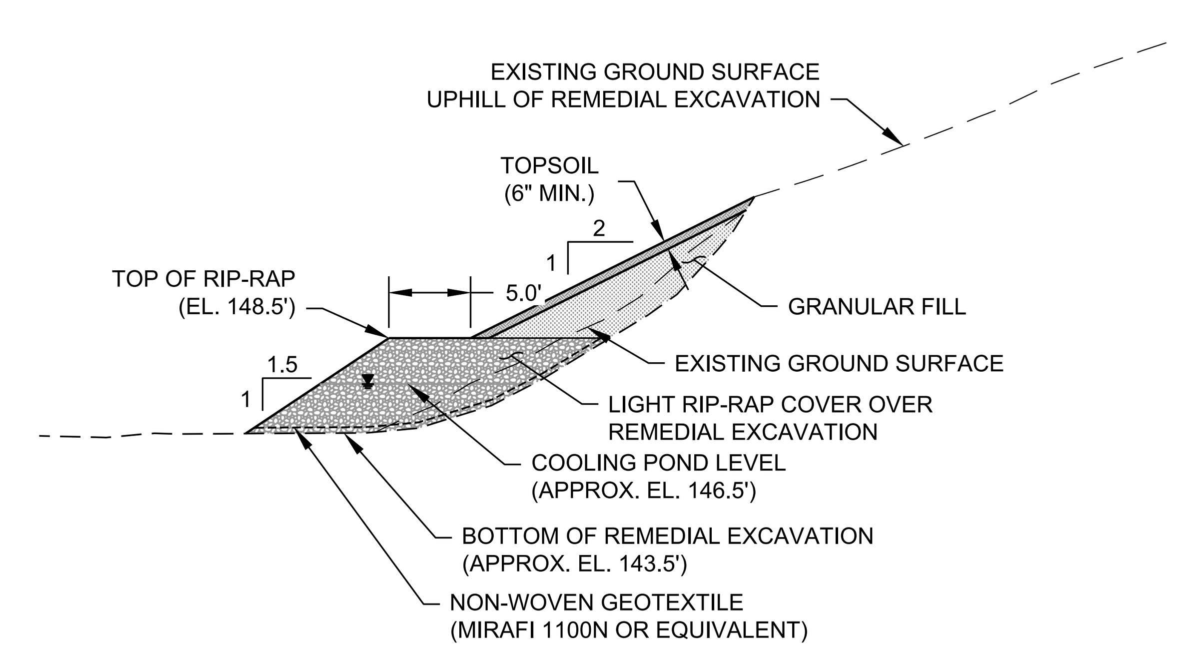
2
C-406
TYPICAL CROSS SECTION AT SECTION 2
NOT TO SCALE



3
C-406
TYPICAL CROSS SECTION AT SECTION 3
NOT TO SCALE



4
C-406
TYPICAL CROSS AT SECTION 4
NOT TO SCALE



5
C-406
TYPICAL CROSS SECTION WITH FILL TO FLATTEN SLOPE
NOT TO SCALE

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www.haleyaldrich.com

Project No.:	131884
Scale:	SHOWN
Date:	APRIL 2024
Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

Rev.	Description	By	Date
A	100% DESIGN	H&A	04/23/24

NUCLEAR METALS, INC.
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

EXCAVATION
SECTIONS
COOLING POND

C-410

Sheet: 24 of 37

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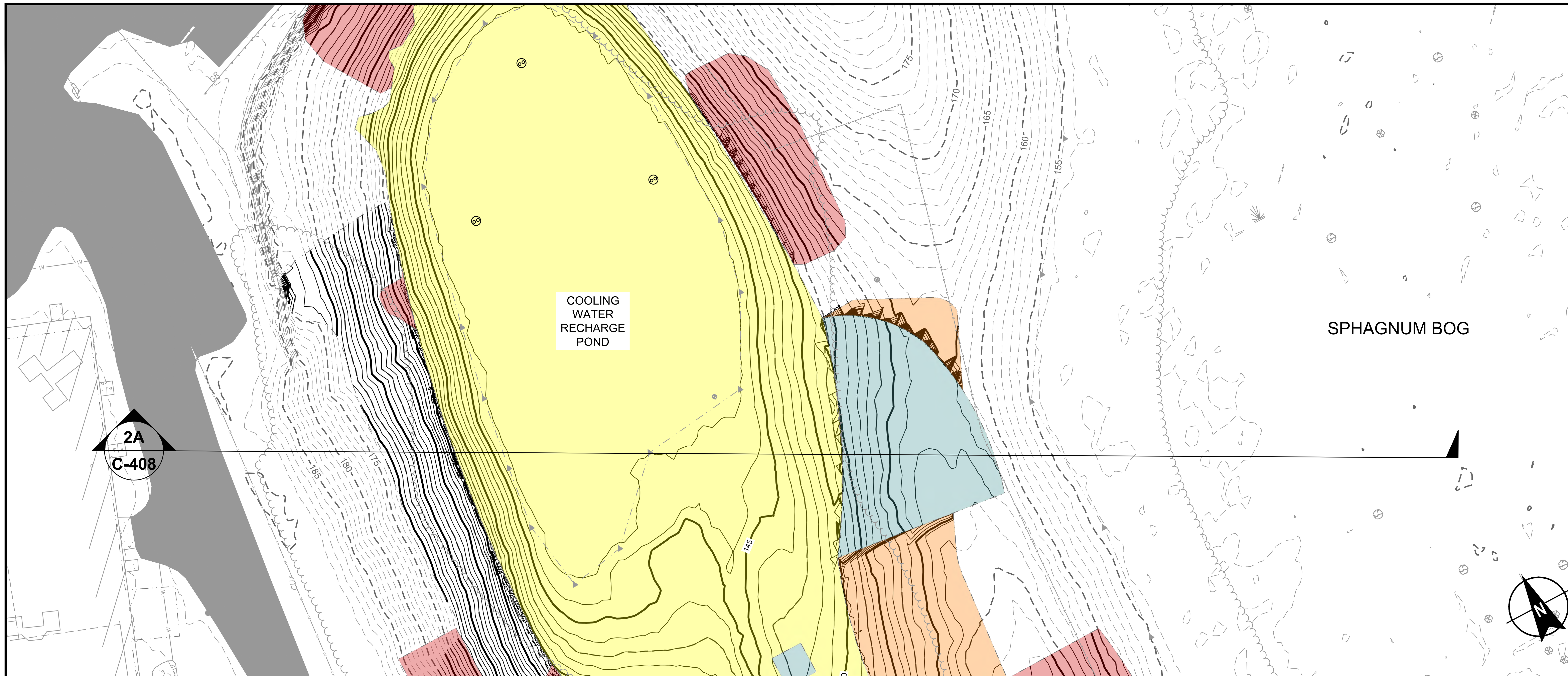
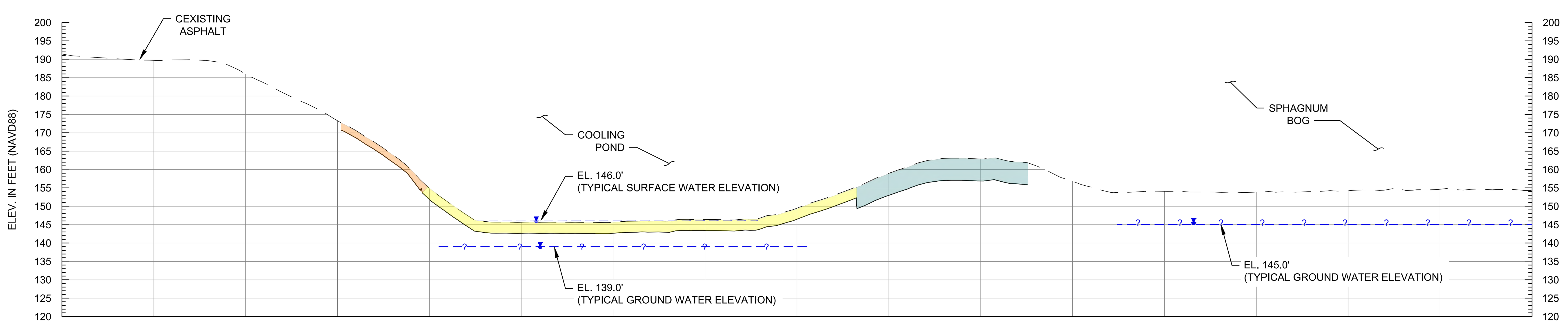


0 20 40 60 80
SCALE IN FEET

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- LIMITS OF EXCAVATION



SECTION ALIGN-2A
SCALE AS SHOWN

HORIZ. 0 20 40 60 80
VERT. 0 20 40 60 80
SCALE IN FEET

EXCAVATION DEPTH IN FEET

- 0.00 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 3.00
- 3.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- 11.00

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. PRIOR TO EXCAVATION OF COOLING WATER POND SEDIMENT, THE MEAN LOW GROUNDWATER ELEVATION WILL BE DEFINED.

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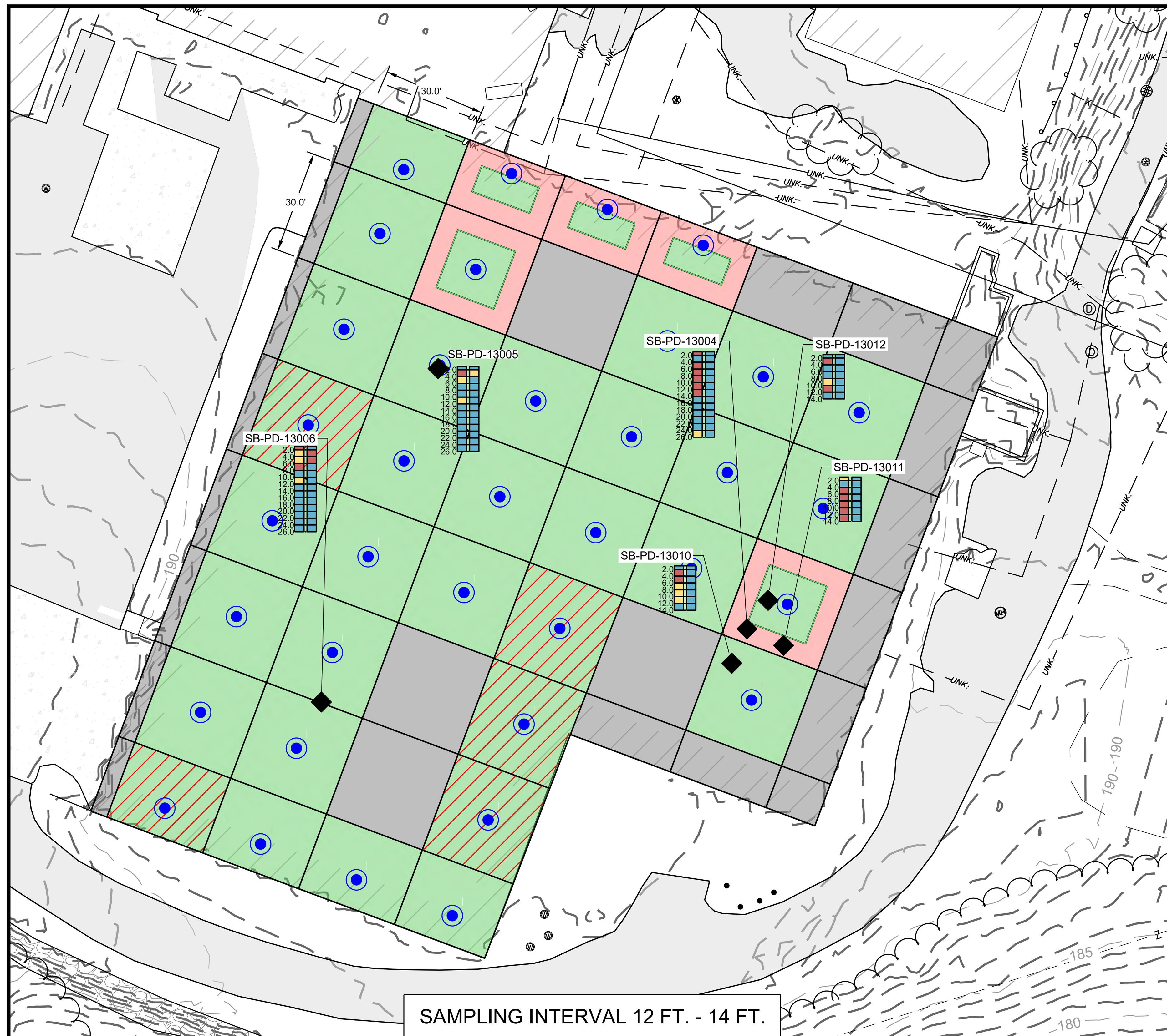
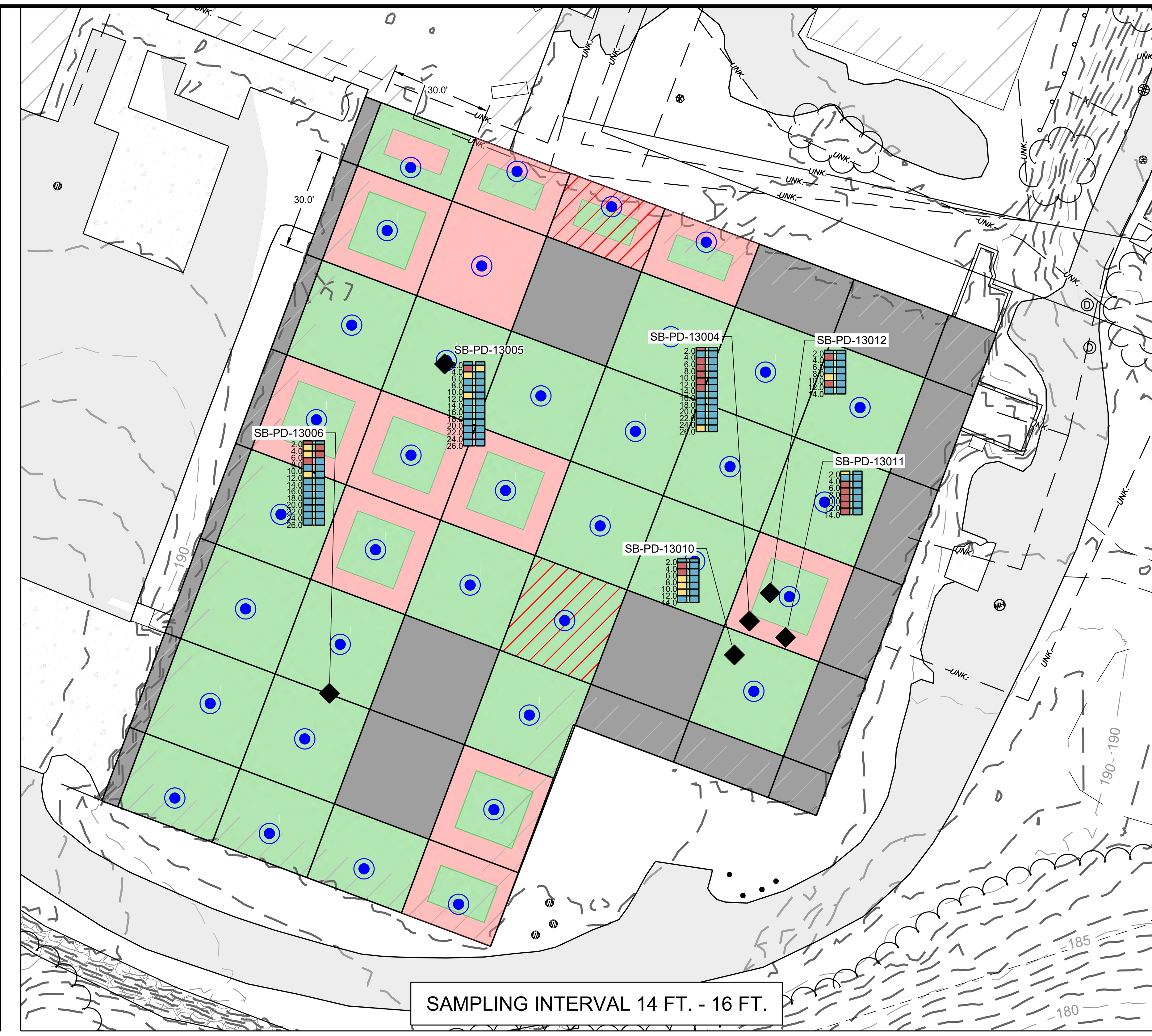
CONCORD, MASSACHUSETTS

GROUNDWATER / SURFACE WATER INTERACTION SECTION

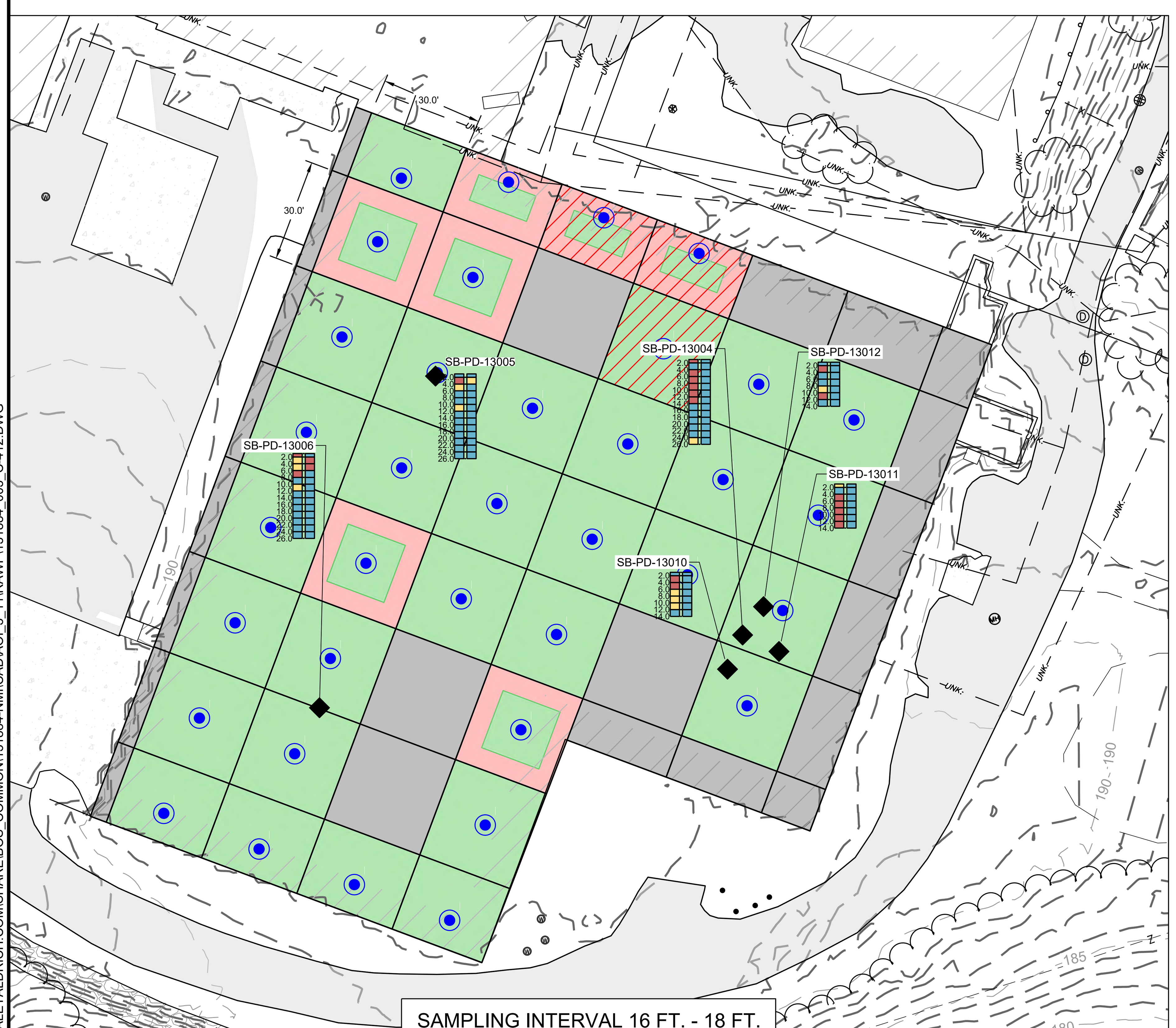
C-411



SAMPLING INTERVAL 12 FT. - 14 FT.



SAMPLING INTERVAL 14 FT. - 16 FT.



SAMPLING INTERVAL 16 FT. - 18 FT.

SAMPLING INTERVAL 18 FT. - 20 FT.

LEGEND

- BUILDING SLAB
- 1 FT EXISTING GROUND CONTOUR
- 100 — 5 FT EXISTING GROUND CONTOUR
- ASPHALT
- CONCRETE
- GRAVEL
- SUPPLEMENTAL PRE-CHARACTERIZATION BORINGS/ GEOPROBES
- PCB OVER ROD CLEANUP LEVEL (PCB>1.0 MG/KG)
- URANIUM OVER ROD CLEANUP LEVEL (U>2.7 MG/KG)
- PCB UNDER ROD CLEANUP LEVEL (PCB<1.0 MG/KG)
- URANIUM UNDER ROD CLEANUP LEVEL (U<2.7 MG/KG)
- ARSENIC, ThORIUM, AND/OR PAH CONCENTRATIONS ABOVE ROD CLEANUP LEVEL.
  ROD CLEANUP LEVELS:
  ARSENIC>13.7 mg/kg;
  ThORIUM>7.4 mg/kg,
  BENZO(A)ANThRACENE>0.34 mg/kg;
  BENZO(A)PYRENE>0.22 mg/kg;
  BENZO(B)FLUORANTENE>0.34 mg/kg;
  IDENO(1,2,3-CD)PYRENE>0.34 mg/kg
- NO DATA/NO SAMPLE COLLECTED

NOTE:
OUTER BOX = URANIUM RESULTS
INNER BOX = PCB RESULTS
RED = CONCENTRATION OVER ROD CLEANUP LEVEL
GREEN = CONCENTRATION UNDER ROD CLEANUP LEVEL

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

N

0 30 60 90 120
SCALE IN FEET

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LANDFILL,SPHAGNUM BOG,
AND COOLING POND
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CONCORD, MASSACHUSETTS

POST EXCAVATION BUILDING E FOOTPRINT

C-412

Sheet: 26 of 37

Saved by: JGAINES Printed: 4/23/2024 10:53 AM Sheet: C-412
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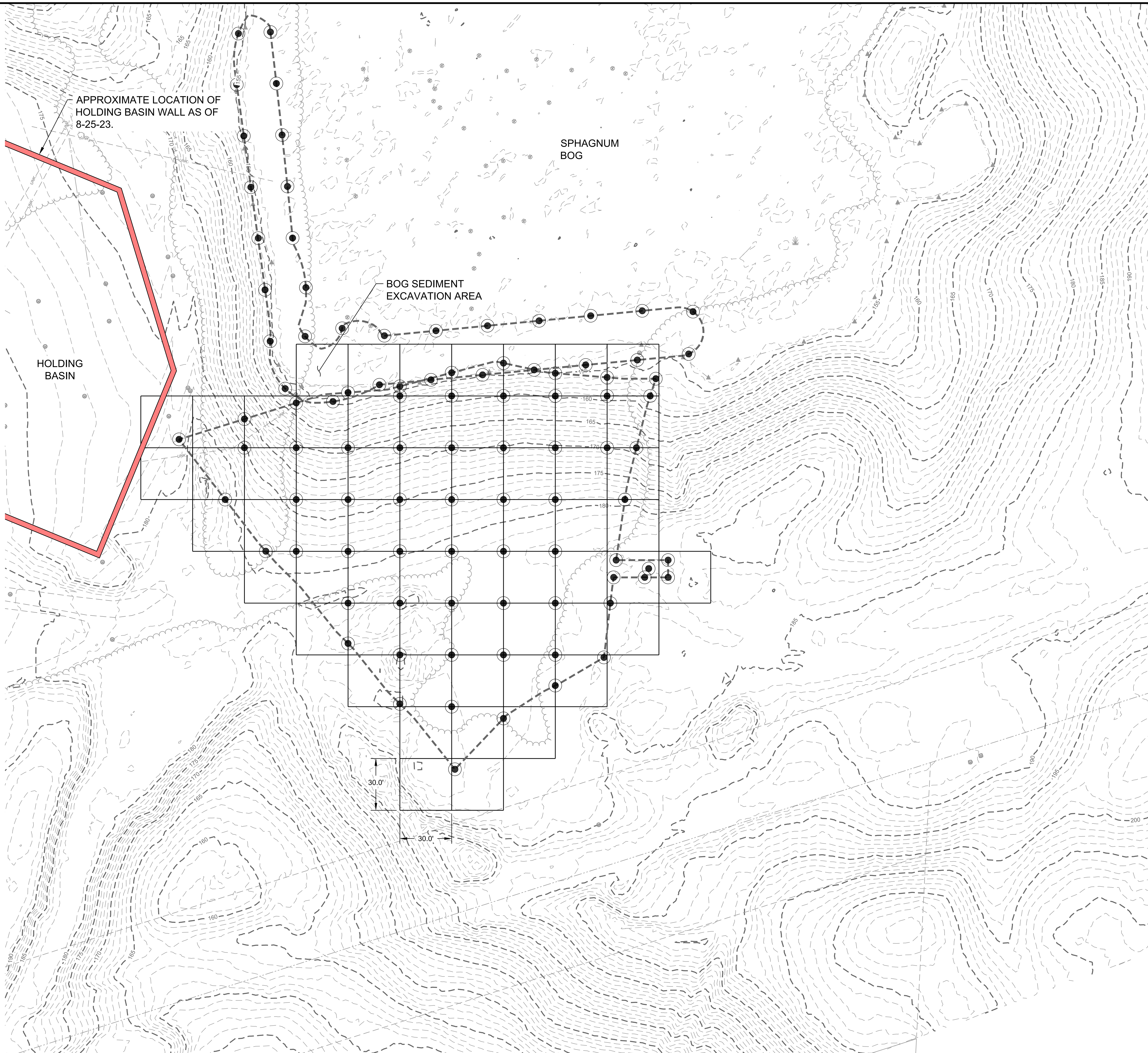

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- PROPOSED CONFIRMATORY SAMPLING LOCATION
- RISK BOUNDARY
- 30' X 30' GRID SAMPLING AREA

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. CONFIRMATORY SAMPLES SHALL BE COLLECTED ON THE BORDER OF THE BOG. HOWEVER, NO ADDITIONAL EXCAVATION OF THE BOG SEDIMENTS WILL BE PERFORMED. THE CONFIRMATION SAMPLES ARE BEING COLLECTED FOR DOCUMENTATION ONLY.

N

0 30 60 90 120
SCALE IN FEET

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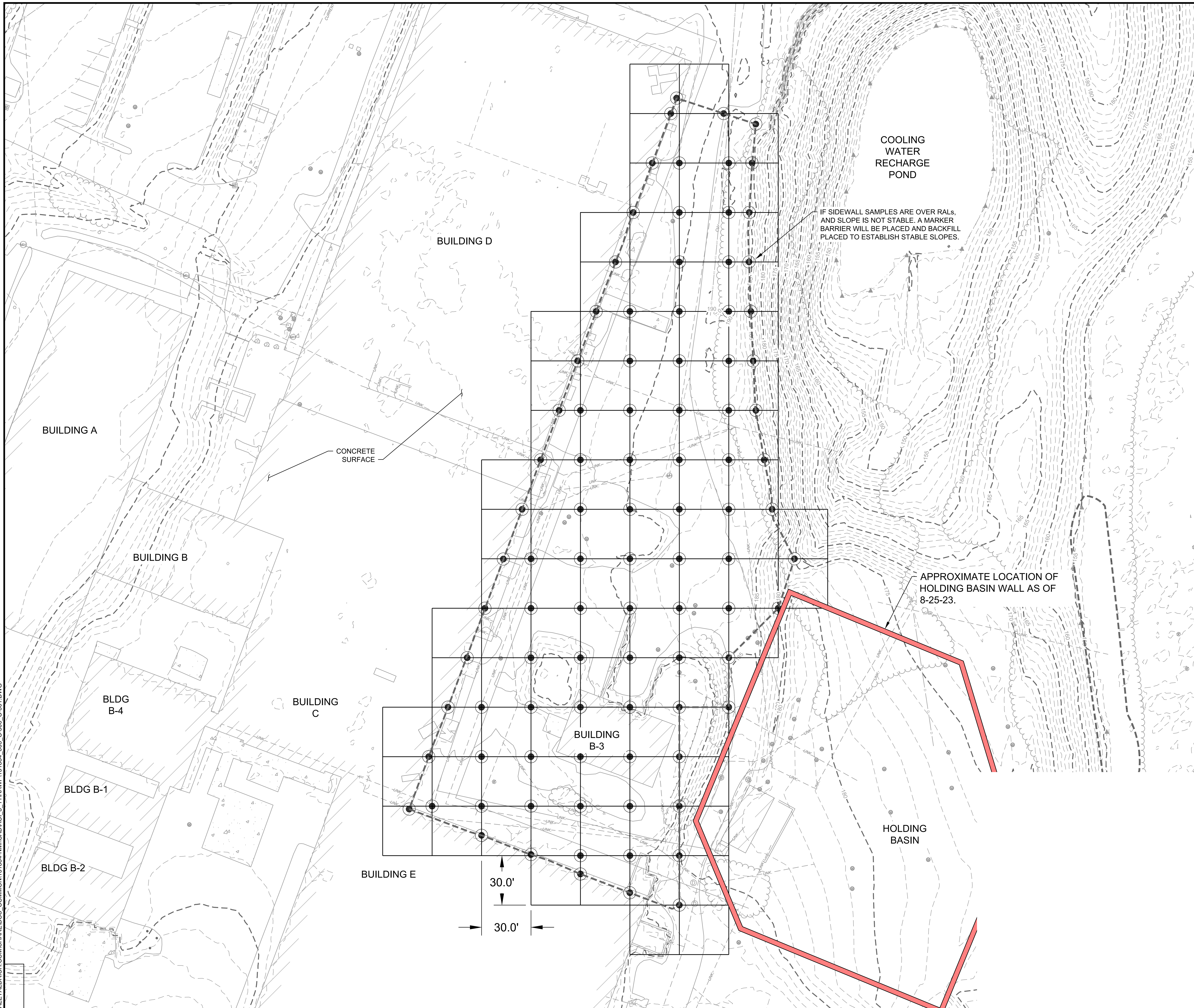
CONCORD, MASSACHUSETTS

CONFIRMATORY SAMPLING LOCATIONS LANDFILL AND SPHAGNUM BOG

C-500

Sheet: 27 of 37



LEGEND

	SITE BOUNDARY
	BUILDING SLAB
	CHAIN LINK FENCE
	GUARDRAIL
	1 FT EXISTING GROUND CONTOUR
100	5 FT EXISTING GROUND CONTOUR
D	STORM DRAIN LINE
S	SANITARY SEWER LINE
W	WATER LINE
E	ELECTRIC LINE
EO	OVERHEAD ELECTRICAL LINE
C	CABLE LINE
G	GAS LINE
T	TELEPHONE LINE
UNK	UNKNOWN UTILITY
	WETLAND BOUNDARY
	VEGETATION BOUNDARY
	TREE/SHRUB
	MONITORING OR PRODUCTION WELL
	CATCH BASIN
	SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
	UTILITY POLE
	POST
	ASPHALT
	CONCRETE
	GRAVEL
	PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
	PROPOSED CONFIRMATORY SAMPLING LOCATION
	RISK BOUNDARY
	30' X 30' GRID SAMPLING AREA

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.

0 30 60 90 120
SCALE IN FEET

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CONFIRMATORY SAMPLING LOCATIONS COURTYARD

C-501

Sheet: 28 of 37

SAMPLE LEGEND

- GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 — SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

SB-RI-09003 — LOCATION ID
EL. 175.5 — ELEVATION (NAVD88, FT)
1.8' — OFFSET (FT) (-) INDICATES LEFT OF SECTION LINE

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. TOTAL ESTIMATED EXCAVATION VOLUME = 5,600 CY.

0 30 60 90 120
SCALE IN FEET

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- PROPOSED CONFIRMATORY SAMPLING LOCATION
- RISK BOUNDARY
- 30' X 30' GRID SAMPLING AREA

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CONCORD, MASSACHUSETTS

CONFIRMATORY SAMPLING LOCATIONS COOLING WATER POND

C-502

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)
- PROPOSED CONFIRMATORY SAMPLING LOCATION
- RISK BOUNDARY
- 30' X 30' GRID SAMPLING AREA

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. SAMPLE LOCATIONS WILL BE ADJUSTED BASED ON INSTITUTIONAL CONTROLS (ICS). A MINIMUM OF 10 FT. OF CLEAN COVER OVER CONTAMINATED SOILS WILL BE ESTABLISHED FOR FINAL GRADING TO BE DETERMINED AS PART OF PHASE 2 WHERE BUILDING C AND D GRADES WILL BE DETERMINED AND FINISHED GRADES WILL BE ESTABLISHED ACCORDINGLY.
3. THE INTERIM GRADES ESTABLISHED AS SHOWN AS SHOWN ON PHASE 4 GRADING OF THE COURTYARD AND BUILDING E WILL BE WILL BE INTERIM GRADES FOR ALLOWING FUTURE INVESTIGATIONS OF BUILDING C AND D, AND FOR THE COMPLETION OF ISS WITH ADEQUATE DRAINAGE CONTROLS TO MINIMIZE EROSION.

N

0 20 40 60 80
SCALE IN FEET

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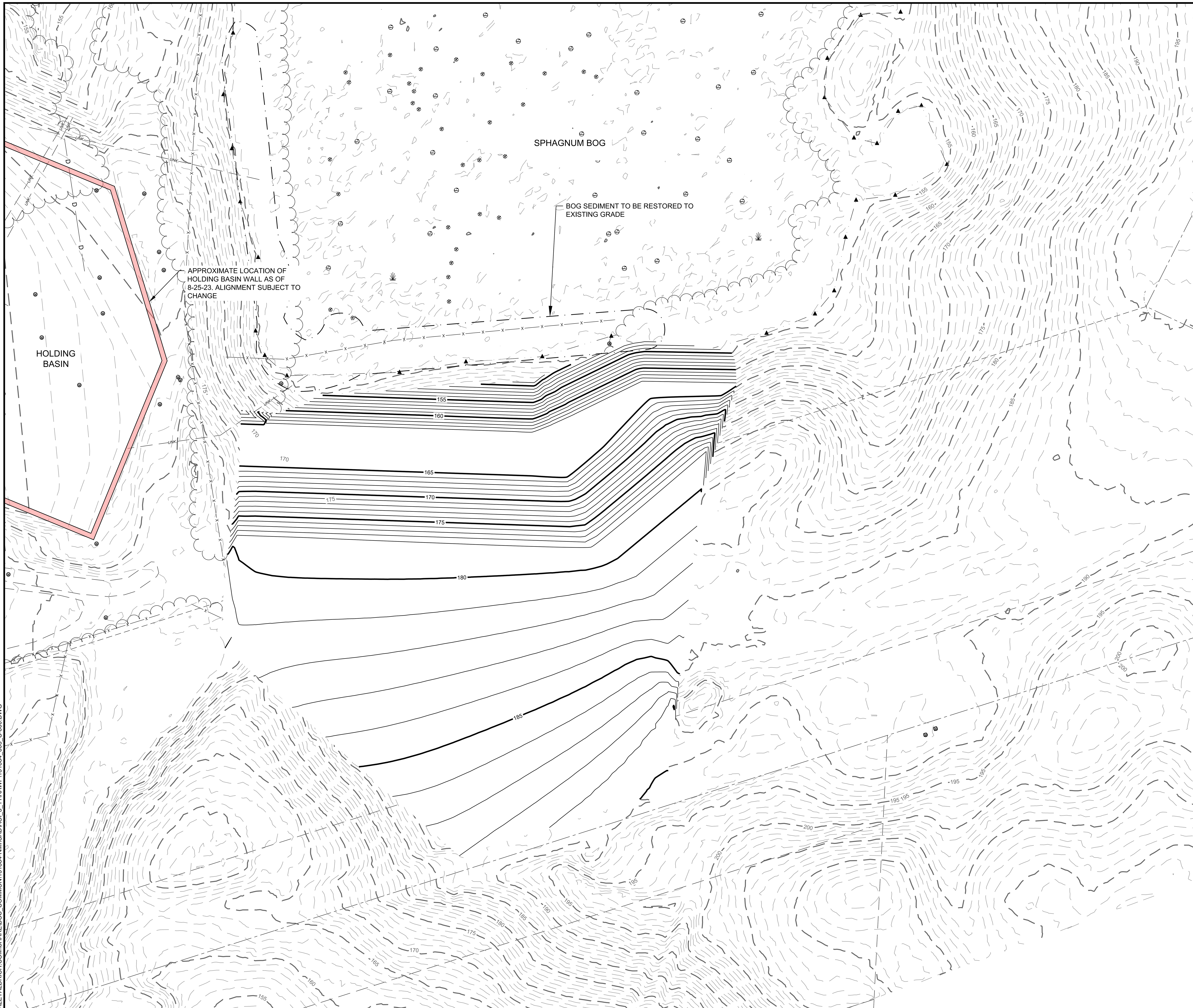
CONCORD, MASSACHUSETTS

CONFIRMATORY SAMPLING LOCATIONS BUILDING E

C-503



LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRIC LINE
- OVERHEAD ELECTRICAL LINE
- CABLE LINE
- GAS LINE
- TELEPHONE LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- ASPHALT
- CONCRETE
- GRAVEL
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. WETLAND SEDIMENT AND VEGETATIVE RESTORATION SHALL BE COMPLETED IN ACCORDANCE WITH SPECIFICATION 32 30 00, WETLAND AND UPLAND RESTORATION.

N

0 30 60 90 120
SCALE IN FEET

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AND COOLING POND
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CONCORD, MASSACHUSETTS

SITE RESTORATION PLAN LANDFILL AND BOG SEDIMENT

C-600

GAINES, JACK
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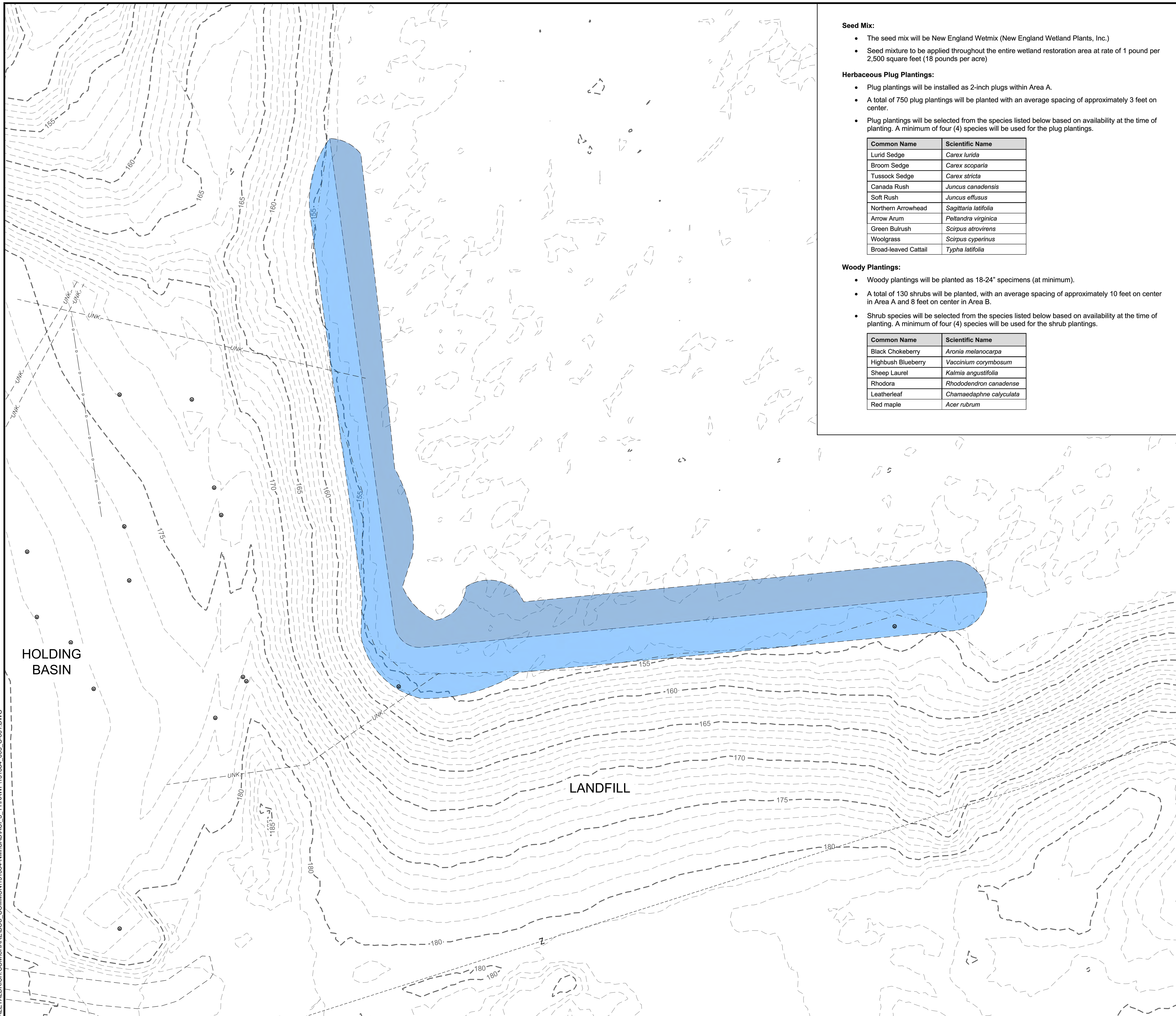

Seed Mix:

- The seed mix will be New England Wetmix (New England Wetland Plants, Inc.)
- Seed mixture to be applied throughout the entire wetland restoration area at rate of 1 pound per 2,500 square feet (18 pounds per acre)

Herbaceous Plug Plantings:

- Plug plantings will be installed as 2-inch plugs within Area A.
- A total of 750 plug plantings will be planted with an average spacing of approximately 3 feet on center.
- Plug plantings will be selected from the species listed below based on availability at the time of planting. A minimum of four (4) species will be used for the plug plantings.

Common Name	Scientific Name
Lurid Sedge	*Carex lurida*
Broom Sedge	*Carex scoparia*
Tussock Sedge	*Carex stricta*
Canada Rush	*Juncus canadensis*
Soft Rush	*Juncus effusus*
Northern Arrowhead	*Sagittaria latifolia*
Arrow Arum	*Peltandra virginica*
Green Bulrush	*Scirpus atrovirens*
Woolgrass	*Scirpus cyperinus*
Broad-leaved Cattail	*Typha latifolia*

Woody Plantings:

- Woody plantings will be planted as 18-24" specimens (at minimum).
- A total of 130 shrubs will be planted, with an average spacing of approximately 10 feet on center in Area A and 8 feet on center in Area B.
- Shrub species will be selected from the species listed below based on availability at the time of planting. A minimum of four (4) species will be used for the shrub plantings.

Common Name	Scientific Name
Black Chokeberry	*Aronia melanocarpa*
Highbush Blueberry	*Vaccinium corymbosum*
Sheep Laurel	*Kalmia angustifolia*
Rhodora	*Rhododendron canadense*
Leatherleaf	*Chamaedaphne calyculata*
Red maple	*Acer rubrum*

LEGEND

SITE BOUNDARY
BUILDING SLAB
CHAIN LINK FENCE
GUARDRAIL
1 FT EXISTING GROUND CONTOUR
5 FT EXISTING GROUND CONTOUR
STORM DRAIN LINE
SANITARY SEWER LINE
WATER LINE
ELECTRIC LINE
OVERHEAD ELECTRICAL LINE
CABLE LINE
GAS LINE
TELEPHONE LINE
UNKNOWN UTILITY
WETLAND BOUNDARY
VEGETATION BOUNDARY
TREE/SHRUB
MONITORING OR PRODUCTION WELL
CATCH BASIN
SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
UTILITY POLE
POST

WETLAND RESTORATION AREAS:

AREA A = 5,990.00 SF.
AREA B = 5,385.00 SF.
TOTAL = 11,375.00 SF.

0 20 40 60 80
SCALE IN FEET

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NUCLEAR METALS, INC.
COURTYARD,
LANDFILL,SPHAGNUM BOG,
AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

WETLAND
RESTORATION
PLAN

C-601

LEGEND

- SITE BOUNDARY
- BUILDING SLAB
- CHAIN LINK FENCE
- GUARDRAIL
- 1 FT EXISTING GROUND CONTOUR
- 100 — 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 100 — 5 FT PROPOSED GROUND CONTOUR
- D — STORM DRAIN LINE
- S — SANITARY SEWER LINE
- W — WATER LINE
- E — ELECTRIC LINE
- OO — OVERHEAD ELECTRICAL LINE
- C — CABLE LINE
- G — GAS LINE
- T — TELEPHONE LINE
- UNK — UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- TREE/SHRUB
- MONITORING OR PRODUCTION WELL
- CATCH BASIN
- SEWER/DRAIN/ELECTRIC/TELEPHONE/ GENERAL MANHOLE
- UTILITY POLE
- POST
- PROPOSED HOLDING BASIN WALL ALIGNMENT AS OF 8-25-23 (ALIGNMENT SUBJECT TO CHANGE)

RESTORATION VOLUME:

CUT: 1,228 CY.
FILL: 7,119 CY.
NET: 5892 CY. <FILL>

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. WETLAND SEDIMENT AND VEGETATIVE RESTORATION SHALL BE COMPLETED IN ACCORDANCE WITH SPECIFICATION 32 30 00, WETLAND AND UPLAND RESTORATION.

N

0 30 60 90 120
SCALE IN FEET

HALEY ALDRICH

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Scale:	SHOWN
Date:	APRIL 2024
Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

Rev.	Description	By	Date
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NUCLEAR METALS, INC.
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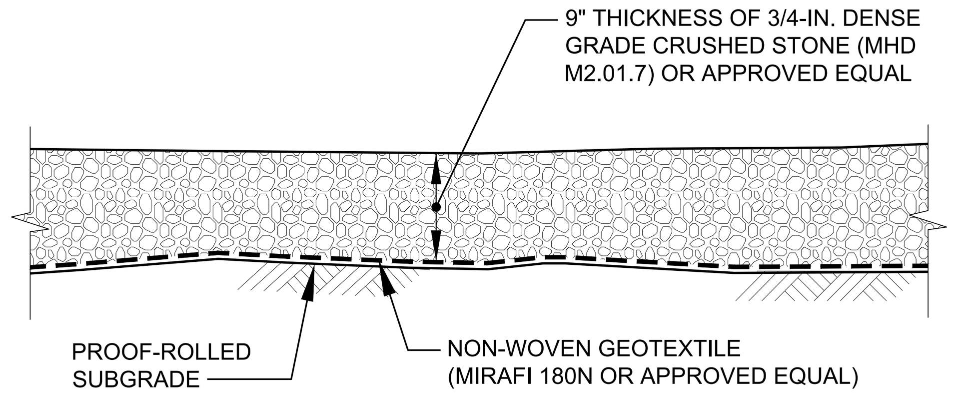
CONCORD, MASSACHUSETTS

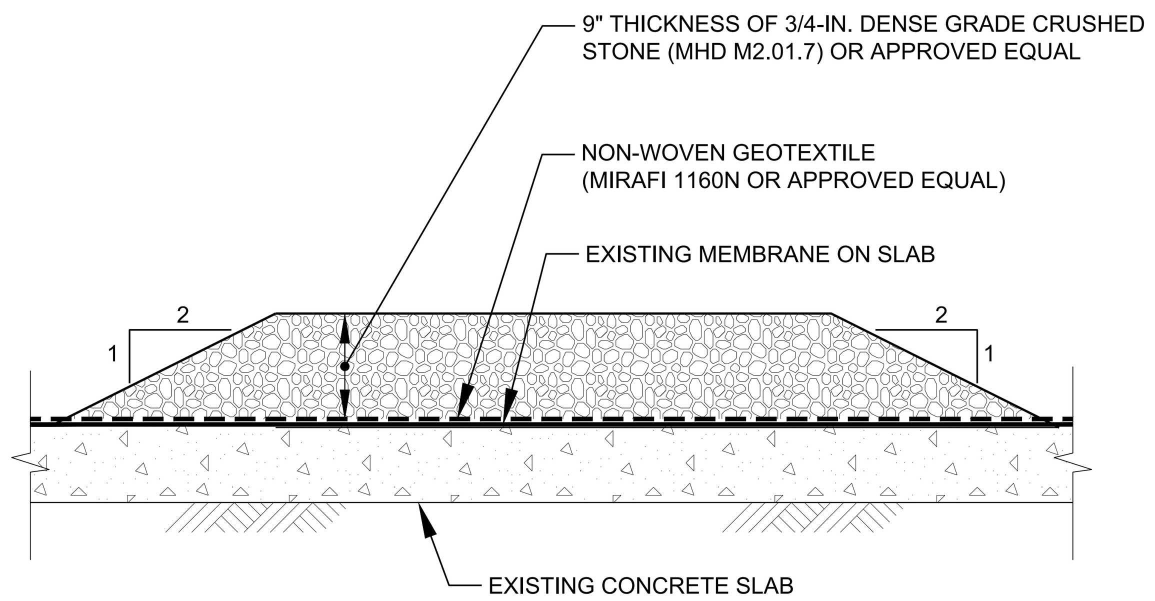
SITE RESTORATION PLAN COOLING POND

C-602

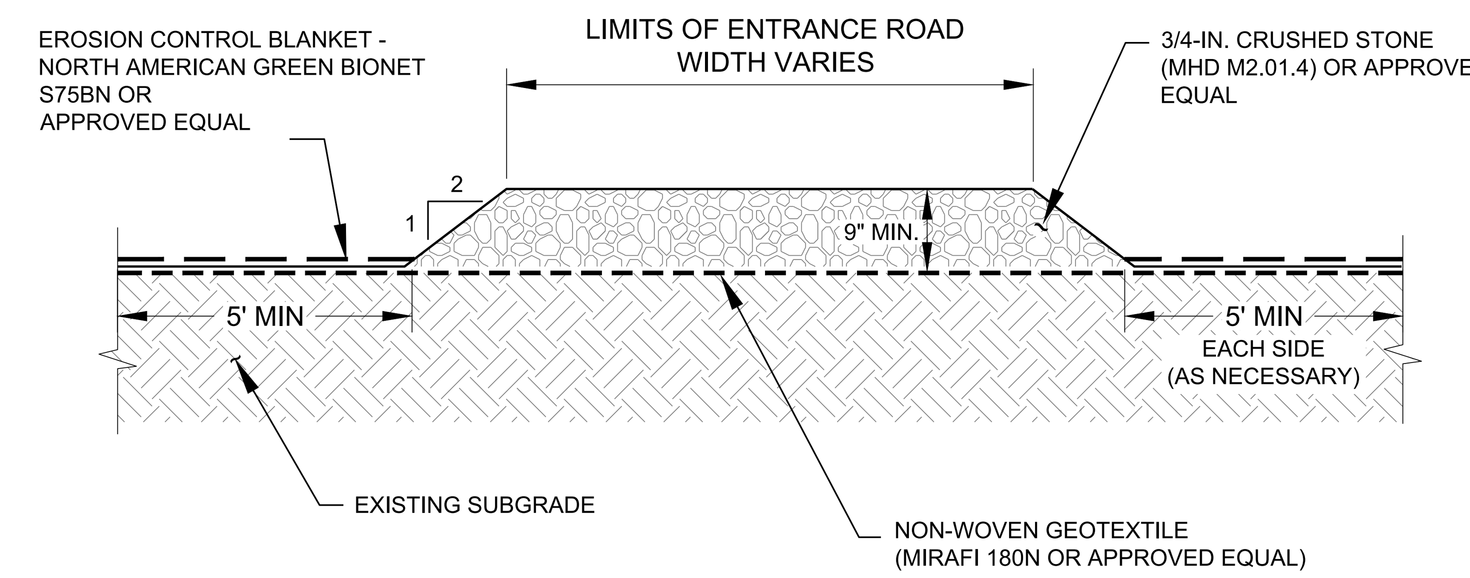
Saved by: JGAINES Printed: 4/23/2024 10:56 AM Sheet: C-602
\\HALEYALDRICH.COM\SHARE\BOS_COMMON\131884-NMI\CAD\AOI_3_11\RAWP\131884_003_C-602.DWG



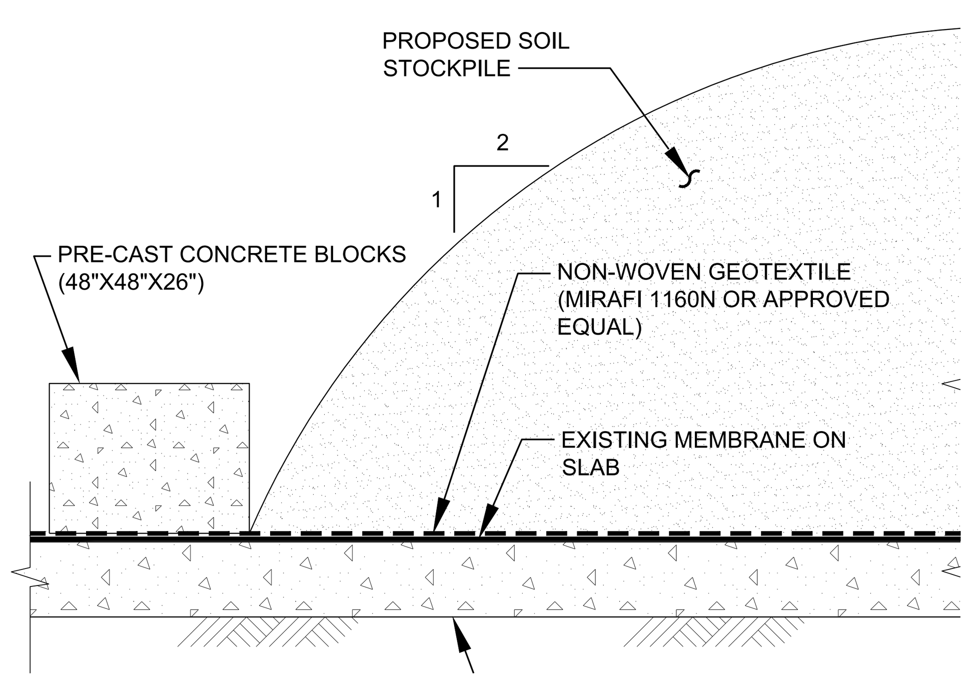
1 PROPOSED TRUCK ROAD DETAIL (ADJACENT TO BUILDING A)
SCALE: NOT TO SCALE



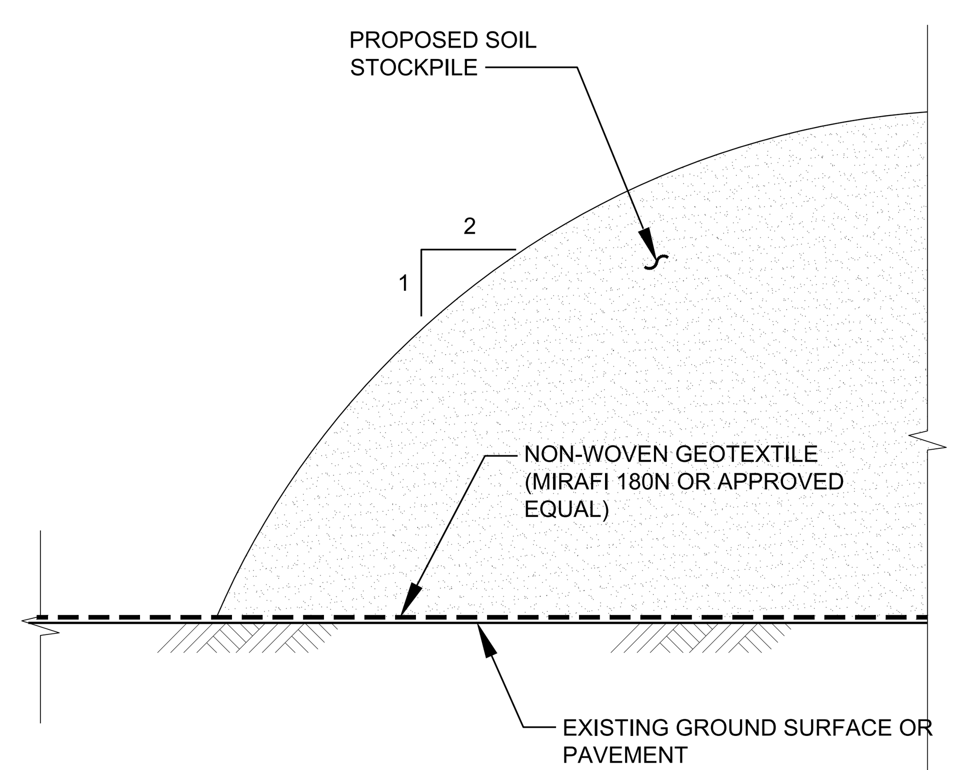
2 PROPOSED TRUCK ROADWAY OVER EXISTING BUILDING SLAB
SCALE: NOT TO SCALE



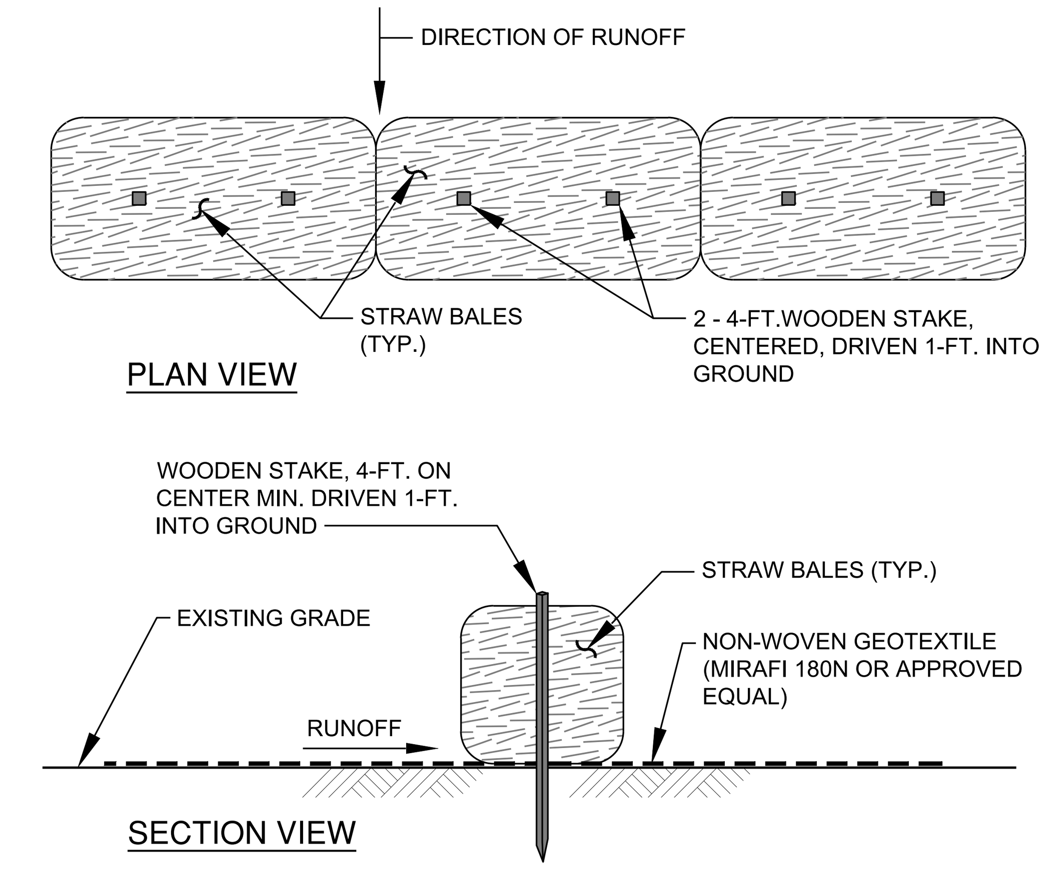
3 PROPOSED TRUCK ROADWAY IN WOODED AREAS
SCALE: NOT TO SCALE



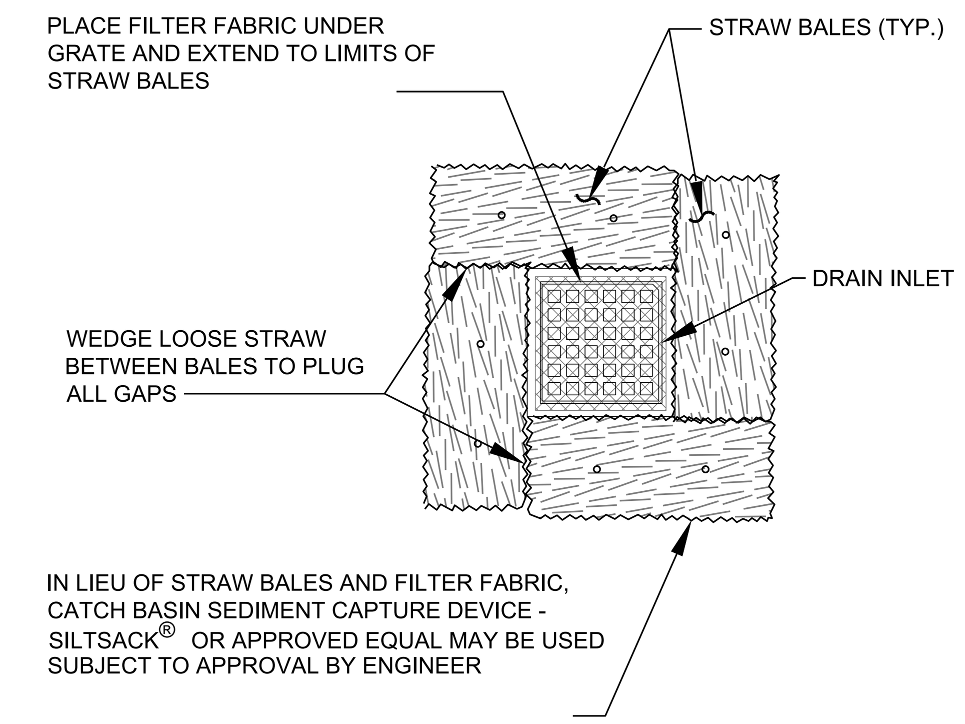
4 EXISTING CLEAN BACKFILL STOCKPILE AREA DEATIL
SCALE: NOT TO SCALE



5 PROPOSED CLEAN FILL SOIL STOCKPILE AREA
SCALE: NOT TO SCALE

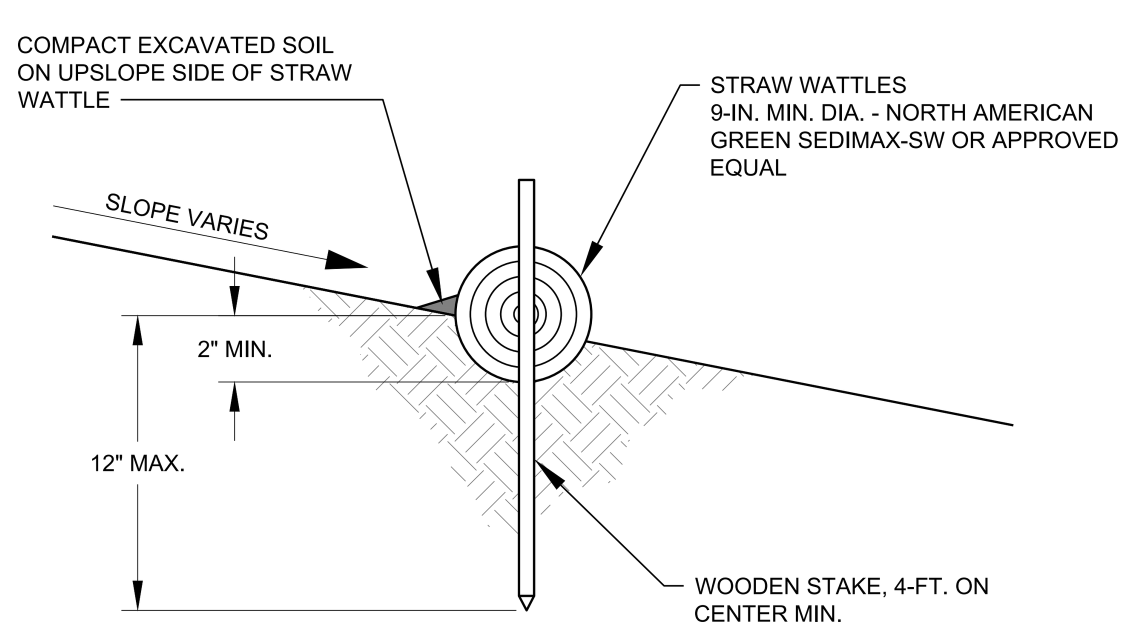


6 PROPOSED STRAW BALE INSTALLATION
SCALE: NOT TO SCALE



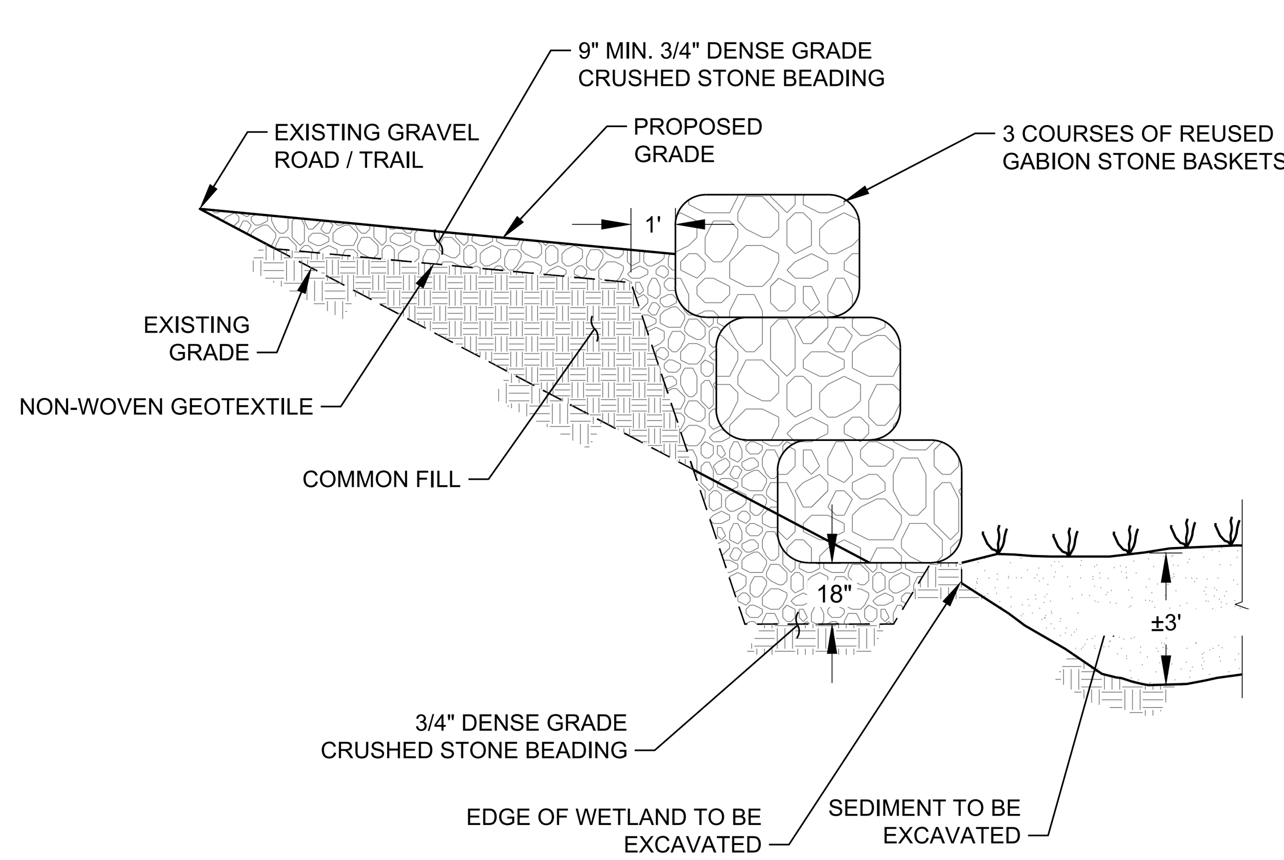
NOTE
STRAW BALE LOCATION TO BE DETERMINED BY SITE FIELD ENGINEER

7 PROPOSED STRAW BALE EROSION CONTROL AROUND DRAIN INLET
SCALE: NOT TO SCALE

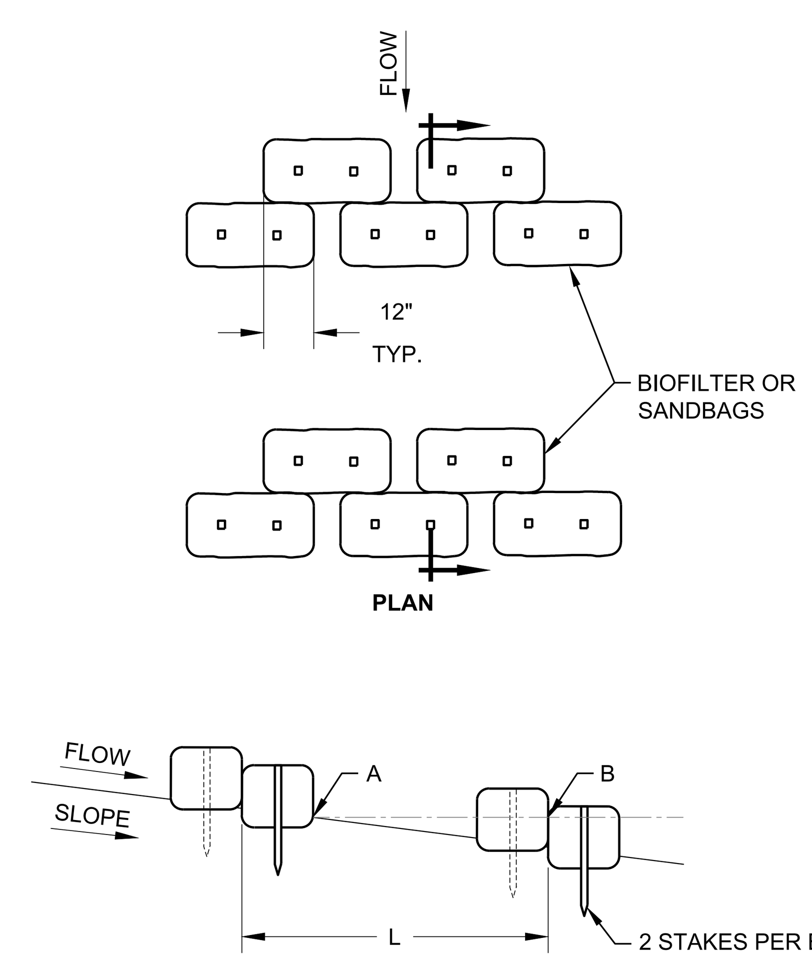


NOTES
1. STRAW BALE LOCATION TO BE DETERMINED BY SITE FIELD ENGINEER
2. NO DISTURBANCE TO THE DOWN SLOPE AREA.

8 PROPOSED STRAW WATTLE EROSION CONTROL
SCALE: NOT TO SCALE



9 PROPOSED ACCESS ROAD FOR SEDIMENT TRANSPORT FROM WETLANDS
SCALE: NOT TO SCALE



BARRIER SPACING		
GRADE	SLOPE	MAX. SPACING
< 10%	1:10	300'
10% TO < 15%	1:10 TO > 1:7.5	150'
15% TO < 20%	1:7.5 TO > 1:5	100'
20% TO ≤ 30%	1:5 TO ≥ 1:3	50'
> 30%	< 1:3	25'

NOTES:
1. INSTALL BARRIERS PARALLEL WITH CONTOURS.
2. DRIVE STAKES FLUSH WITH TOP OF BAG AND INTO UNDISTURBED GROUND A MIN. OF 12". (TYPE 2 ONLY). STAKES MAY BE OMITTED IF BAGS ARE PLACED ON PAVED SURFACE.
3. SPACE BAGS (L) SO POINTS "A" AND "B" ARE OF EQUAL ELEVATION.
4. TYPE 2 USES BIOFILTER BAGS TYPE 4 USES SANDBAGS.

10 SANDBAG INSTALLATION DETAIL
SCALE: NOT TO SCALE

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COURTYARD, LANDFILL,SPHAGNUM BOG, AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

SITE PREPARATION DETAILS (1 OF 2)

C-700

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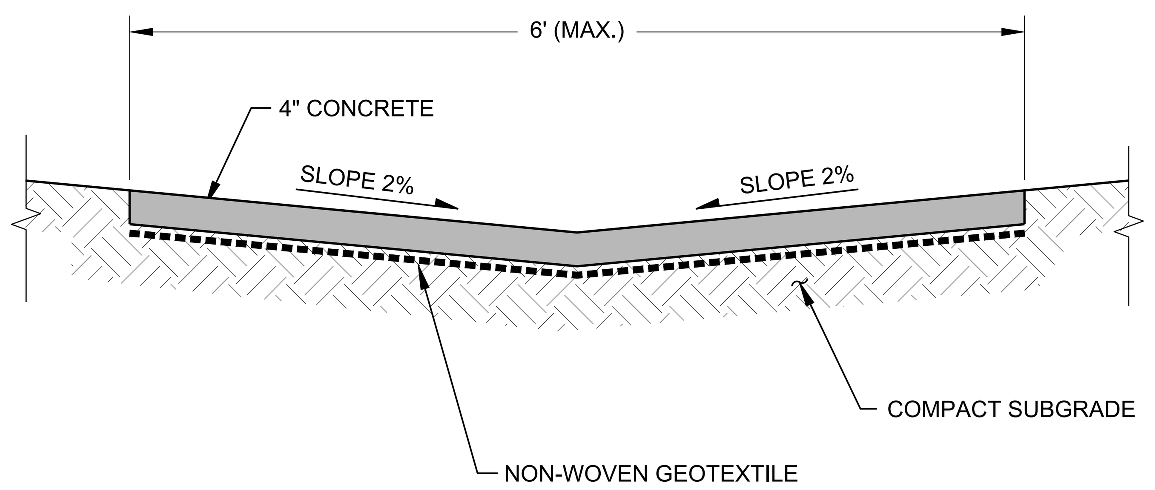
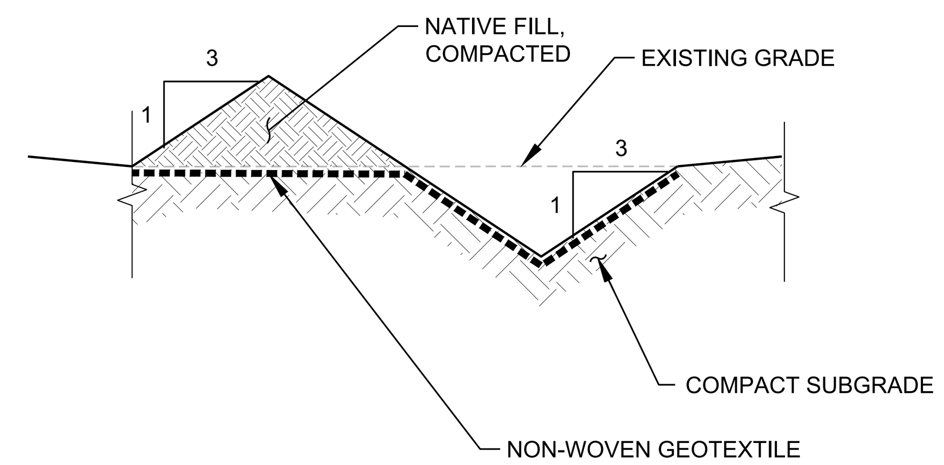
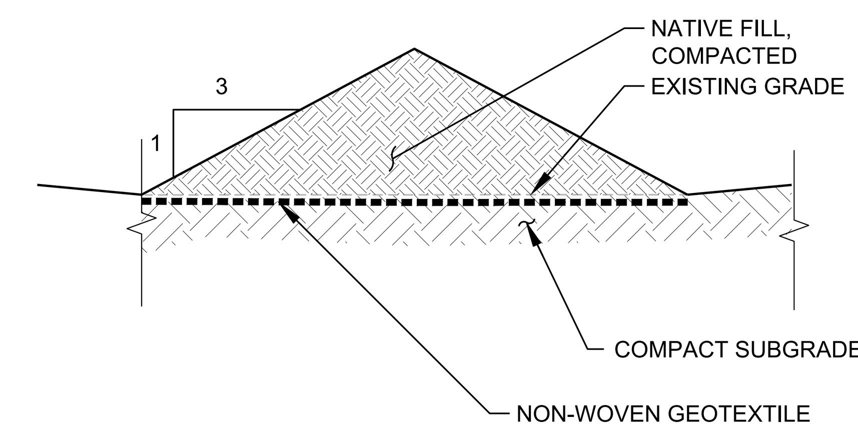


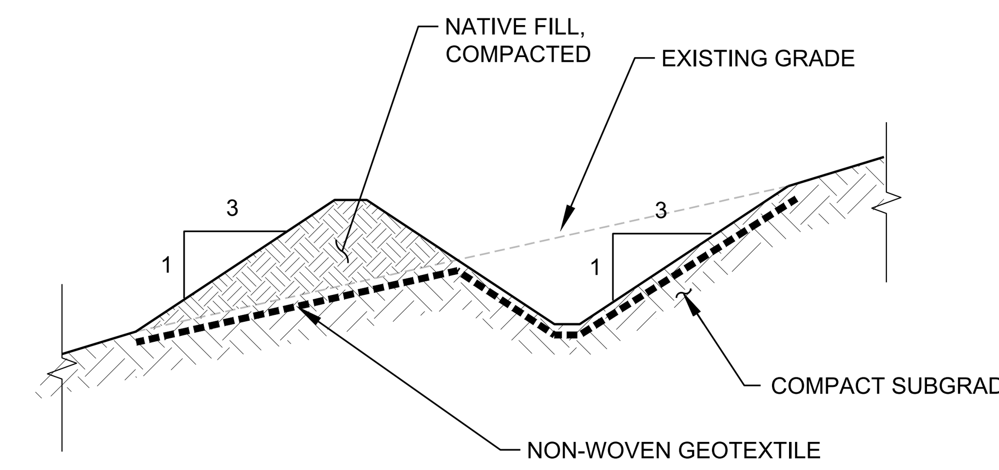
1 CONCRETE V-DITCH
SCALE: NOT TO SCALE



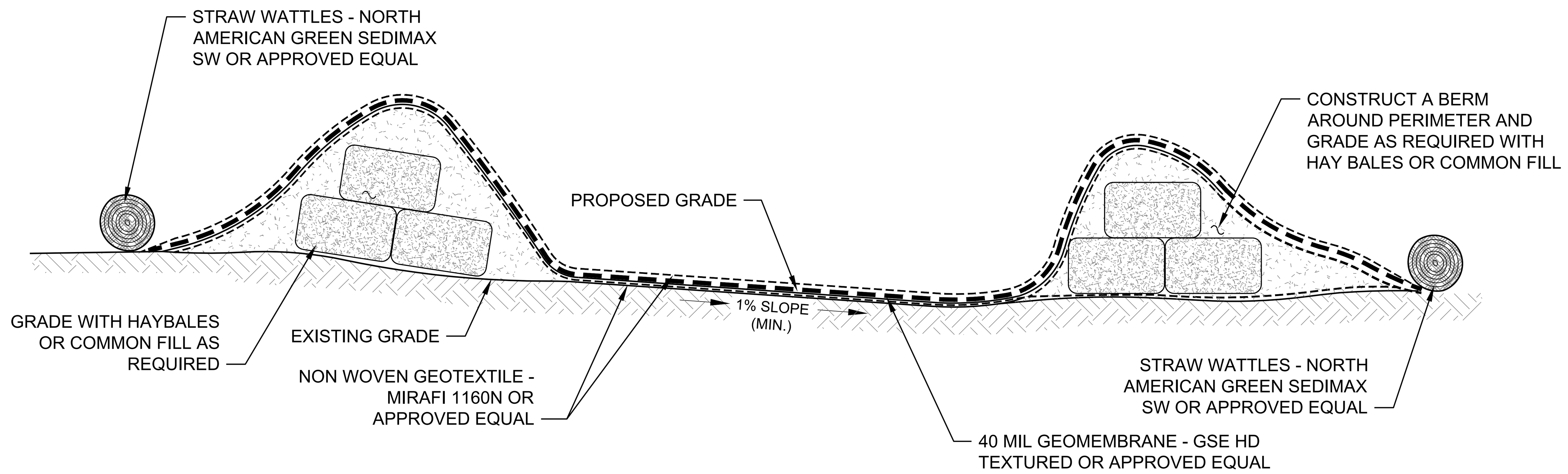
2 DRAINAGE SWALE
SCALE: NOT TO SCALE



3 DRAINAGE BERM
SCALE: NOT TO SCALE



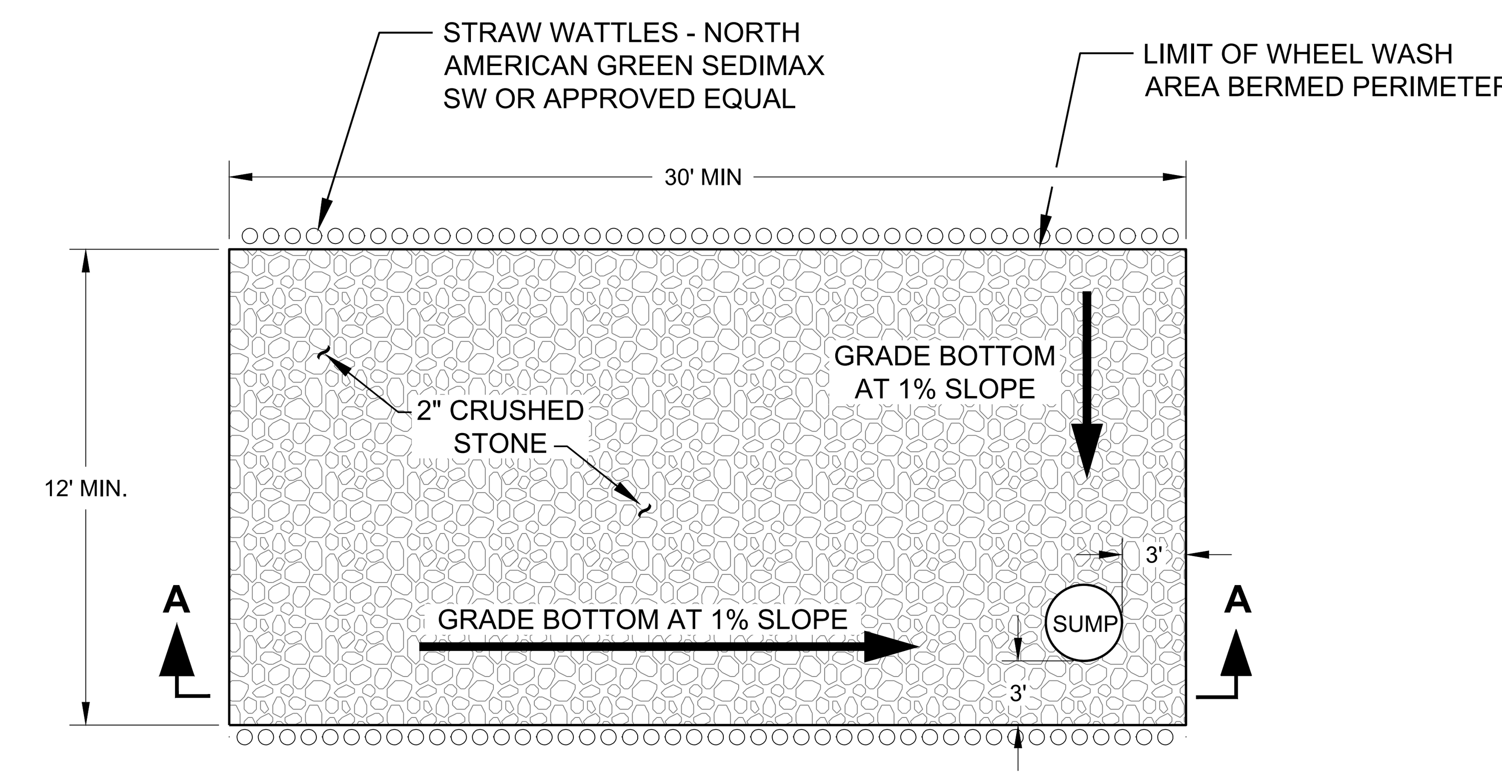
4 DETENTION POND
SCALE: NOT TO SCALE



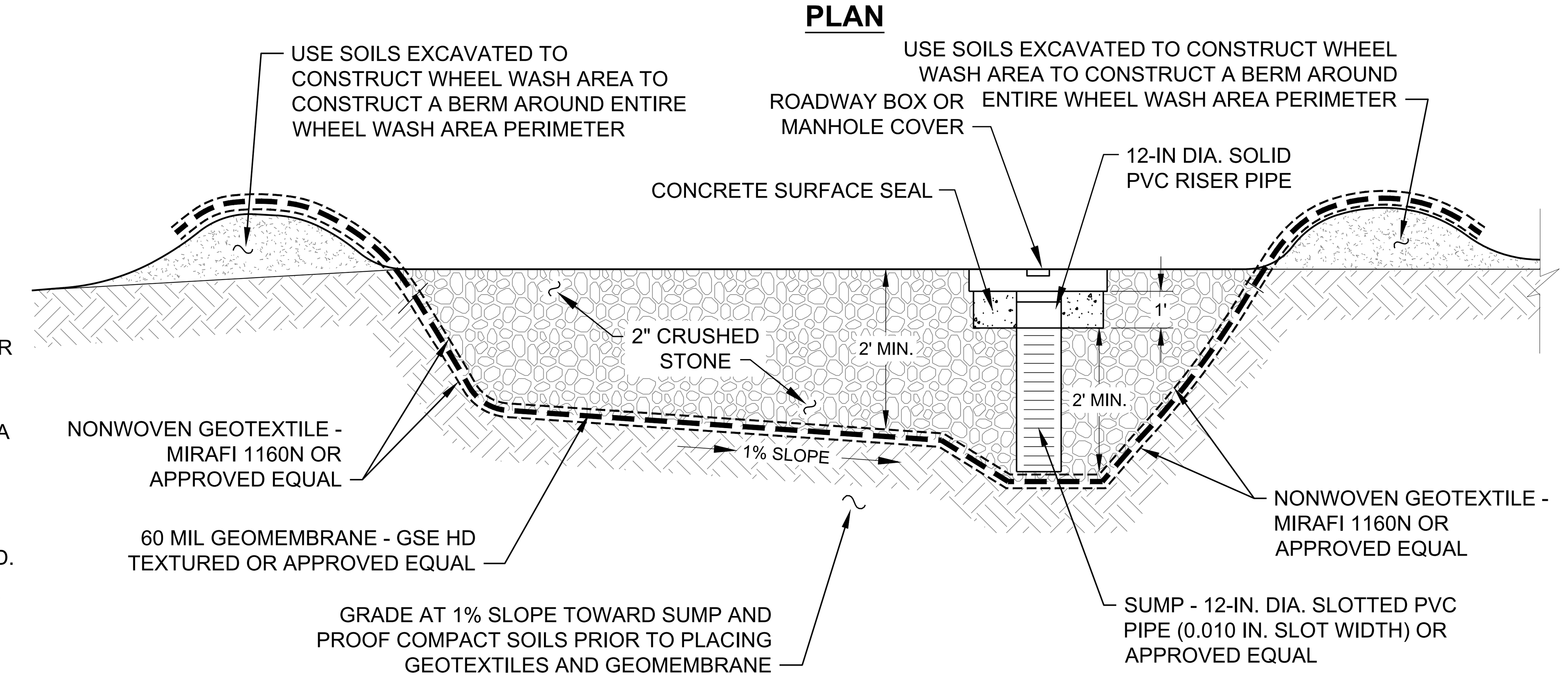
5 EXCAVATED MATERIAL PROCESSING AREA
SCALE: NOT TO SCALE

WHEEL WASH AREA NOTES:

1. WATER PUMPED FROM SUMP SHALL BE PUMPED TO THE DEWATERING EFFLUENT TREATMENT AREA AND TREATED IN ACCORDANCE WITH SECTION 312319 CONSTRUCTION DEWATERING AND WATER TREATMENT.
2. AT END OF CONSTRUCTION, ALL MATERIALS FROM THE WHEEL WASH AREA SHALL BE EXCAVATED AND DISPOSED OF IN A MANNER ACCEPTABLE TO THE ENGINEER. THE EXCAVATION SHALL BE BACKFILLED WITH DENSE GRADE TO MATCH THE SURROUNDING ACCESS ROAD.
3. BLEND THE WHEEL WASH AREA WITH THE ADJACENT ROADWAY.
4. CONSTRUCT A BERM AROUND ENTIRE WHEEL WASH AREA AS SHOWN.
5. SUBGRADE CONDITION TO BE INSPECTED BY THE ENGINEER PRIOR TO PLACEMENT OF GEOTEXTILES AND GEOMEMBRANE. IF SUBGRADE CONDITION IS DETERMINED BY THE ENGINEER TO BE UNSUITABLE, A 4-IN. MIN. SAND LAYER MAY BE REQUIRED BETWEEN THE LOWER GEOTEXTILE AND THE GEOMEMBRANE.



PLAN



SECTION A - A

6 WHEEL WASH / DECONTAMINATION PAD (AS NECESSARY)
SCALE: NOT TO SCALE

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Rev.	Description	By	Date
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COURTYARD, LANDFILL,SPHAGNUM BOG, AND COOLING POND
SSS PHASE 1
RAWP REMEDIAL DESIGN
2229 MAIN STREET
CONCORD, MASSACHUSETTS

SITE PREPARATION DETAILS (2 OF 2)

C-701

Sheet: 35 of 37

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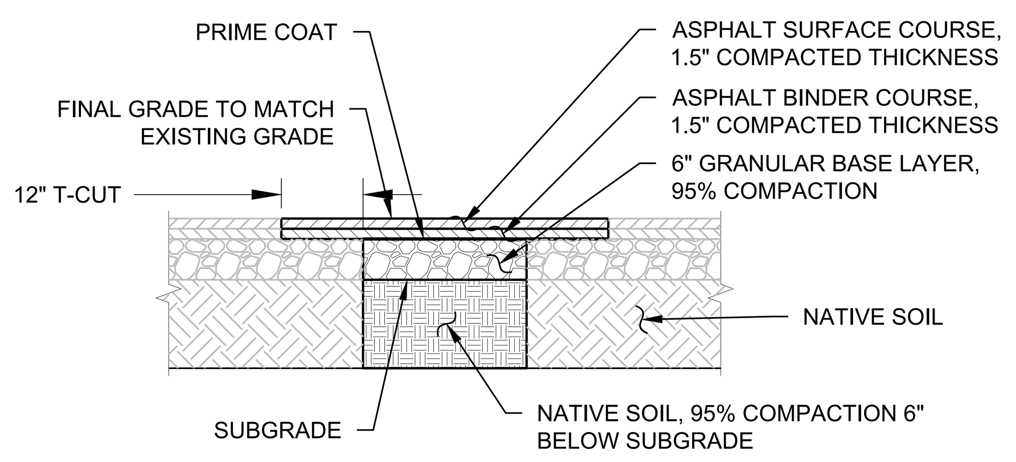
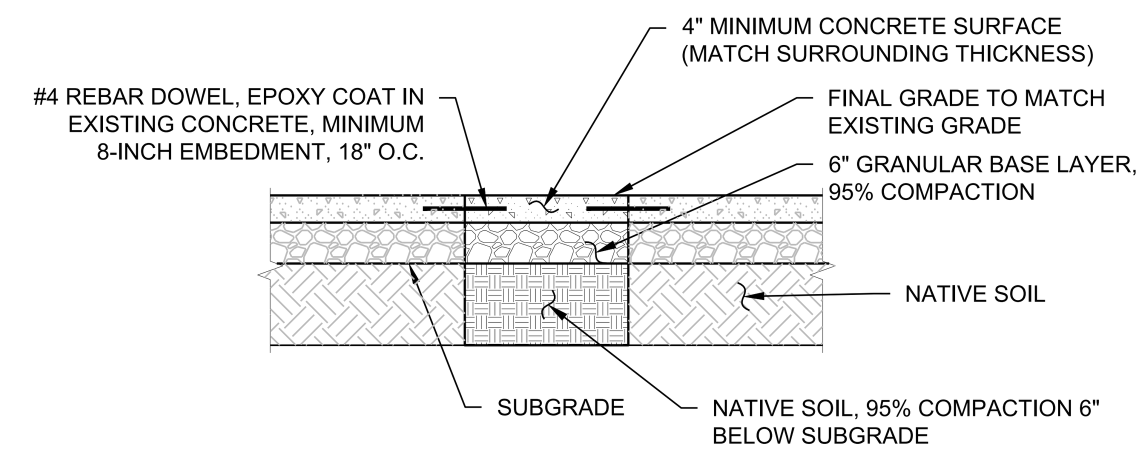
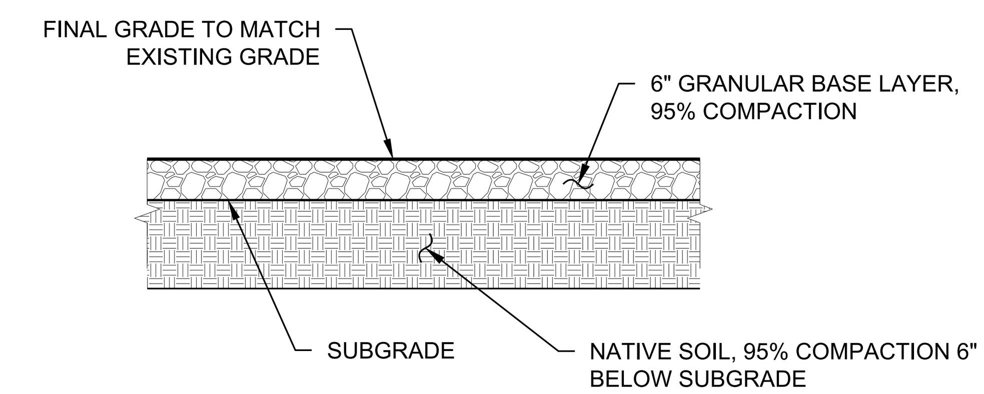


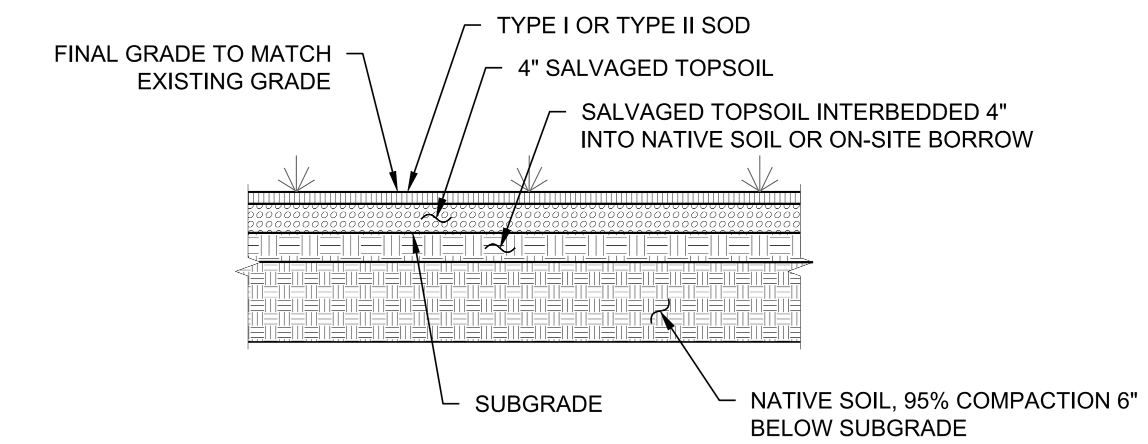
1 **ASPHALT RESTORATION**
SCALE: NOT TO SCALE



2 **CONCRETE RESTORATION**
SCALE: NOT TO SCALE



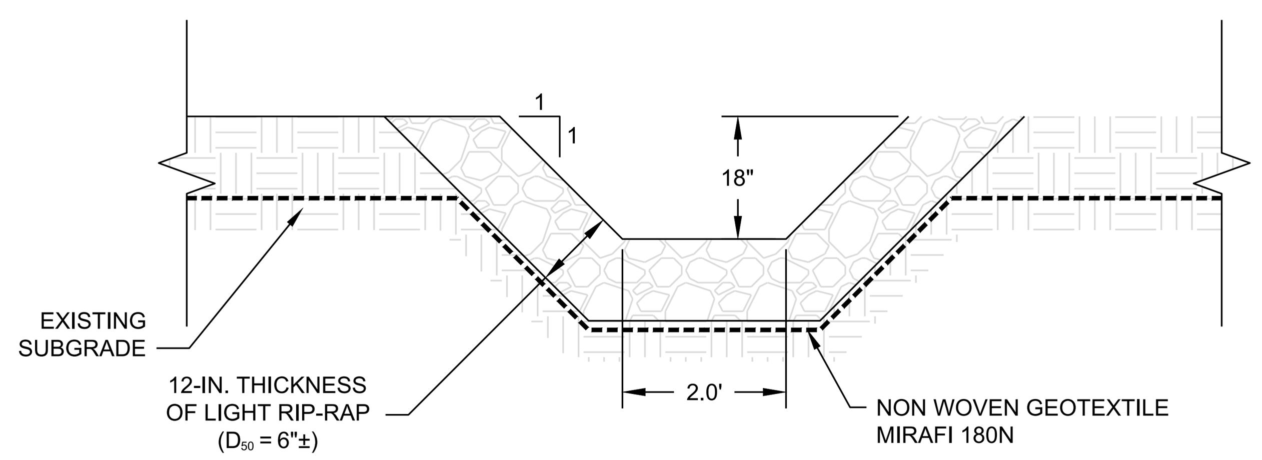
3 **GRAVEL RESTORATION**
SCALE: NOT TO SCALE



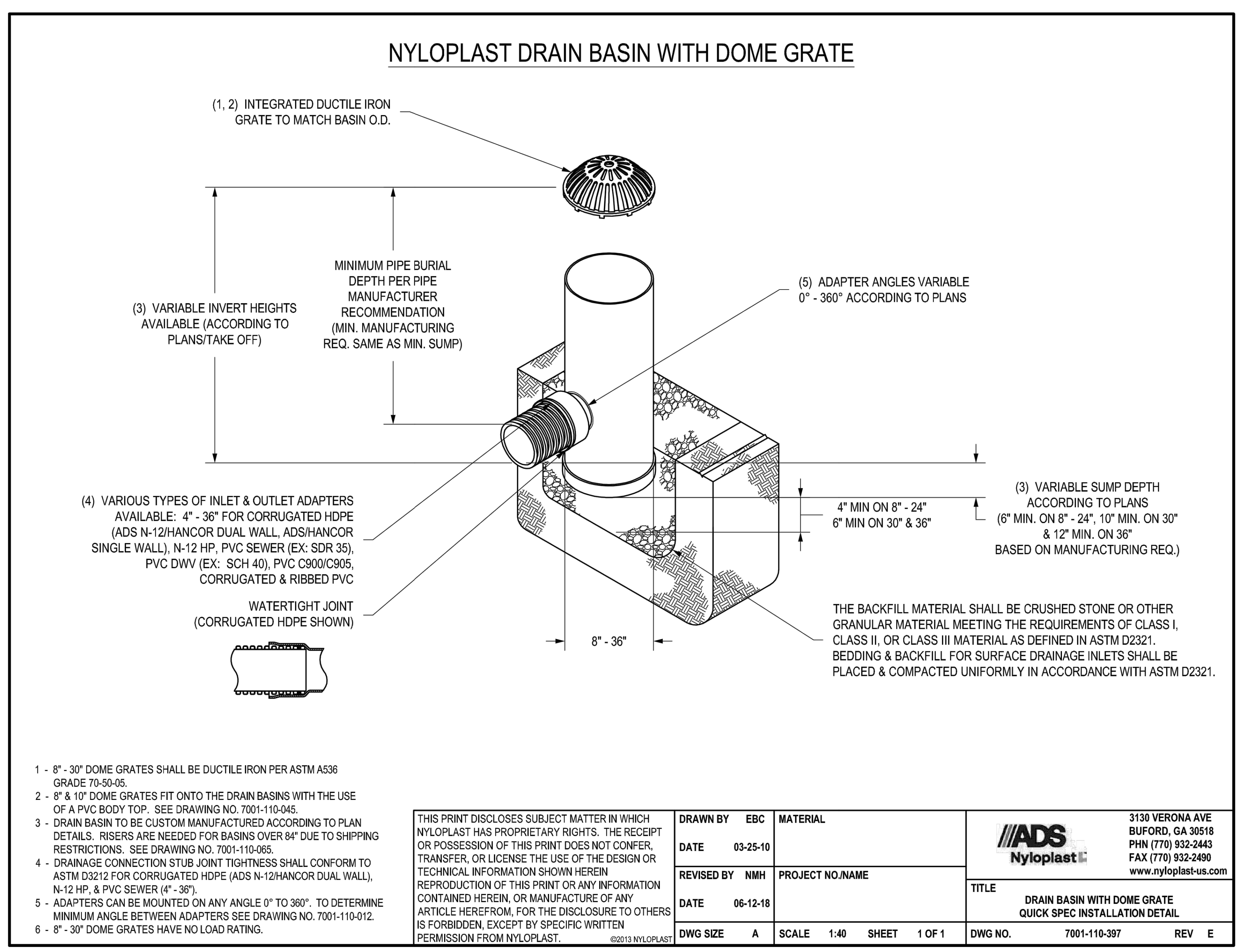
4 **VEGETATIVE RESTORATION**
SCALE: NOT TO SCALE

GENERAL NOTES FOR RESTORATION:

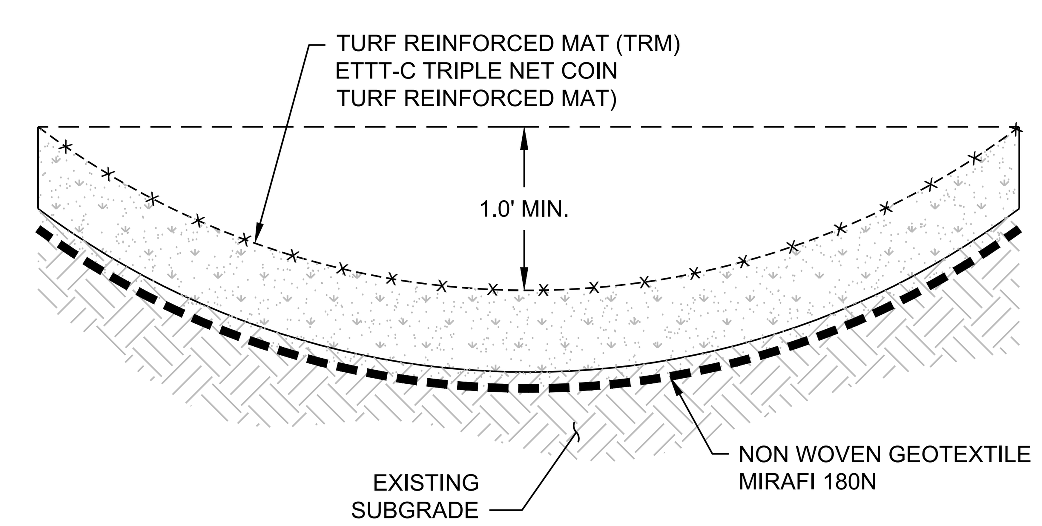
1. SOILS EXCAVATED ON-SITE SHALL NOT BE REUSED ON-SITE AS BACKFILL MATERIAL UNLESS PRIOR APPROVAL IS GRANTED FROM THE EPA AND MASSDEP.



5 **RIP-RAP SWALE DETAIL**
SCALE: NOT TO SCALE



6 **NYOPLAST DRAIN BASIN WITH DOME GRATE DETAIL**
SCALE: NOT TO SCALE



7 **TURF - REINFORCED MAT (TRM) SWALE DETAIL**
SCALE: NOT TO SCALE

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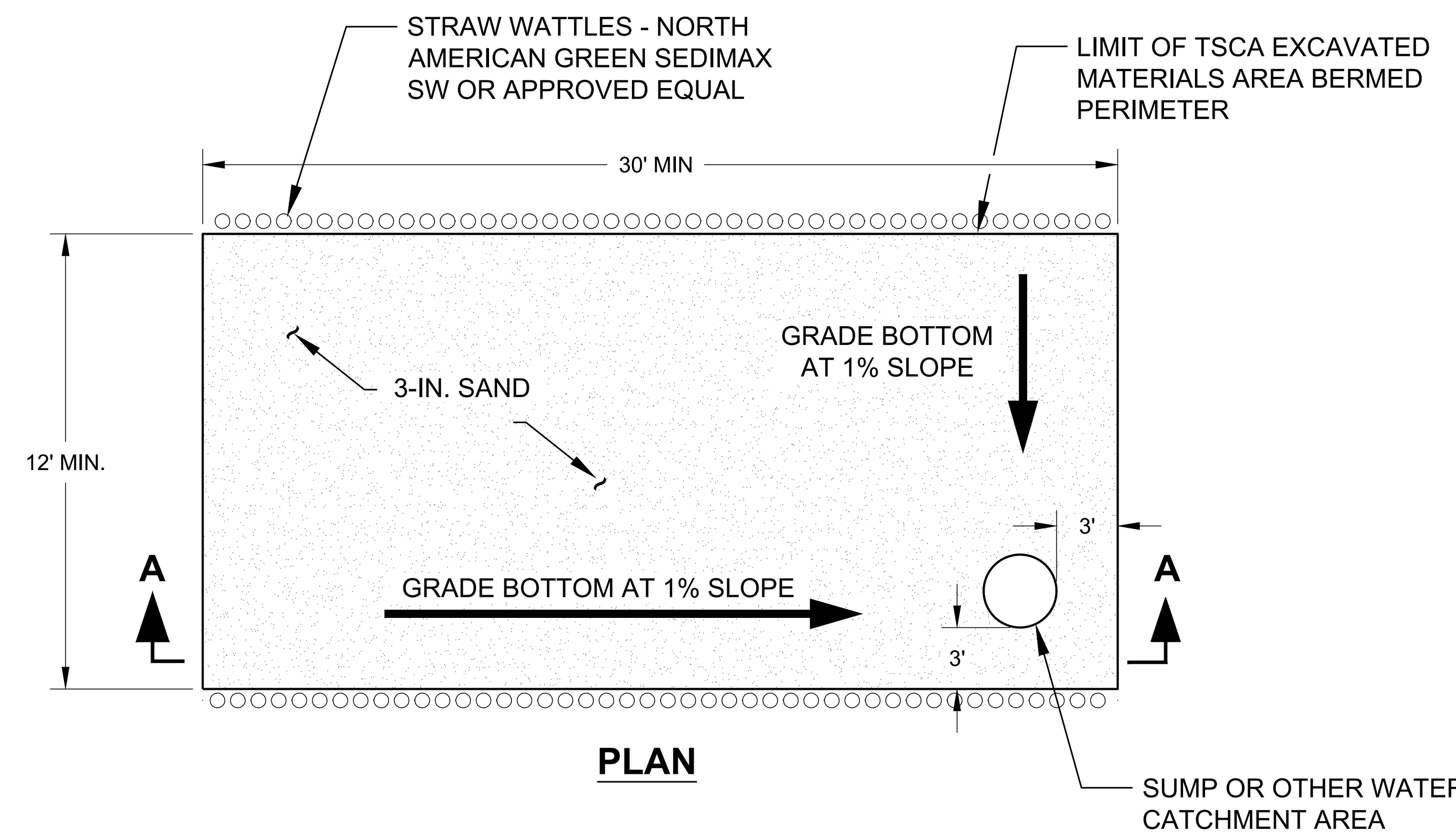
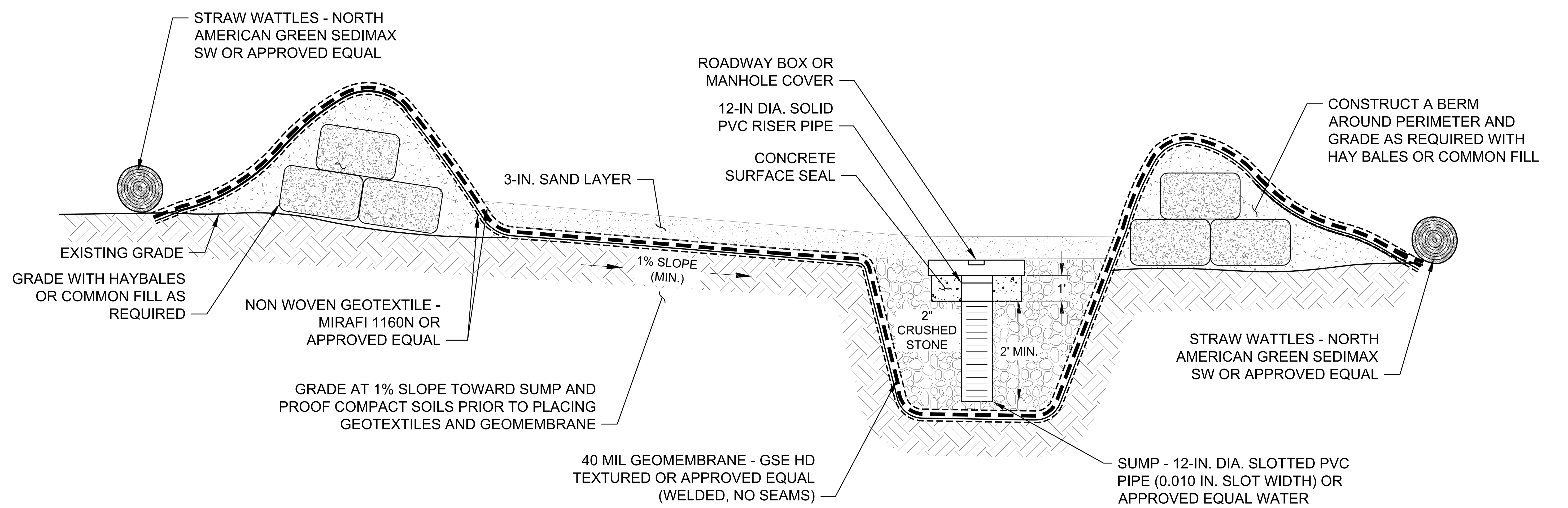
CONCORD, MASSACHUSETTS

CONSTRUCTION DETAILS

C-702



PLAN



SECTION A - A

TSCA EXCAVATED MATERIAL PROCESSING AREA NOTES:

1. SUBGRADE CONDITION TO BE INSPECTED BY THE ENGINEER PRIOR TO PLACEMENT OF GEOTEXTILES AND GEOMEMBRANE. IF SUBGRADE CONDITION IS DETERMINED BY THE ENGINEER TO BE UNSUITABLE, A 4-IN. MIN. SAND LAYER MAY BE REQUIRED BETWEEN THE LOWER GEOTEXTILE AND THE GEOMEMBRANE.

2. WATER PUMPED FROM SUMP SHALL BE COLLECTED AND DISPOSED OF OFF-SITE. ONCE THE DEWATERING EFFLUENT TREATMENT (DETS) AREA IS CONSTRUCTED, WATER WILL BE PUMPED TO THE DETS AND TREATED IN ACCORDANCE WITH SECTION 312319 CONSTRUCTION DEWATERING AND WATER TREATMENT.

3. AT END OF CONSTRUCTION, ALL MATERIALS FROM THE TSCA EXCAVATED MATERIAL PROCESSING AREA SHALL BE EXCAVATED AND DISPOSED OF IN A MANNER ACCEPTABLE TO THE ENGINEER. CONFIRMATORY SAMPLING WILL BE CONDUCTED ON UNDERLYING MATERIAL AFTER TSCA EXCAVATED MATERIALS PROCESSING AREA IS DISASSEMBLED.

4. 40 MIL GEOMEMBRANE MUST BE WELDED OR ONE CONTINUOUS PIECE.

5 TSCA EXCAVATED MATERIAL PROCESSING AREA
SCALE: NTS

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Checked By:	HA
Approved By:	HA
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LANDFILL,SPHAGNUM BOG,
AND COOLING POND
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CONCORD, MASSACHUSETTS

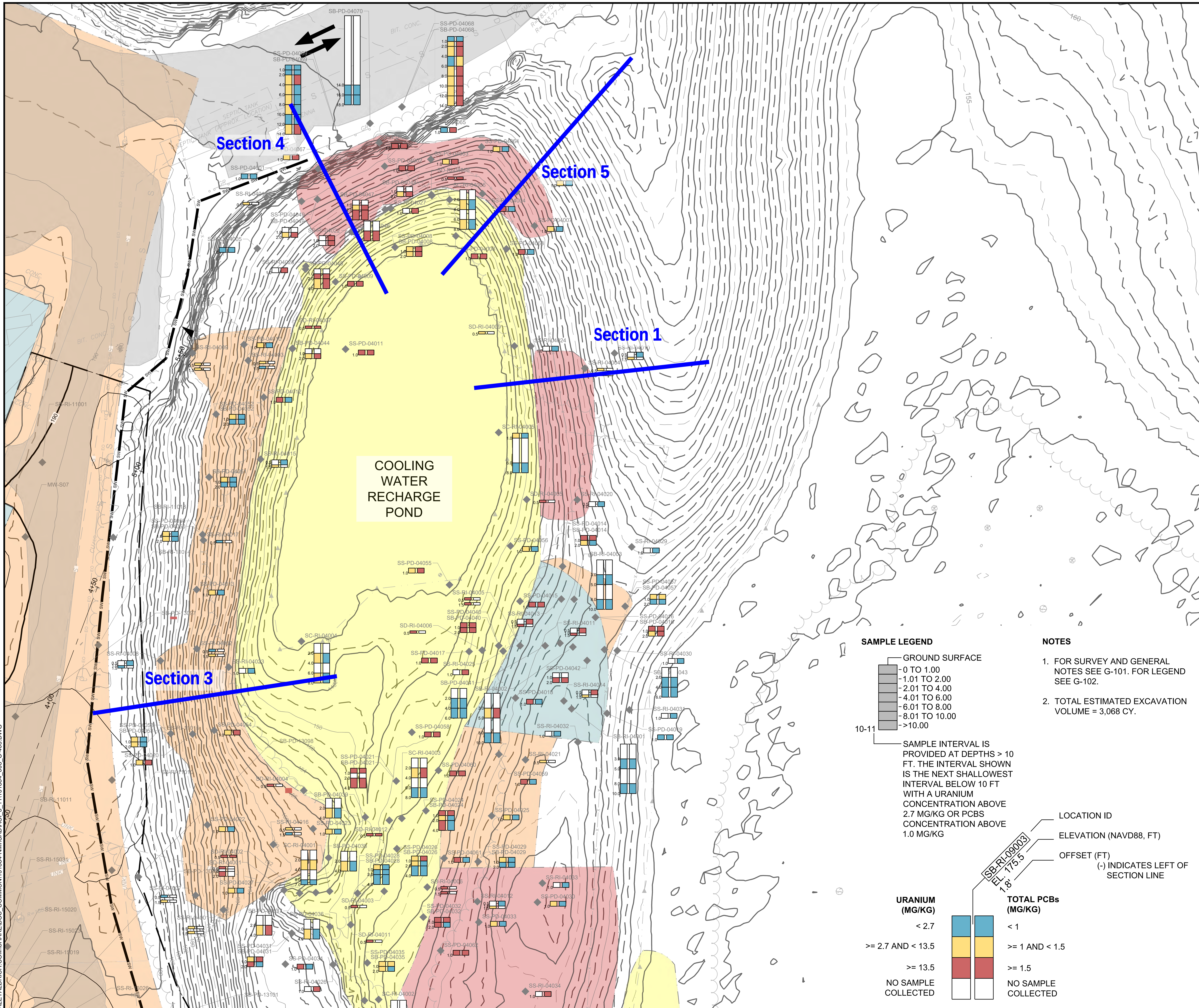
TSCA EXCAVATED MATERIAL PROCESSING AREA DETAIL

C-703

ATTACHMENT A3

Calculations

WORK IN PROGRESS - V.1



SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS > 10 FT. THE INTERVAL SHOWN IS THE NEXT SHALLOWEST INTERVAL BELOW 10 FT WITH A URANIUM CONCENTRATION ABOVE 2.7 MG/KG OR PCBS CONCENTRATION ABOVE 1.0 MG/KG

SB-RI-09003 — LOCATION ID
EL. 175.5 — ELEVATION (NAVD88, FT)
1.8' — OFFSET (FT) (-) INDICATES LEFT OF SECTION LINE

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-101. FOR LEGEND SEE G-102.
2. TOTAL ESTIMATED EXCAVATION VOLUME = 3,068 CY.

LEGEND

- SITE BOUNDARY
- LIMIT OF RESTORATION AREA
- GRAVEL TRUCK PATH
- PRE-CAST CONCRETE BLOCKS
- TRUCK ROUTE
- TEMPORARY STAGING/STOCKPILE AREA
- PROPOSED DEMOLITION AREA
- FORMER BUILDING SLAB
- CHAIN LINK FENCE
- GUARD RAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRICAL LINE
- OVERHEAD ELECTRICAL LINE
- UNK UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- MONITORING OR PRODUCTION WELL
- STORM DRAIN
- ELECTRICAL BOX
- TREE/SHRUB
- ASPHALT
- CONCRETE
- GRAVEL
- HISTORICAL SAMPLING LOCATION

EXCAVATION DEPTH IN FEET

- 0.00 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 3.00
- 3.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00

0 20 40 60 80
SCALE IN FEET

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KEY PLAN
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Checked By:	HA
Approved By:	HA
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95% DESIGN

DRAFT

Rev.	Description	By	Date
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NUCLEAR METALS, INC.
COURTYARD, LANDFILL, AND COOLING POND REMEDIAL DESIGN

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CONCORD, MASSACHUSETTS

EXCAVATION PLAN FOR COOLING WATER POND SLOPES

C-405

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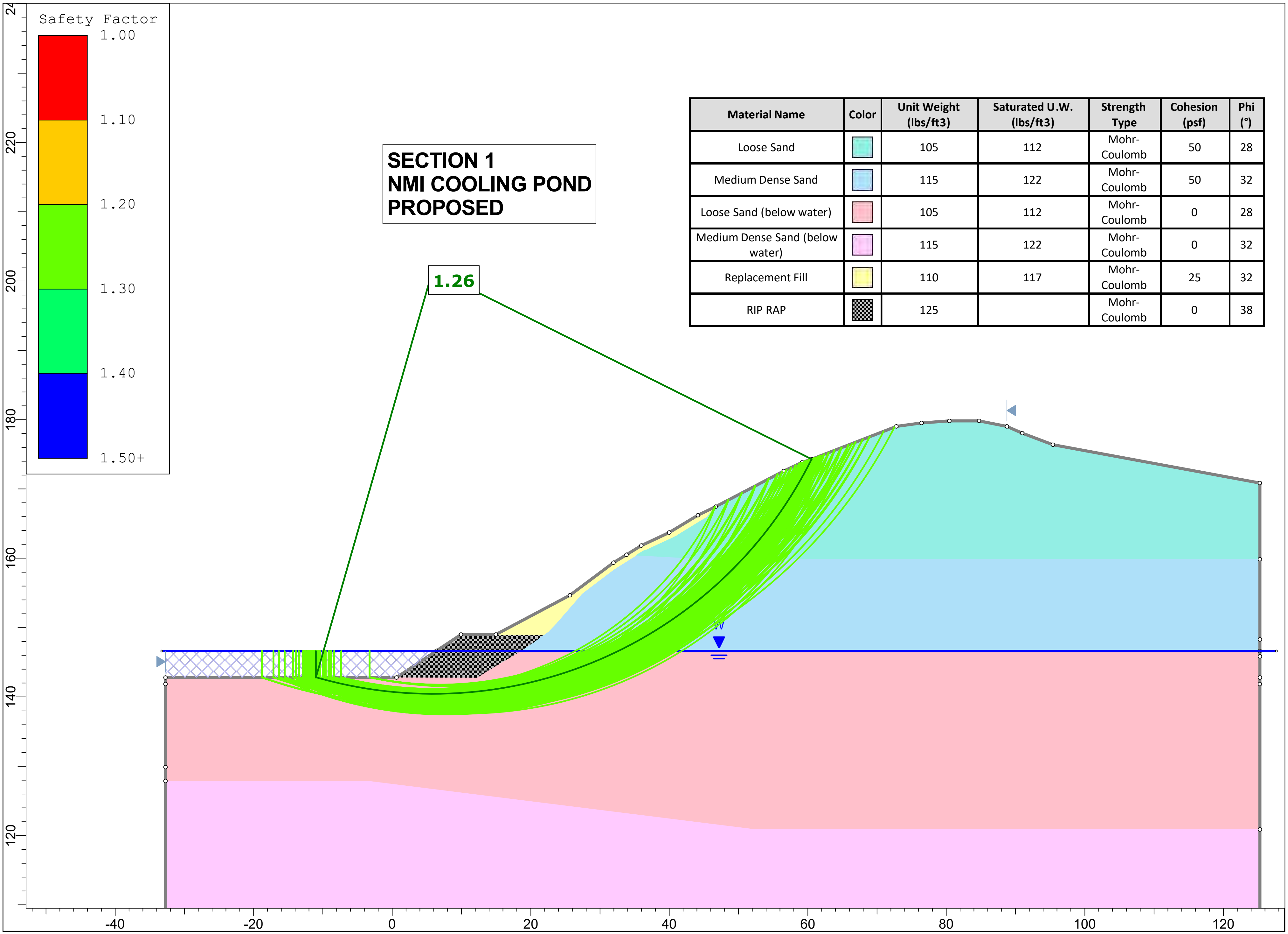
NMI COOLING POND		
SLOPE STABILITY EVALUATION		Factor of Safety
Condition		PROPOSED
EAST	SECTION 1	1.26
SOUTH-WEST	SECTION 3	1.32
NORTH	SECTION 4	1.29
NORTH- EAST	SECTION 5	1.40

SECTION 1



Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Loose Sand		105	112	Mohr-Coulomb	50	28
Medium Dense Sand		115	122	Mohr-Coulomb	50	32
Loose Sand (below water)		105	112	Mohr-Coulomb	0	28
Medium Dense Sand (below water)		115	122	Mohr-Coulomb	0	32
Replacement Fill		110	117	Mohr-Coulomb	25	32
RIP RAP		125		Mohr-Coulomb	0	38

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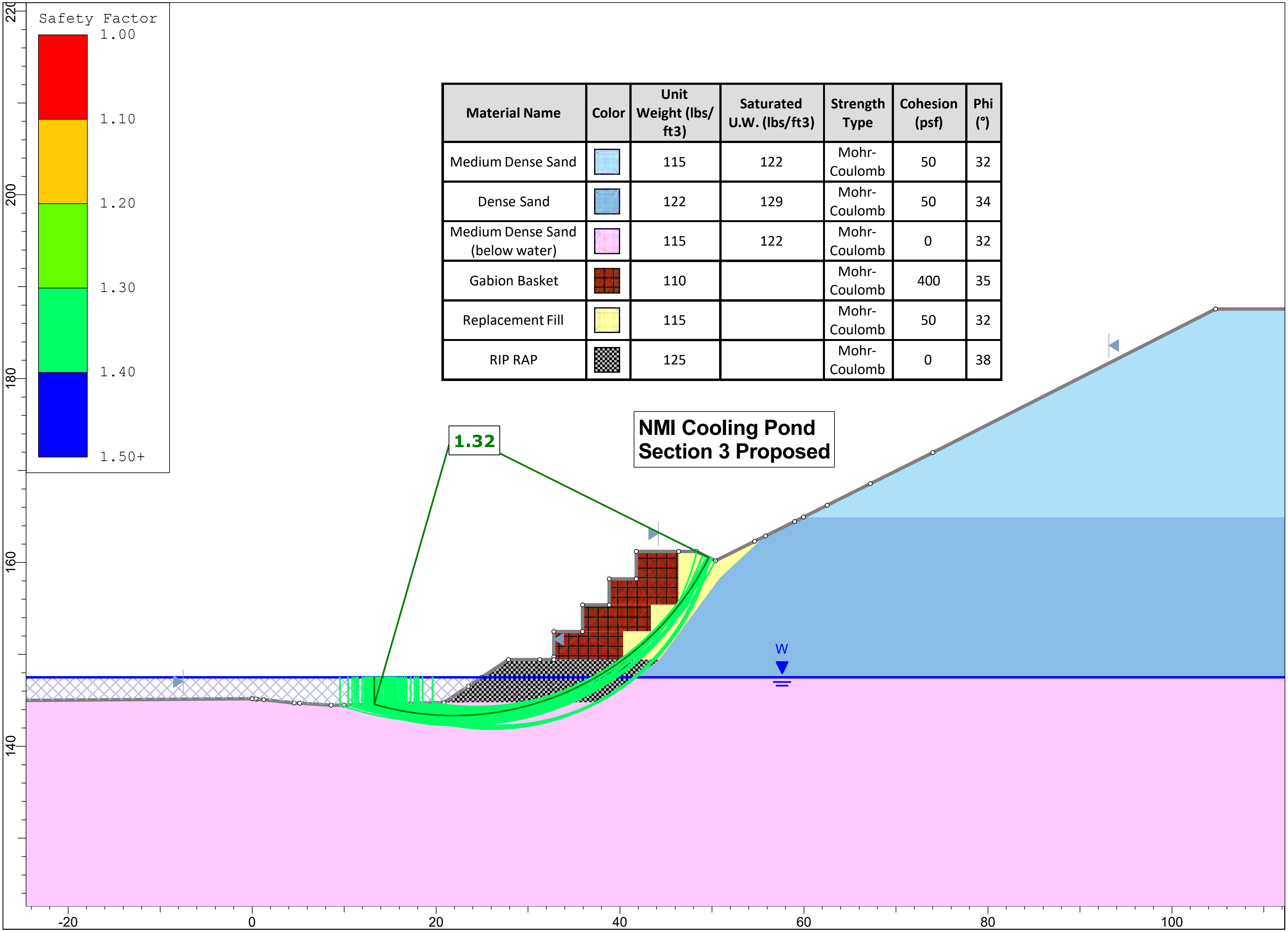
HALEY & ALDRICH 3/18/2023, 2:01:51 PM

SECTION 3



Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Medium Dense Sand		115	122	Mohr-Coulomb	50	32
Dense Sand		122	129	Mohr-Coulomb	50	34
Medium Dense Sand (below water)		115	122	Mohr-Coulomb	0	32
Gabion Basket		110		Mohr-Coulomb	400	35
Replacement Fill		115		Mohr-Coulomb	50	32
RIP RAP		125		Mohr-Coulomb	0	38

Sliding analysis for proposed gabion wall at toe of slope at Section 3.

Resisting force:

Unit weight of gabion wall = 110 pcf
Unit weight of soil beneath gabion wall = 115 pcf
Composite interface friction angle of gabion wall/soil to rip-rap = 32 degrees
Dimensions of gabion wall = 3 ft * 7.5 ft * 3 cages + 3 ft * 4.5 ft * 1 cage = 81 sf
Soil beneath gabion wall = 6 ft * 3 ft + 3 ft * 3 ft = 27 sf

Weight of gabion = 81 sf * 110 pcf = 8910 lbs
Weight of soil beneath gabion wall = 27 sf * 115 pcf = 3105 lbs
Total weight at interface of rip-rap = 8910 + 3105 = 12,000 lbs

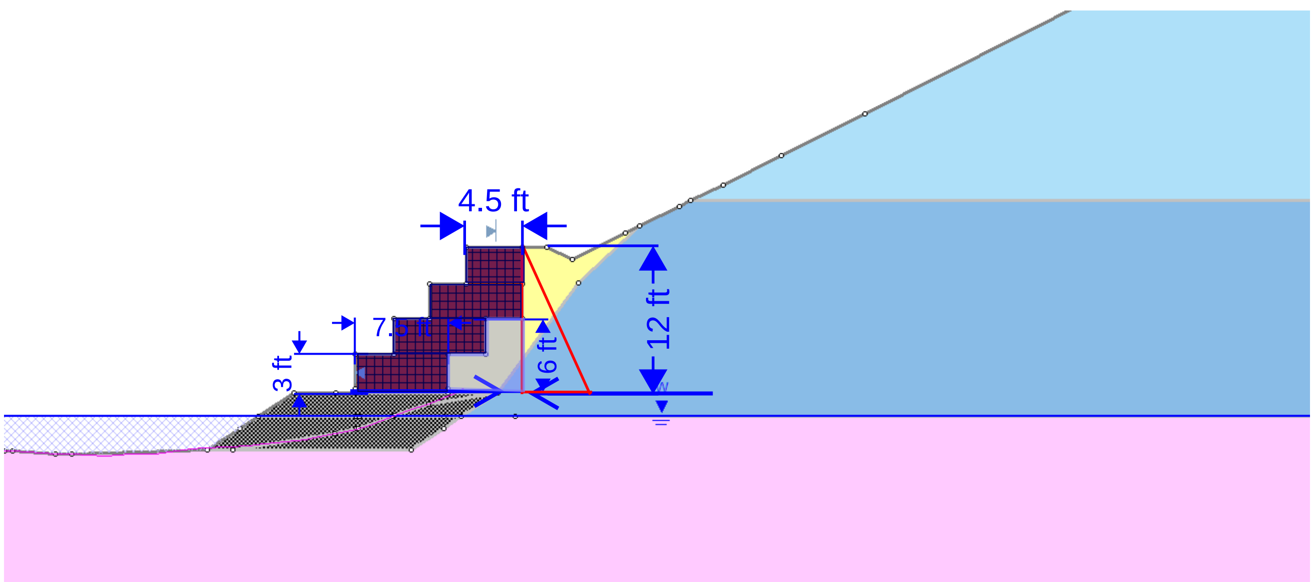
Resisting force = 12,000 * tan(32) = 8,400 lbs

Driving force:

Height of slope behind gabion wall = 12 ft
Unit weight of soil behind wall = 122 pcf
Internal friction angle of soil behind wall = 32 degrees
Slope angle behind wall = 26.7 degrees = 2:1 slope
Active pressure coefficient Ka = 0.5

Driving force = 12 ft * 12 ft * 0.5 * 122 pcf * 0.5 = 4,400 lbs

Sliding factor of safety = 8,400/4,400 = 1.91



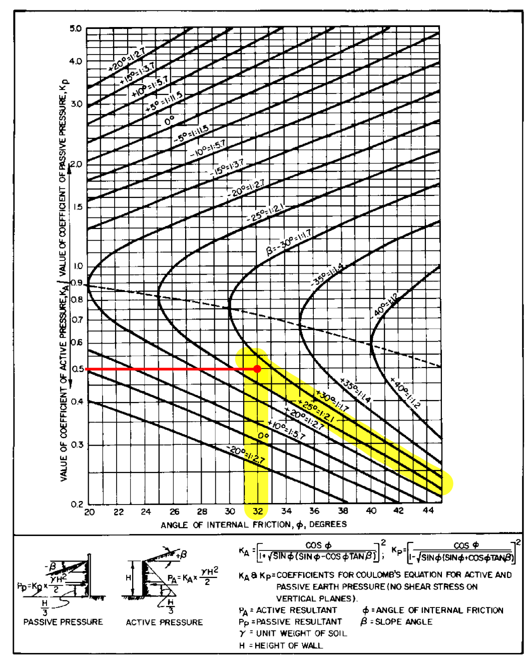
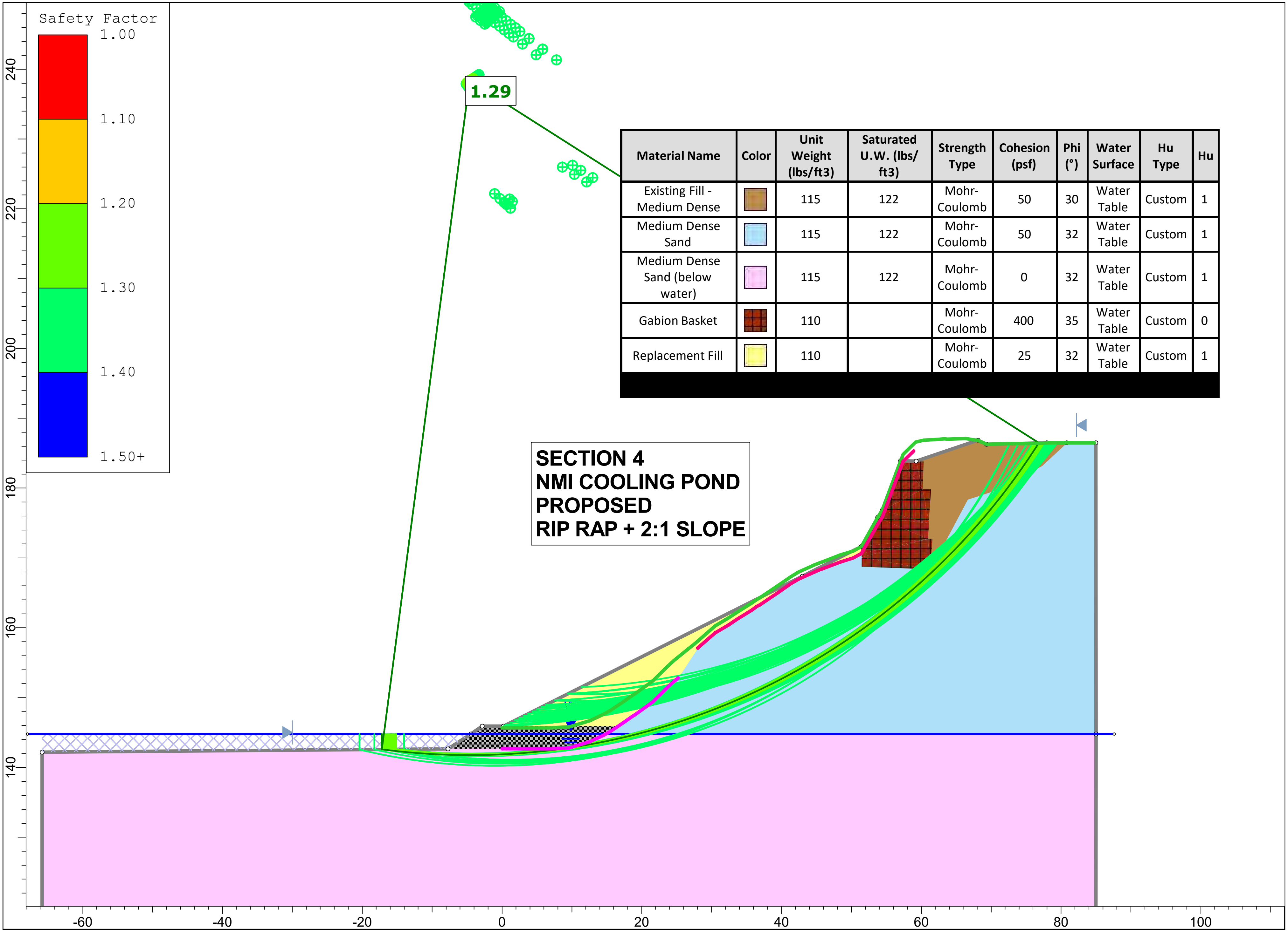


FIGURE 3
Active and Passive Coefficients, Sloping Backfill
(Granular Soils)

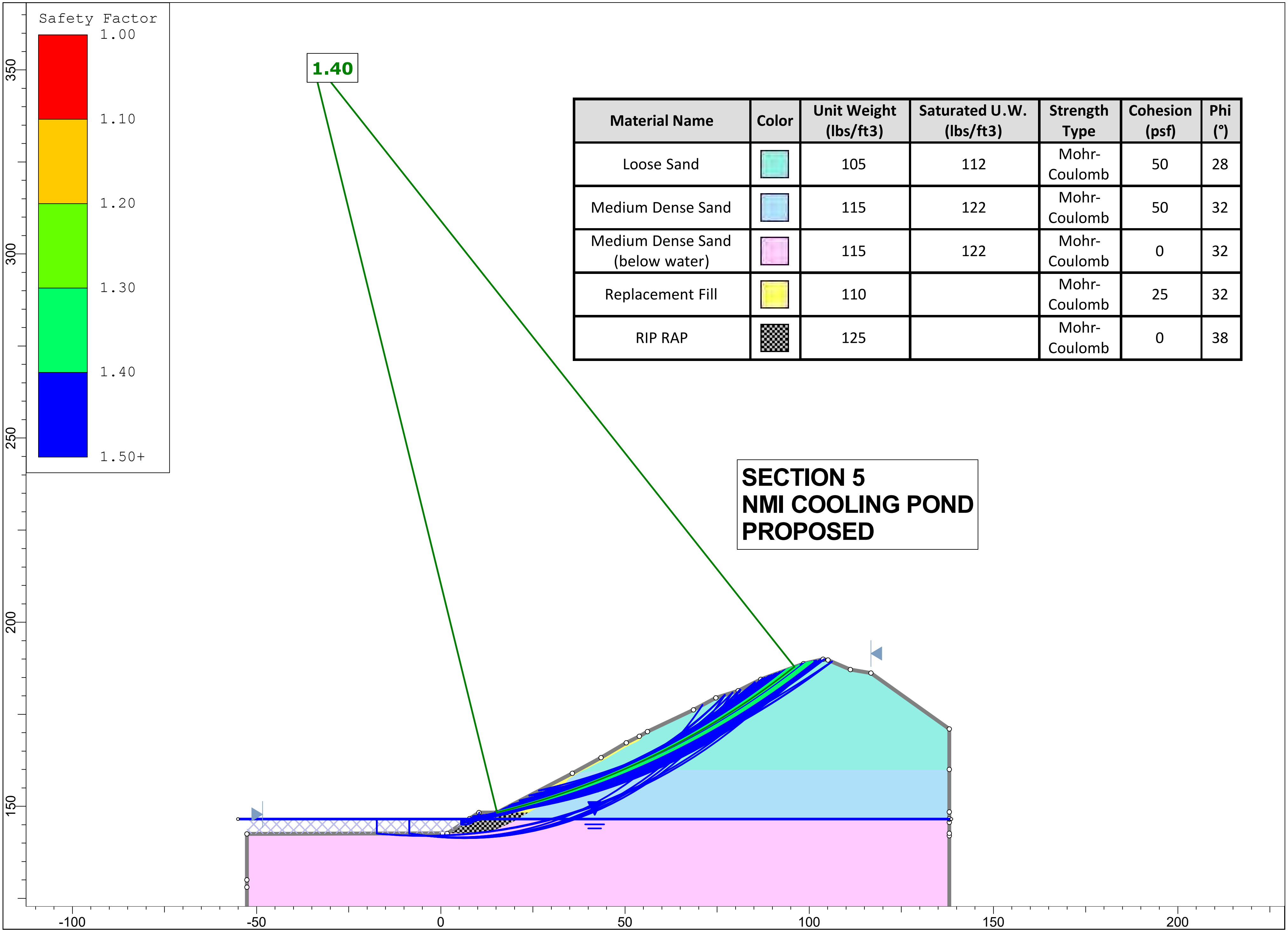
Change 1, September 1986 7.2-64

SECTION 4



Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Water Surface	Hu Type	Hu
Existing Fill - Medium Dense		115	122	Mohr-Coulomb	50	30	Water Table	Custom	1
Medium Dense Sand		115	122	Mohr-Coulomb	50	32	Water Table	Custom	1
Medium Dense Sand (below water)		115	122	Mohr-Coulomb	0	32	Water Table	Custom	1
Gabion Basket		110		Mohr-Coulomb	400	35	Water Table	Custom	0
Replacement Fill		110		Mohr-Coulomb	25	32	Water Table	Custom	1

SECTION 5



Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Loose Sand		105	112	Mohr-Coulomb	50	28
Medium Dense Sand		115	122	Mohr-Coulomb	50	32
Medium Dense Sand (below water)		115	122	Mohr-Coulomb	0	32
Replacement Fill		110		Mohr-Coulomb	25	32
RIP RAP		125		Mohr-Coulomb	0	38

HALEY ALDRICH	CALCULATIONS	File No.	131884
		Sheet	1 of 7
Client	*de maximis, inc.*	Date	10-Feb-23
Project	Nuclear Metals, Inc. Superfund Site	Computed by	JLW
Subject	Holding Basin Stormwater Drainage Feature Design	Checked by	SHL

PROBLEM STATEMENT & OBJECTIVE

1 Calculate runoff volumes from subcatchments located around the Holding Basin.

2 Calculate sizing requirements of stormwater structural best management practices to hold the volume of runoff.

REFERENCES

1 Natural Resources Conservation Service (NRCS), Web Soil Survey, Middlesex Country (MA017), https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

2 National Oceanic and Atmospheric Administration (NOAA), Atlas 14-Point Precipitation Frequency Estimates, Maynard, Massachusetts (19-4580), https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ma

3 Hydrologic Engineering Center, Soil Conservation Service (SCS) - National Resources Conservation Service (NRCS) Rainfall Distribution Map, https://www.hec.usace.army.mil/confluence/hmsdocs/hmstrm/precipitation/scs-storm

ASSUMPTIONS & DEFINITIONS

1 Hydrologic Soil Group (HSG) A was used for each of the Holding Basin subcatchment areas based on the NRCS Web Soil Survey for the site.

2 Brush, fair condition was assumed for grassy areas and paved parking was assumed for any areas covered with concrete or asphalt.

3 Rainfall totals (inches) were sourced from NOAA 14-point precipitation estimates for 24-hour storm events: 2-year (3.26 inches), 5-year (4.24 inches) and 10-year (5.06 inches).

4 A Type III Storm event was used for the site rainfall based on the SCS-NRCS Rainfall Distribution Map.

5 The * indicates that values were calculated in HydroCAD using the SCS Technical Release 20 (TR-20) Runoff Method for runoff calculations.

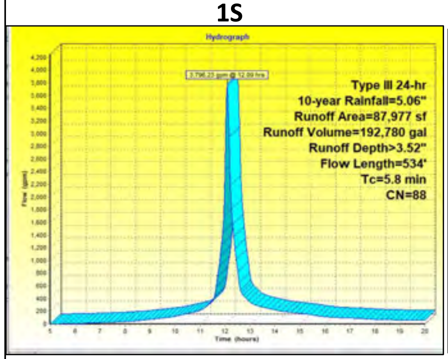
SUBCATCHMENT AREA CALCULATIONS

	HydroCAD Inputs									Calculations	
Subcatchment ID	Subcatchment Description	Area Runoff is Routed	Total Area (Acres)	Impervious Area			Pervious Area			Weighted Curve Number	Total Runoff Volume, gallons (10-year, 24-hour storm)*
				Type	Curve Number	Area (Acres)	Type	Curve Number	Area (Acres)		
1S	1S encompasses part of Building D and a majority of the paved courtyard area	Proposed Swale	2.02	Paved Parking	98	1.69	Brush, Fair	35	0.33	87.71	192,780
2S	2S encompasses the eastern half of Building E, a portion of the courtyard and the paved road sloping toward the courtyard adjacent to Building E.	Proposed Swale	1.08	Paved Parking	98	0.74	Brush, Fair	35	0.34	78.17	75,605
3S	3S encompasses the area of brush south of the holding basin	Holding Basin	0.38	Paved Parking	98	0.04	Brush, Fair	35	0.34	41.63	2,411
4S	4S encompasses the area of brush which wraps around the eastern and northern side of the holding basin	Holding Basin	0.26	-	-	-	Brush, Fair	35	0.26	35	449

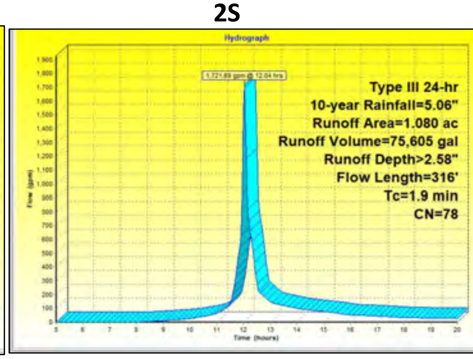
Note: The weighted curve number is calculated by multiplying the ratio of the individual area to total area by each area's curve number and then adding each product.

Subcatchment Hydrographs

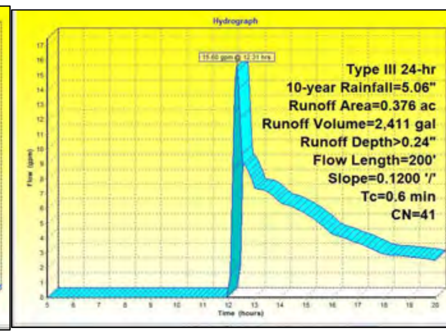
1S



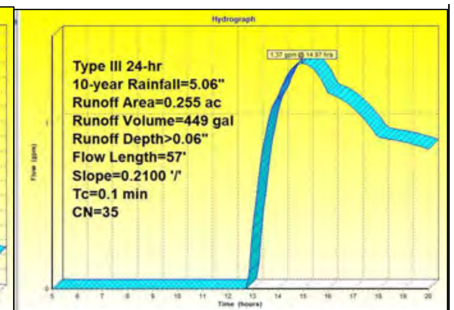
2S



3S



4S



HALEY ALDRICH	CALCULATIONS	File No.	131884
		Sheet	2 of 7
Client	*de maximis, inc.*	Date	10-Feb-23
Project	Nuclear Metals, Inc. Superfund Site	Computed b	JLW
Subject	Holding Basin Stormwater Drainage Feature Design	Checked by	SHL

NEW AND EXISTING DRAINAGE FEATURE SIZING

Drainage Feature	Description	Subcatchments Routed:	Depth (ft)	Total Width (ft)	Side Slope (ft)	Length (ft)	Inlet Invert (Elevation ft NGVD29)	Outlet Invert (Elevation ft NGVD29)	Profile Slope (ft) (Across Length)	Material (curve #)
New Drainage Swale (Reach 2R)	Drainage swale located on the western side of the HB, intended to replace the existing catch basins, conveying water to the north towards the Cooling Pond.	1S and 2S	2	5	1:01	150	180	172	0.053	Lined with Riprap, 6-inch
Existing Holding Basin (HB) (1DB)	With the Drainage pond on the western side of the HB, subcatchments 3S and 5S on the eastern and southern side are still routed to the HB.	3S and 5S	See Custom Stage Data							

Note: Dimensions for stormwater features are consistent with CAD drawings and verified for adequate runoff volume capacity in HydroCAD.

EXISTING HOLDING BASIN MODEL SIZING

HB Custom Stage Data - Prismatic Shape

Elevation (ft NGVD29)	Surface Area (square ft)	Incremental Storage (gallons)*	Cumulative Storage (gallons)*
160	696	0	0
161	5,365	22,668	22,668
162	7,254	47,195	69,863
172	16,900	903,360	973,223

DRAINAGE FEATURE PERFORMANCE SUMMARY*

Drainage Feature	Storm Event (Type III Storm 24-hour)	Rainfall (inches)	Inflow Volume (gallons)*	Outflow Volume (gallons)*	Peak Stormwater Elevation (ft NGVD29)*	Bottom Elevation (ft NGVD29)*	Overflow Elevation (ft NGVD29)*
New Drainage Swale (Reach 2R)	2-year	3.26	141,057	140,929	180.80	180	NA
	5-year	4.24	209,085	208,928	180.99		
	10-year	5.06	268,385	268,204	181.12		
Existing HB (1DB)	2-year	3.26	0	-	-	160	NA
	5-year	4.24	957	-	160.04		
	10-year	5.06	2,860	-	160.13		

Note: The * indicates that values were calculated in HydroCAD using the SCS Technical Release 20 (TR-20) Runoff Method was used for runoff calculations.

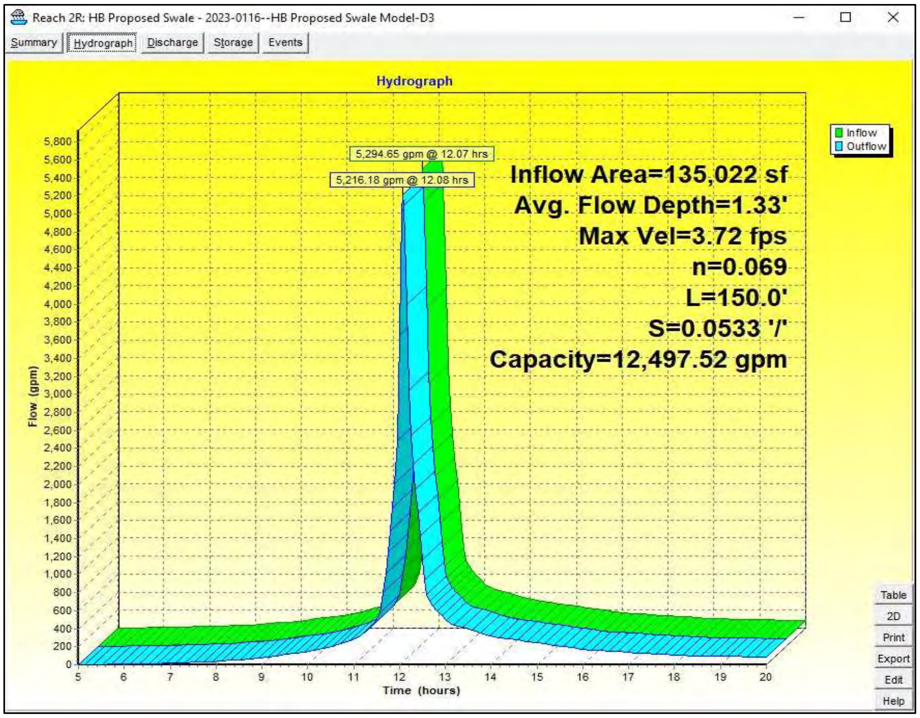
CONCLUSIONS

The stormwater features that were sized in HydroCAD design drawings have the capacity to hold runoff volumes generated from a 2-year to 10-year storm. The drainage swale constructed on the west side of the HB captures a majority of the runoff to the HB. A minimal amount of runoff is generated from subcatchment areas 3S and 5S (Up to approximately 0.1 ft of water accumulated in the HB during a 10-year storm).

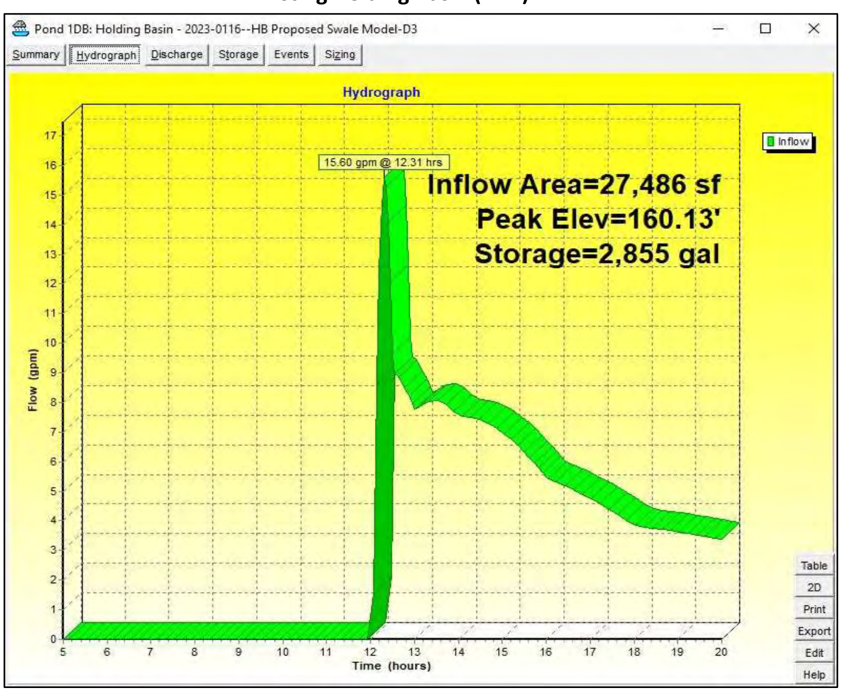
HALEY ALDRICH	CALCULATIONS	File No.	131884
		Sheet	3 of 7
Client	*de maximis, inc.*	Date	10-Feb-23
Project	Nuclear Metals, Inc. Superfund Site	Computed by	JLW
Subject	Holding Basin Stormwater Drainage Feature Design	Checked by	SHL

DRAINAGE FEATURE HYDROGRAPHS (FROM HYDROCAD - DURING 10-YEAR STORM)

New Drainage Swale (Reach 2R)

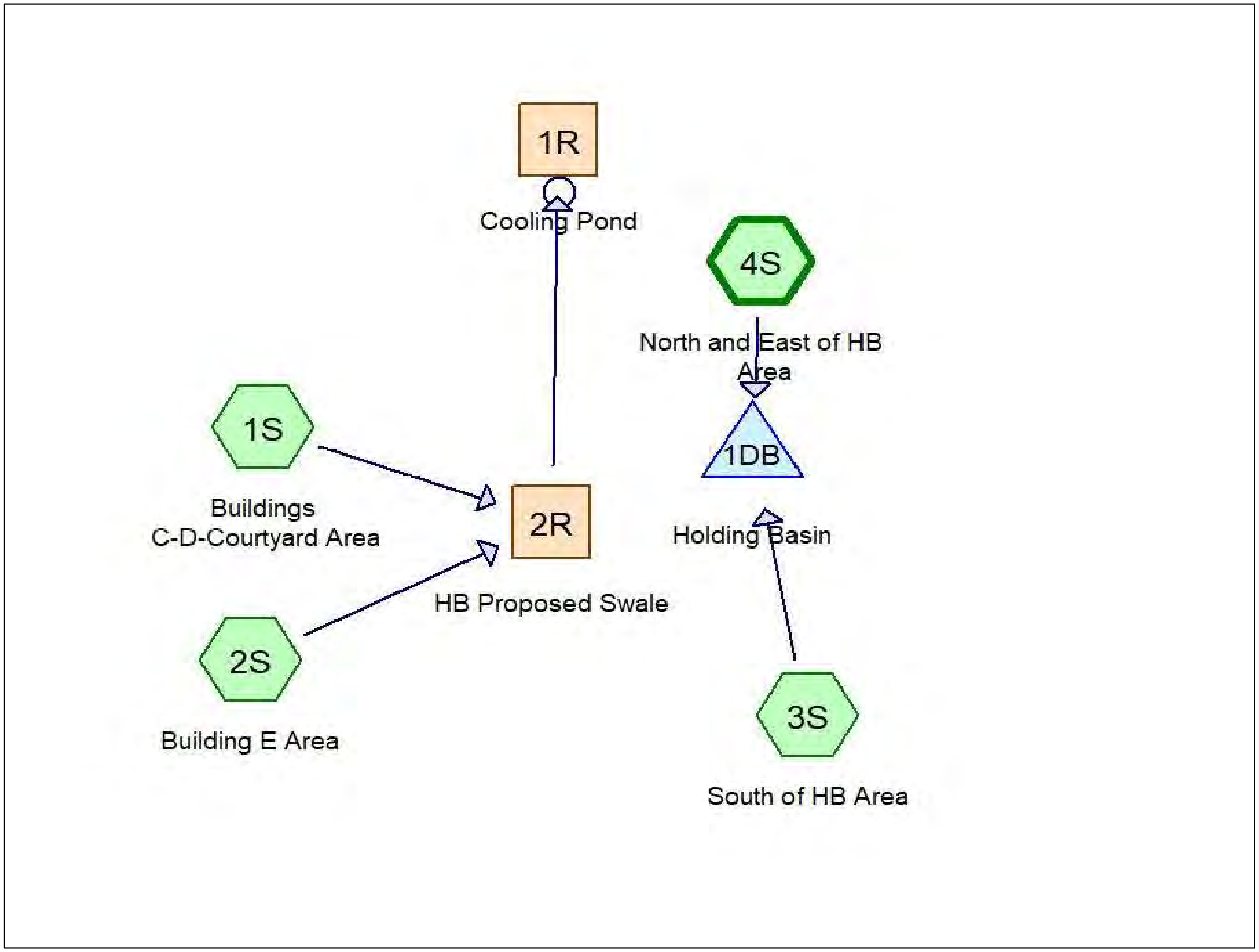


Existing Holding Basin (1DB)



HALEY ALDRICH	CALCULATIONS	File No.	131884
		Sheet	4 of 7
Client	*de maximis, inc.*	Date	10-Feb-23
Project	Nuclear Metals, Inc. Superfund Site	Computed by	JLW
Subject	Holding Basin Stormwater Drainage Feature Design	Checked by	SHL

HydroCAD Nodes Layout



HALEY ALDRICH	CALCULATIONS	File No.	131884
		Sheet	5 of 7
Client	*de maximis, inc.*	Date	10-Feb-23
Project	Nuclear Metals, Inc. Superfund Site	Computed by	JLW
Subject	Holding Basin Stormwater Drainage Feature Design	Checked by	SHL

PROBLEM STATEMENT & OBJECTIVE

1 Determine best erosion control material for lining of the drainage swale (Reach 2R) outlet down the steep Cooling Pond slope.

REFERENCES

1 Federal Highway Administration (FHWA), Hydraulic Toolbox, https://www.fhwa.dot.gov/engineering/hydraulics/software/toolbox404.cfm.

2 North American Green, Erosion and Sediment Control Systems Overview, https://nagreen.com/sites/default/files/2022-06/GEN_EC_BRO_4.22.pdf

3 North American Green, Erosion Controls Material Design Software, ECMDS Version 7.0, https://nagreen.com/ECMDS

ASSUMPTIONS & DEFINITIONS

1 A 100-year storm was used for estimation of the flow velocity out of the drainage swale (Reach 2R).

2 The * indicates that values were calculated in HydroCAD using the SCS Technical Release 20 (TR-20) Runoff Method for runoff calculations.

3 The + indicates that values were calculated in FHWA hydraulic toolbox.

4 gpm = gallons per minute

5 cfs = cubic feet per second

6 lbs/ft^2 = pounds per square foot

FLOW FROM SWALE OUTLET INTO CHANNEL

Flow of Water Exiting the Drainage Swale (Reach 2R) (gpm)*	Flow of Water Exiting the Drainage Swale (Reach 2R) (cfs)*
9,200	20.50

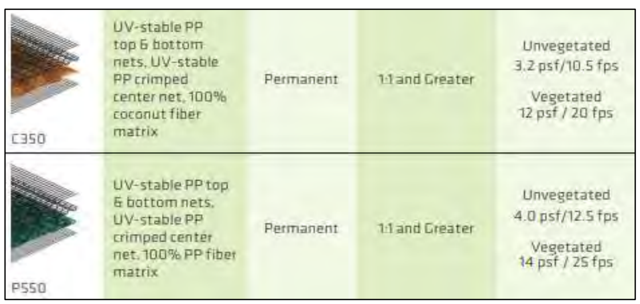
SWALE OUTLET CHANNEL SIZING AND VELOCITY

Hydraulic Toolbox Inputs				Hydraulic Toolbox Outputs				
Channel Width (ft)	Channel Side Slope (ft/ft)	Longitudinal Slope (ft/ft)	Mannings Roughness	Average Velocity of Flow (fps)+	Depth of Flow (ft) +	Wetted Perimeter of Channel (ft) +	Max Shear Stress (lbs/ft^2) +	Average Shear Stress (lbs/ft^2) +
20	1:01	0.33	0.03	7.47	0.136	20.39	2.8	2.77

TURF REINFORCED MAT SELECTION

Turf Reinforced mats were selected based on the calculated shear stress of 2.8 lbs/ft2 and 7.47 ft/s velocity.

North American Green VMAX C350 and P550 Turf Reinforced Mats Recommended Based on Unvegetated Performance Specifications.



C350	UV-stable PP top & bottom nets, UV-stable PP crimped center net, 100% coconut fiber matrix	Permanent	1:1 and Greater	Unvegetated 3.2 psf/10.5 fps Vegetated 12 psf / 20 fps
P550	UV-stable PP top & bottom nets, UV-stable PP crimped center net, 100% PP fiber matrix	Permanent	1:1 and Greater	Unvegetated 4.0 psf/12.5 fps Vegetated 14 psf / 25 fps

Source: Turf Reinforced Mat Specifications from North American Green Erosion and Sediment Control Systems Overview, https://nagreen.com/sites/default/files/2022-06/GEN_EC_BRO_4.22.pdf

See Pages 6 and 7 for turf reinforced mat evaluations based on the North American Green Erosion Controls Material Design Software

NORTH AMERICAN GREEN EROSION CONTROLS MATERIAL DESIGN SOFTWARE OUTPUTS

North American Green VMAX C350 Turf Reinforced Mat Channel Stability Analysis

PROJECTS | TUTORIALS | DOCUMENTS | PHOTOS | ACCOUNT | COST SAVING ESTIMATE | HELP

CHANNEL ANALYSIS

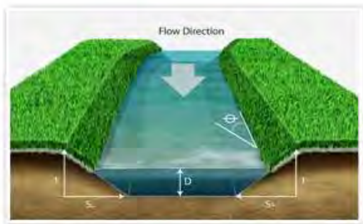
Home > View Projects > Project > Cooling Pond Outlet C350

Print This Page

View Computations

Duplicate Analysis
Delete Analysis

Name	Cooling Pond Outlet C350
Discharge	20.49
Channel Slope	0.33
Channel Bottom Width	20
Left Side Slope	1
Right Side Slope	1
Low Flow Liner	
Retardence Class	C 6-12 in
Vegetation Type	None
Vegetation Density	None
Soil Type	Sandy Loam (GM)



C350

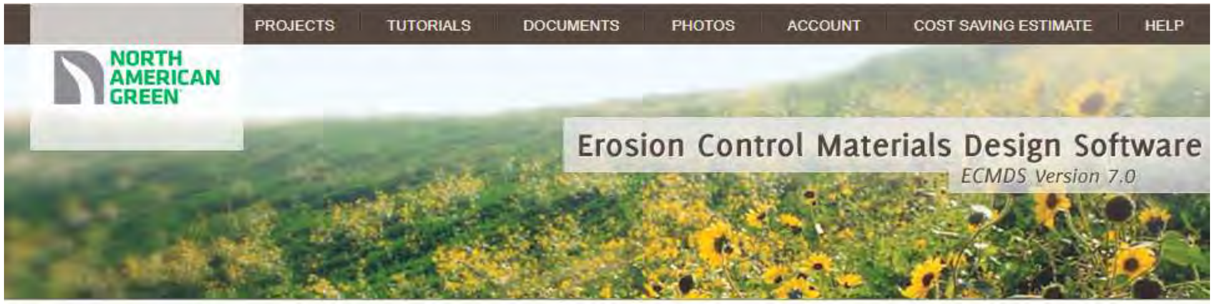
Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
C350 Unvegetated	Straight	20.49 cfs	7.47 ft/s	0.14 ft	0.03	3.2 $lbs/ft2$	2.8 $lbs/ft2$	1.14	STABLE	E
Underlying Substrate	Straight	20.49 cfs	7.47 ft/s	0.14 ft	0.03	3.03 $lbs/ft2$	2.77 $lbs/ft2$	1.09	STABLE	E
C350 Reinforced Vegetation	Straight	20.49 cfs	7.47 ft/s	0.14 ft	0.03	12 $lbs/ft2$	2.8 $lbs/ft2$	4.28	STABLE	E
Underlying Substrate	Straight	20.49 cfs	7.47 ft/s	0.14 ft	0.03	3.2 $lbs/ft2$	2.77 $lbs/ft2$	1.16	STABLE	E

To ensure the mat is not lifted with the flow of water, North American Green recommended the use of Falcon Hex Pins to secure the mat to the slope surface.

HALEY ALDRICH	CALCULATIONS	File No.	131884
		Sheet	7 of 7
Client	*de maximis, inc.*	Date	10-Feb-23
Project	Nuclear Metals, Inc. Superfund Site	Computed by	JLW
Subject	Holding Basin Stormwater Drainage Feature Design	Checked by	SHL

NORTH AMERICAN GREEN EROSION CONTROLS MATERIAL DESIGN SOFTWARE OUTPUTS

North American Green VMAX P550 Turf Reinforced Mat Channel Stability Analysis



CHANNEL ANALYSIS

Home > View Projects > Project > Cooling Pond Outlet P550

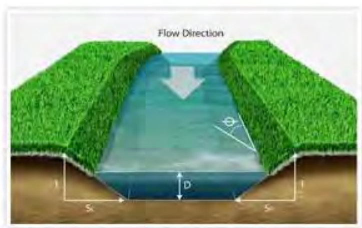
Print This Page

View Computations

Duplicate Analysis

Delete Analysis

Name	Cooling Pond Outlet P550
Discharge	20.49
Channel Slope	0.33
Channel Bottom Width	20
Left Side Slope	1
Right Side Slope	1
Low Flow Liner	
Retardence Class	C 6-12 in
Vegetation Type	None
Vegetation Density	None
Soil Type	Sandy Loam (GM)



P550

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
P550 Unvegetated	Straight	20.49 cfs	7.47 ft/s	0.14 ft	0.03	3.2 lbs/ft2	2.8 lbs/ft2	1.14	STABLE	E
Underlying Substrate	Straight	20.49 cfs	7.47 ft/s	0.14 ft	0.03	3.03 lbs/ft2	2.77 lbs/ft2	1.09	STABLE	E
P550 Reinforced Vegetation	Straight	20.49 cfs	7.47 ft/s	0.14 ft	0.03	14 lbs/ft2	2.8 lbs/ft2	4.99	STABLE	E
Underlying Substrate	Straight	20.49 cfs	7.47 ft/s	0.14 ft	0.03	3.2 lbs/ft2	2.77 lbs/ft2	1.16	STABLE	E

To ensure the mat is not lifted with the flow of water, North American Green recommended the use of Falcon Hex Pins to secure the mat to the slope surface.

PROBLEM STATEMENT & OBJECTIVE

To evaluate the following related to the proposed use of the existing septic system for the infiltration of treated water:

a) Evaluate the mounding potential for the existing chamber leach field under 100 gpm flow rate which is expected to be the steady state flow discharged through the dewatering and treatment system (30 days).
b) Evaluate the mounding at a 500 gpm flow rate, which is a temporary 3 day period of time to dewater the Pond.

REFERENCES

1. Massachusetts Stormwater Guidance.
2. Discroll (1986), Groundwater and Wells.
3. Hantush, M.S., 1967, Growth and decay of groundwater mounds in response to uniform percolation: Water Resources Research, v. 3, p. 227–234.

ASSUMPTIONS

1. All elevations reference the NGVD 1929 datum.
2. Ground surface elevation is El. 185 to 190.
3. Seasonal high groundwater elevation estimated to be El. 145.
4. Sand and gravel saturated thickness is estimated to be 50 ft; Groundwater is approximately 45 ft. below ground surface.
5. The average hydraulic conductivity of the sand and gravel deposit is 25 ft/day, based on RI/FS and PDI data.
6. The estimated flow rate of 100 gpm is based on an estimate of groundwater flow expected within the northern portion of the Cooling Water Pond that is influenced by groundwater (see attached **Page 2** of this calculation set).
6. The estimated volume of standing water in the Cooling Water Pond is: (125 ftx80ftx8ft)x7.48gal/ft3 = 598,400 gals.
7. Based on this volume, it will take 4 days to dewater the pond at 100 gpm. The initial dewatering will then be at higher rate of 500 gpm to dewater the pond within a 1-day period. To be conservative the 500 gpm rate is carried out for 3-days.

STEADY STATE FLOW OF 100 GPM FOR 30-DAYS:

1. The existing leach field is about 7,000 square ft. (200 ftx35 ft). At 100 gpm, loading rate is 2.7 ft/day.
2. Initial saturated thickness (b) is 50 ft.
3. Estimated maximum groundwater mounding after 30 days of 100 gpm distributed into the system is 7 ft., or El. 147.
4. The Hantush (1967) solution result for 100 gpm discharge for a period of 30 days is located on **Page 3.**

FLOW TO SYSTEM OF 500 GPM FOR 3-DAYS:

1. The proposed 500 gpm flow rate distributed over 7,000 sq ft. is equivalent to a loading rate of 13.5 ft/day.
2. Initial saturated thickness (b) is 50 ft.
3. Estimated maximum groundwater mounding for 500 gpm after 3 days is 19 ft. above static water level, or El. 164.
4. The bottom of the existing chamber leachfield is El. 177, or 13 ft. below grade on average so the maximum mound is still below the bottom of the stone layer underlying the septic system.
5. The Hantush (1967) solution result for 3 days of discharge at 500 gpm is located on **Page 4**.

HALEY ALDRICH	CALCULATIONS	File No. 131884-003 Sheet 2 of 4
Client *de maximis, inc.*		Date 09/1/2023
Project NMI Site - West Concord, Massachusetts		Computed By: M. Kelley
Subject Dewatering Calculation - Estimate for Dewatering Cooling Water Pond		Checked By: S. Larkin

PROBLEM: Determine the expected flow rate to dewater the area of the excavation .

ASSUMPTIONS: It is assumed that the required drawdown is 3 ft. over an area of 40 ft. x 60 ft., based on the following:
Static Groundwater El. = 139.0 within Pond; Dewatering to El. 136.0, which is about 1 ft. below the excavation subgrade elevation.

$$Q = \frac{k(H^2 - h^2)}{1055 \log R / r_e}$$

$$h = \sqrt{H^2 - \frac{1055 Q \log R / r_e}{k}}$$

Q = flow, gpm
k = hydraulic conductivity, gpd/sq.ft.
H = saturated thickness before pumping, ft.
h = saturated thickness after pumping, ft.
R = radius of influence, ft. (based on Sichart equation).
r_e = effective well radius.
r = radius within the cone of depression, ft.

Seepage calculations, k = 1.00E-02 cm/sec. to 5.00E-03 cm/sec.

Area	Description	Q (gpm)	k (gpd/ft.^{2})	H (ft.)	h (ft.)	R (ft.)	r_e (ft.)	s (ft.)	Excavation Length (ft.)	Excavation Width (ft.)
1. K_{max}		92.9	2.12E+02	50	47	117.6	27.64	3	40	60
2. K_{min}		56.3	1.06E+02	50	47	91.3	27.64	3	40	60

NOTES:
R = radius estimated by Sichart equation, plus re, as radius of influence will be from sides of excavation, rather than center.

Summary: The flow rate of about 55 to 100 gpm is the steady state flow rate of groundwater contributing into the zone with drawdown of 3 ft. In this case the zone is 40 ft. by 60 ft. This area corresponds to the northern portion of the Pond that is influenced by groundwater.

Steady-state flow of 100 GPM for 30 days

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values

2.7000	*R*	**Recharge (infiltration) rate (feet/day)**
0.200	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
25.00	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
17.000	x	**1/2 length of basin (x direction, in feet)**
100.000	y	**1/2 width of basin (y direction, in feet)**
30.000	t	**duration of infiltration period (days)**
40.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

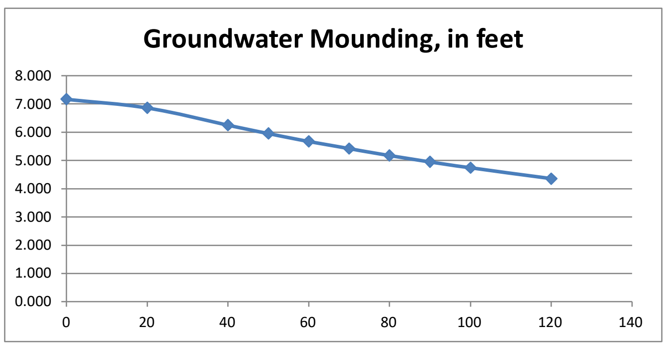
inch/hour	feet/day
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

47.166	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
7.166	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
7.166	0
6.859	20
6.248	40
5.950	50
5.673	60
5.416	70
5.175	80
4.949	90
4.737	100
4.351	120

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

Sheet 4 of 4
Flow to system of 500 GPM for 3 days

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
13.5000	***R***	**Recharge (infiltration) rate (feet/day)**
0.200	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
25.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
17.000	**x**	**1/2 length of basin (x direction, in feet)**
100.000	**y**	**1/2 width of basin (y direction, in feet)**
3.000	**t**	**duration of infiltration period (days)**
40.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

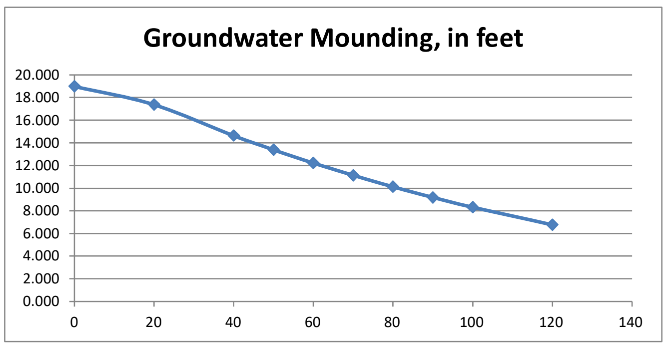
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

58.984	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
18.984	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
18.984	**0**
17.368	**20**
14.638	**40**
13.391	**50**
12.225	**60**
11.137	**70**
10.125	**80**
9.186	**90**
8.317	**100**
6.775	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

APPENDIX B

Amendment to Field Sampling Plan

HALEY & ALDRICH, INC.
465 Medford St.
Suite 2200
Boston, MA 02129
617.886.7400

TECHNICAL MEMORANDUM

22 September 2022
File No. 131884-004

TO: *de maximis, inc.*
Bruce Thompson

FROM: Haley & Aldrich, Inc.
Mark D. Kelley, P.E., Senior Hydrogeologist
Jay Peters, Senior Associate

SUBJECT: Nuclear Metals, Inc. (NMI)
Amendment to Field Sampling Plan
Perimeter Dust Monitoring
Concord, Massachusetts

The purpose of this Memorandum is to provide a supplement to the Field Sampling Plan (FSP) prepared as part of the Remedial Design Work Plan that was approved by the Environmental Protection Agency (EPA) in September 2020. This supplement is for Dust Monitoring during active construction at the NMI Site. This FSP supplement was prepared for the construction at for Area of Interest (AOI) 8 and AOI 9 and will be reviewed and updated as necessary as construction progresses. The dust monitoring is intended to be perimeter air monitoring as described herein. The dust monitoring action levels were established using a risk-based approach as outlined and documented in Attachment B-1.

FENCE-LINE/WORK AREA PERIMETER MONITORING

The Engineer will monitor air quality at the Fence-line/Work Area Perimeter as described in the RAWP including all soil excavations, building slab removal, and sediment excavation activities.

In no instance shall the airborne dust levels at any location on the perimeter surrounding the Limits of Work exceed the lower of 150 *u*g/cubic meter (*u*g/m^3) measured as PM-10 as defined by 310 CMR 6.04 and the values provided in the Table -1 below (presented by Work Area). It is anticipated that MIE Data RAM Portable Real-Time Aerosol Monitor or and equivalent instrument will be used to monitor the perimeter air to determine dust levels during construction activities. A typical instrument cut-sheet is attached as Attachment B-2 for a DustTrak instrument that is an acceptable instrument.

Based on the available soil and sediment quality data and an evaluation of exposure scenarios, the action levels for dust at the perimeter of the RA work areas are as follows, and when implemented will ensure that receptors outside of the fence-line will not experience unacceptable exposures or risks:

Table 1: *Perimeter Dust Thresholds by Work Area*

Work Area	Dust*
Holding Basin Area (Earthwork and Containment Wall Construction)	130 µg/m^3
AOI 8 and AOI 9 Courtyard, Landfill, Cooling Water Pond, and Sediment Building Slabs and Building Footprint (Building A-D) and Paved Areas and Islands Identified During Penetrator Hunt Survey and Sampling Building E and All other Areas	150 µg/m^{3**}
* Dust levels at the downwind location are "corrected" by subtracting the upwind dust levels, which represents background ambient air quality, with comparison to the noted criteria. The Contractor shall implement active dust control measures before the dust action level in this table is exceeded. The value in this table represents a stop work threshold that, once exceeded, dust generating activities must stop pending the Contractor's resolution of work practices and dust control measures. Work may continue when the work practices and dust control is corrected to the satisfaction of the SD Representative and Engineer. ** This value represents USEPA's National Ambient Air Quality Standard (NAAQS) for particulates (PM_{10}) and, consequently, dust levels cannot exceed this value during the remedial activities (i.e., the 150 µg/m^3 value is a ceiling dust concentration).	

The SD's Representative or Engineer will conduct continuous quantitative dust monitoring at selected upwind and downwind locations (total of two) to monitor effectiveness of the Contractor's dust control measures for the duration of the earthwork operations. Such quantitative dust monitoring will be conducted during the normal 8-hr. workday, except during wet weather, moist ground conditions, or when construction activities and traffic on exposed ground surfaces are limited such that visible nuisance dust conditions are not evident. The location of the dust monitoring stations will be coordinated with the Contractor. Additional dust monitoring may be required in connection with the Contractor's Health & Safety Plan.

The SOPs and the HASP include instrumentation calibration requirements, a description of the monitoring requirements, and the corresponding action levels. At a minimum, perimeter monitoring stations will be located upwind and downwind of each work area.

DUST AND ODOR CONTROL

Mitigation of dust and odor will be performed in accordance with the Temporary Environmental Controls Specification Section 015719. The QAO will periodically check during intrusive activities involving soil, sediment and/or waste movement that the RAC is actively monitoring for fugitive dust and vapors in the work area and at the Site perimeter and that the RAC is implementing appropriate and effective dust and odor control measures. The QAO will immediately report observations of visible dust or detection of noticeable odors at the Site perimeter to the EOR and the RAC. The QAO will monitor the area after the RAC implements dust and/or odor control measures to confirm the effectiveness of the measures. Mitigation measures will be implemented to reduce perimeter dust if the action level is approached for any remedial area. The following measures will be implemented as necessary:

1. Wet suppression shall be used to provide temporary control of dust. Several applications per day may be necessary to control dust, depending upon meteorological conditions and work activity. The Contractor shall apply we suppression on a routine basis, as necessary or directed by the Engineer, to control dust.
2. The wet suppression equipment shall consist of sprinkler pipelines, tanks, tank trucks, or other devises capable of providing regulated flow, uniform spray and positive shut-off. During freezing temperatures, calcium chloride shall be used for dust suppression if necessary.

The Contractor is responsible for performing dust monitoring for worker protection in accordance with the Specification Section 01 35 29 Health and Safety.

Attachment B-1 – Dust Monitoring Action Level Calculations
Attachment B-2 – Cut-Sheet for DustTrak Instrument

ATTACHMENT B1

Dust Monitoring Action Level Calculations

Development of Dust Monitoring Action Levels

This appendix provides documentation for the derivation of action levels for use in monitoring dust that that may be generated during the remedial activities for soil at the NMI Site.

At a minimum, the USEPA National Ambient Air Quality Standard (NAAQS) value for PM_{10} equal to 150 microgram per cubic meter ($\mu g/m^3$) based on a 24-hour time weighted average (TWA) is required as a dust monitoring action level. The NAAQS PM_{10} represents the maximum permissible concentration of dust that is allowed in the air, regardless of any specific compounds that are within the dust (for example, if clean beach sand was being excavated, the NAAQS PM_{10} of 150 microgram per cubic meter [$\mu g/m^3$] would apply).

If the PM_{10} that is generated from soil at a Site contains chemicals of potential concern (COPCs), then an evaluation must be completed to determine if a PM_{10} concentration of 150 $\mu g/m^3$ is protective of potential exposures to nearby receptors. Based on the outcome of that evaluation, a lower PM_{10} may be proposed as an action level to ensure that risks to nearby receptors remain within acceptable levels. When the concentration of COPCs in the PM_{10} are accounted for, monitoring for PM_{10} is widely accepted as a perimeter air monitoring method. The following subsections describe the methodology that has been used to evaluate whether a PM_{10} concentration of 150 $\mu g/m^3$ is protective as a perimeter air monitoring action level.

APPROACH

To determine whether using the PM_{10} NAAQS as a dust monitoring action level is appropriately protective of potential exposure to the COPCs identified in the Final Human Health Risk Assessment (HHRA; Haley and Aldrich, 2013) during the proposed removal activities, concentrations of the COPCs in air were calculated, hypothetical exposures to the COPCs were quantified, and risks were estimated. If the estimated risks were higher than a cancer risk of 1×10^{-4} or a hazard index of 1, PM10 concentrations protective for lower risks were calculated.

EXPOSURE ASSESSMENT

Air concentrations of COPCs were calculated based on an assumption that the total dust concentration in air at the PM_{10} NAAQS level of 150 $\mu g/m^3$, the COPCs in the soil at exposure areas (EAs) within the Site would become airborne in dust, and that the constituent concentrations in dust would be the same as the constituent concentrations in soil. Predicted dust concentrations were calculated based on the highest of the COPC exposure point concentrations (EPCs) in surface and subsurface soil from the future land use EAs evaluated in the HHRA. The EPCs were divided by the particulate emission factor (PEF) to estimate the airborne particulate concentration. A PEF of 6.67×10^6 cubic meter per kilogram (m^3/kg) was derived for residential receptors based on a dust concentration of 150 $\mu g/m^3$. The highest EPCs in surface and subsurface soil from the future land use EAs and the respective predictive dust concentrations are summarized in Table 1.

The exposure pathway considered in this evaluation was inhalation exposure to COPCs in soil via dust inhalation. The primary receptors exposed to the COPCs in the soil were nearby residents assumed to be present at the perimeter of the Site where removal areas have been identified, for the duration of removal activities. For the evaluation of inhalation exposures, the exposure duration was assumed to be 6 years of onsite soil removal activity for an exposure time of 8 hours per day and an exposure frequency of 350 days per year. The six years of exposure was assumed to occur to a young child (ages 1 through 6). This provides a conservative estimate of potential exposures because excavation activities are anticipated to occur fewer than 350 days per year, and the dust action level will be applied at the edge of the excavation areas, meaning that actual dust concentrations at the site perimeter will be lower than at the edge of the excavations.

RISK CHARACTERIZATION

Calculating child resident's exposure is a common and conservative approach to represent risks for residential exposures. Hence, the non-cancer hazard index (HI) and the incremental lifetime excess cancer risk (ILECR) for child receptors were calculated using the following approach:

- Risk and Hazard Index Calculation for dust inhalation: Cancer risks associated with the inhalation of airborne particulates of COPCs, except uranium and thorium, in soil were calculated by multiplying the dust inhalation exposure concentration (EC) with the inhalation unit risk (IUR), as presented below:

  $$EC\ (\mu g/m^3)\ X\ IUR\ (\mu g/m^3)^{-1} = ELCR \qquad \text{(Equation 1)}$$

  The calculated value is an Excess Lifetime Cancer Risk (ELCR) and represents an upper bound of the probability of an individual developing cancer over a lifetime as the result of exposure to a COPC. Chemical-specific ELCR values were then summed for all COPCs to produce a total ELCR. ECs and ELCRs associated with the carcinogenic effects of the COPCs in the dust at the Site are presented in Table 2 and 4, respectively.

  Non- cancer hazards associated with the inhalation of airborne particulates of COPCs, in soil are calculated by dividing the dust inhalation EC by its reference concentration (RfC), as presented below:

  $$EC\ (\mu g/m^3)\ /\ RfC\ (\mu g/m^3) = HQ \qquad \text{(Equation 2)}$$

  The calculated value is a hazard quotient (HQ). Chemical-specific HQs were then summed for all COPCs to produce a hazard index (HI). ECs and HIs associated with non-carcinogenic effects of the COPCs in the dust at the Site are presented in Table 3 and 6, respectively.

- Risk Calculation for inhalation exposure to uranium and thorium: Methodology for calculating carcinogenic risks associated with the radionuclides, specifically uranium, thorium, and their isotopes, was presented in the final HHRA (Haley and Aldrich, 2013) and assumed an exposure time of 18 hours per day, an exposure frequency of 161 days per year, and a PEF of 3.35×10^6 m^3/kg. The risks associated with uranium and thorium at a PM_{10} of 150 $\mu g/m^3$ and the highest soil EPCs were derived using an equality that accounts for the differences in the PEFs and receptor exposure assumptions between the HHRA and those applied to evaluation of the dust monitoring action level. Following equation was used for calculating the radionuclide inhalation exposure concentration in the final HHRA (Haley and Aldrich, 2013):

  $$[EPC_i\ X\ 1/PEF\ (m^3/kg)\ X\ 1000\ (g/kg)\ X\ IR\ X\ EF\ X\ ET\ X\ ED]\ X\ IUR = ELCR \qquad \text{(Equation 3)}$$

  In the final HHRA (Haley and Aldrich, 2013), the highest EPCs for uranium (793 mg/kg) and thorium (7.35 mg/kg) resulted in ELCRs of 8E-9 and 4-10, respectively. Assuming all other exposure factors for exposure to the radionuclides at the Site for residential receptors are the same, ELCRs for uranium and thorium are calculated as follows:

$$8E\text{-}9 / [(161 \times 18)/3.35E{+}06] = ELCR_{uranium} / [(350 \times 8)/6.67E{+}06] \text{ and}$$

$$4E\text{-}10 / [(161 \times 18)/3.35E{+}06] = ELCR_{thorium} / [(350 \times 8)/6.67E{+}06]$$

For this evaluation, ELCR for uranium and thorium were calculated using the equality presented above, and the calculations are presented in Table 5.

RISK AND HAZARD RESULTS

HI and ELCR values were compared to acceptable risk levels established in the National Contingency Plan (NCP; USEPA, 1990). According to the NCP and USEPA (1991) guidance "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions," USEPA uses an HI of unity (i.e., 1) and a 10^{-4} (one in ten thousand) to 10^{-6} (one in one million) risk range as a "target range" within which the USEPA strives to manage risks as part of a Superfund cleanup.

The cumulative ELCR of 5×10^{-6} is within the "target range" for the offsite child resident that may potentially have indirect exposure to the onsite COPCs from inhalation of dust. Total HI of 2 is above the target HI of 1, with manganese as the highest contributor with HQ of 1.6.

MANGANESE HAZARD

A soil concentration of 1,043 mg/kg manganese was calculated for a target HQ of 1, assuming an exposure duration of 6 years, an exposure time of 8 hours per day, an exposure frequency of 350 days per year, and total dust concentration in air at the PM_{10} NAAQS level of 150 µg/m^3. This manganese concentration in soil, for target HQ of 1 was then compared with the manganese EPCs in all future land use EAs. Two future land use EAs were identified where the EPCs for manganese were above the calculated manganese concentration of 1,043 mg/kg in soil for the target HQ of 1: Future A-8 (AOI 14-Off-property) and Future B5 (AOI 1-Holding Basin). The Future A-8 area is not an area where soil remediation is required because the risks calculated in the HHRA were within acceptable levels. Therefore, a corresponding dust concentration for a target HQ of 1 was estimated for Future B-5, as presented in the table below:

Soil Depth Interval	Exposure Area	Manganese EPC (mg/kg)	Dust Concentration Level (µg/m^3)
Subsurface Soil	Future B5- AOI 1 Holding Basin	1,180	133

SUMMARY

These results indicate that the NAAQS PM10 value is protective for the Site COPCs for all future land use EAs except B5. Therefore, an Action Level for PM10 of 150 µg/m^3, equal to the NAAQS for PM10, is protective of potential exposure to Site COPCs which could become airborne during removal activities and is appropriate as a perimeter air monitoring action level for the Site for all remediation areas except the Holding Basin. For the Holding Basin, a dust monitoring action level of 133 µg/m^3 is protective of potential exposure to Site COPCs which could become airborne during removal activities.

References

1. Haley and Aldrich, Inc. 2013. Final Human Health Risk Assessment. Nuclear Metals, Inc. Superfund Site. Concord. Massachusetts. 04 September.

2. USEPA. 1989. Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response, Washington, D.C. December 1989. EPA/540/1-89/002.

3. USEPA. 1990. "Code of Federal Regulations, Title 40, Part 300, National Oil and Hazardous Substances Pollution Contingency Plan"; Federal Register; 8 March.

4. USEPA. 1991. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER 9655.0-30. April. 1991.

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

6. USEPA. 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation

Enclosures:

Table 1 – Soil and Predicted Outdoor Air Concentrations for Chemicals of Potential Concern: On-Site Receptors
Table 2 – Exposure Concentrations and Chronic Daily Intakes for Carcinogenic Chemicals of Potential Concern in Dust: Residents
Table 3 – Exposure Concentrations and Chronic Daily Intakes for Noncarcinogenic Chemicals of Potential Concern in Dust: Residents
Table 4 – Estimated ILECRs for Chemicals of Potential Concern in Dust: Residents
Table 5 – Estimated ILECRs for Uranium and Thorium from External Exposure to Ionizing Radiation: Residents
Table 6 – Estimated Noncancer HQs/His for Chemicals of Potential Concern in Dust: Residents

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TABLES

TABLE 1
SOIL AND PREDICTED OUTDOOR AIR CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN : ON-SITE RECEPTORS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Soil Exposure Point Concentration (mg/kg) [a]	Outdoor Airborne Particulate Exposure Point Concentration [a] (mg/m^3) [b]
Volatile Organic Compounds		
Tetrachloroethene (PCE)	9.3E-04	1.4E-10
Trichloroethene	6.1E-01	9.2E-08
Polycyclic Aromatic Hydrocarbons		
Benzo(a)anthracene	2.1E+00	3.2E-07
Benzo(a)pyrene	2.2E+00	3.4E-07
Benzo(b)fluoranthene	3.5E+00	5.2E-07
Benzo(k)fluoranthene	4.7E-01	7.0E-08
Indeno(1,2,3-cd)pyrene	1.0E+00	1.5E-07
Total Petroleum Hydrocarbons		
TPH (C11-C22) Aromatic	1.8E+02	2.6E-05
Metals		
Aluminum	1.3E+04	1.9E-03
Antimony	1.0E+00	1.5E-07
Arsenic	1.8E+01	2.7E-06
Beryllium	3.5E+00	5.2E-07
Chromium (total)	2.7E+01	4.1E-06
Cobalt	5.6E+00	8.4E-07
Copper	4.6E+02	7.0E-05
Iron	2.0E+04	2.9E-03
Lead	4.9E+01	7.4E-06
Manganese	1.7E+03	2.5E-04
Mercury (inorganic)	3.7E-01	5.5E-08
Molybdenum	1.5E+02	2.2E-05
Thallium	1.5E+00	2.3E-07
Thorium	7.3E+00	1.1E-06
Titanium	7.3E+02	1.1E-04
Tungsten	2.3E+01	3.5E-06
Uranium, soluble salts	7.9E+02	1.2E-04
Vanadium	3.1E+01	4.7E-06
Zirconium	1.9E+01	2.8E-06
Polychlorinated Biphenyls		
Aroclor-1254 (PCB-1254)	1.8E+01	2.7E-06
Aroclor-1260 (PCB-1260)	2.8E+01	4.3E-06

TABLE 1
SOIL AND PREDICTED OUTDOOR AIR CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN : ON-SITE RECEPTORS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Soil Exposure Point Concentration (mg/kg) [a]	Outdoor Airborne Particulate Exposure Point Concentration [a] (mg/m^3) [b]
Semi-Volatile Organic Compounds		
Carbazole	2.7E-01	4.0E-08

Abbreviations:
bgs = Below ground surface
m^3/kg = Cubic meters per kilogram
mg/kg = Milligrams per kilogram
mg/m^3 = Milligrams per cubic meter

Notes:
[a] Highest exposure point concentration (EPC) between surface and subsurface soil for future land use EAs is selected as the EPC for this evaluation.
[b] Outdoor airborne particulate concentration is calculated by dividing the soil EPCs by the particulate emission factor (PEF). For residential receptors, a PEF of 6.7×10^6 m^3/kg was estimated for a dust concentration of 150 $\mu g/m^3$.

TABLE 2
EXPOSURE CONCENTRATIONS AND CHRONIC DAILY INTAKES FOR CARCINOGENIC CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future On-Site Resident, Child
	Soil Pathway
	EC: Particulate Inhalation (mg/m^3)
Volatile Organic Compounds	
Tetrachloroethene (PCE)	3.8E-12
Trichloroethene	3.3E-09
Polycyclic Aromatic Hydrocarbons	
Benzo(a)anthracene	4.6E-08
Benzo(a)pyrene	4.9E-08
Benzo(b)fluoranthene	7.6E-08
Benzo(k)fluoranthene	1.0E-08
Indeno(1,2,3-cd)pyrene	2.2E-08
Total Petroleum Hydrocarbons	
TPH (C11-C22) Aromatic	NC
Metals	
Aluminum	NC
Antimony	NC
Arsenic	7.5E-08
Beryllium	1.4E-08
Chromium (total)	NC
Cobalt	2.3E-08
Copper	NC
Iron	NC
Lead	NA
Manganese	NC
Mercury (inorganic)	NC
Molybdenum	NC
Thallium	NC
Thorium	NA
Titanium	NC
Tungsten	NC
Uranium, soluble salts	NA
Vanadium	NC
Zirconium	NC
Polychlorinated Biphenyls	
Aroclor-1254 (PCB-1254)	7.5E-08
Aroclor-1260 (PCB-1260)	1.2E-07

TABLE 2
EXPOSURE CONCENTRATIONS AND CHRONIC DAILY INTAKES FOR CARCINOGENIC CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future On-Site Resident, Child
	Soil Pathway
	EC: Particulate Inhalation (mg/m^3)
Semi-Volatile Organic Compounds	
Carbazole	NC

Abbreviations:
bgs = Below ground surface
EC = Exposure concentration
mg/m^3 = Milligrams per cubic meter
NA = Not applicable.
NC = Not considered a carcinogen

TABLE 3

EXPOSURE CONCENTRATIONS AND CHRONIC DAILY INTAKES FOR NONCARCINOGENIC CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS

NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child
	Soil Pathway
	EC: Particulate Inhalation (mg/m^3)
Volatile Organic Compounds	
Tetrachloroethene (PCE)	4.5E-11
Trichloroethene	2.9E-08
Polycyclic Aromatic Hydrocarbons	
Benzo(a)anthracene	NA
Benzo(a)pyrene	1.1E-07
Benzo(b)fluoranthene	NA
Benzo(k)fluoranthene	NA
Indeno(1,2,3-cd)pyrene	NA
Total Petroleum Hydrocarbons	
TPH (C11-C22) Aromatic	NA
Metals	
Aluminum	6.1E-04
Antimony	4.8E-08
Arsenic	8.7E-07
Beryllium	1.7E-07
Chromium (total)	NA
Cobalt	2.7E-07
Copper	NA
Iron	NA
Lead	na
Manganese	8.0E-05
Mercury (inorganic)	1.8E-08
Molybdenum	7.0E-06
Thallium	NA
Thorium	NA
Titanium	NA
Tungsten	NA
Uranium, soluble salts	3.8E-05
Vanadium	1.5E-06
Zirconium	NA
Polychlorinated Biphenyls	
Aroclor-1254 (PCB-1254)	NA
Aroclor-1260 (PCB-1260)	NA

TABLE 3

EXPOSURE CONCENTRATIONS AND CHRONIC DAILY INTAKES FOR NONCARCINOGENIC CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS

NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child
	Soil Pathway
	EC: Particulate Inhalation (mg/m^3)
Semi-Volatile Organic Compounds	
Carbazole	NA

Abbreviations:

bgs = Below ground surface
EC = Exposure concentration
mg/m^3 = Milligrams per cubic meter
NA = Not applicable or no toxicity value available for inhalation pathway.

TABLE 4
ESTIMATED ILECRS FOR CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical		Hypothetical Future on-Site Resident, Child	
		Soil Pathway	
		Particulate Inhalation	Cumulative ILECR
Volatile Organic Compounds			
Tetrachloroethene (PCE)		9.9E-16	9.9E-16
Trichloroethene		1.3E-11	1.3E-11
Polycyclic Aromatic Hydrocarbons			
Benzo(a)anthracene		2.8E-09	2.8E-09
Benzo(a)pyrene		3.0E-08	3.0E-08
Benzo(b)fluoranthene		4.6E-09	4.6E-09
Benzo(k)fluoranthene		6.2E-11	6.2E-11
Indeno(1,2,3-cd)pyrene		1.3E-09	1.3E-09
Total Petroleum Hydrocarbons			
TPH (C11-C22) Aromatic		NC	NC
Metals			
Aluminum		NC	NC
Antimony		NC	NC
Arsenic		3.2E-07	3.2E-07
Beryllium		3.4E-08	3.4E-08
Chromium (total)		NC	NC
Cobalt		2.1E-07	2.1E-07
Copper		NC	NC
Iron		NC	NC
Lead		NA	NA
Manganese		NC	NC
Mercury (inorganic)		NC	NC
Molybdenum		NC	NC
Thallium		NC	NC
Thorium	[a]	1.9E-07	1.9E-07
Titanium		NC	NC
Tungsten		NC	NC
Uranium, soluble salts	[a]	3.9E-06	3.9E-06
Vanadium		NC	NC
Zirconium		NC	NC
Polychlorinated Biphenyls			
Aroclor-1254 (PCB-1254)		4.3E-08	4.3E-08
Aroclor-1260 (PCB-1260)		6.6E-08	6.6E-08

TABLE 4
ESTIMATED ILECRS FOR CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child	
	Soil Pathway	
	Particulate Inhalation	Cumulative ILECR
Semi-Volatile Organic Compounds		
Carbazole	NC	NC
Cumulative ILECR	**4.8E-06**	**5E-06**

Abbreviations:
bgs = Below ground surface
ILECR = Incremental lifetime excess cancer risk
NA = Not applicable.
NC = Not considered a carcinogen.

Notes:
[a] Inhalation risks for uranium and thorium are calculated in Table 5.

TABLE 5
ESTIMATED ILECRS FOR URANIUM AND THORIUM FROM EXTERNAL EXPOSURE TO IONIZING RADIATION: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

For Exposure factors:	**EF=161 days/yr; ET=18 hrs/day; PEF=3.35E+09 m^3/kg**
	ILCR
Uranium (EPC = 793 mg/kg)	8E-09
Thorium (EPC = 7.35 mg/kg)	4E-10

For Exposure factors:	**EF=350 days/yr; ET=8 hours/day; PEF = 6.67E+06 m^3/kg**
	ILCR
Uranium (EPC = 793 mg/kg)	4E-06
Thorium (EPC = 7.35 mg/kg)	2E-07

Abbreviations:
days/yr = Days per year
EF = Exposure frequency
ET = Exposure time
hrs/day = Hours per day
m^3/kg = Meters cubed per kilogram
PEF = Particulate emission factor

TABLE 6
ESTIMATED NONCANCER HQS/HIS FOR CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child	
	Soil Pathway	
	Particulate Inhalation	Total Hazard Index
Volatile Organic Compounds		
Tetrachloroethene (PCE)	1.1E-09	1.1E-09
Trichloroethene	1.5E-05	1.5E-05
Polycyclic Aromatic Hydrocarbons		
Benzo(a)anthracene	NA	NA
Benzo(a)pyrene	5.4E-02	5.4E-02
Benzo(b)fluoranthene	NA	NA
Benzo(k)fluoranthene	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA
Total Petroleum Hydrocarbons		
TPH (C11-C22) Aromatic	NA	NA
Metals		
Aluminum	1.2E-01	1.2E-01
Antimony	1.6E-04	1.6E-04
Arsenic	5.8E-02	5.8E-02
Beryllium	8.3E-03	8.3E-03
Chromium (total)	NA	NA
Cobalt	4.5E-02	4.5E-02
Copper	NA	NA
Iron	NA	NA
Lead	NA	NA
Manganese	1.6E+00	1.6E+00
Mercury (inorganic)	5.9E-05	5.9E-05
Molybdenum	3.5E-03	3.5E-03
Thallium	NA	NA
Thorium	NA	NA
Titanium	NA	NA
Tungsten	NA	NA
Uranium, soluble salts	4.5E-02	4.5E-02
Vanadium	1.5E-02	1.5E-02
Zirconium	NA	NA
Polychlorinated Biphenyls		
Aroclor-1254 (PCB-1254)	NA	NA
Aroclor-1260 (PCB-1260)	NA	NA

TABLE 6
ESTIMATED NONCANCER HQS/HIS FOR CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child	
	Soil Pathway	
	Particulate Inhalation	Total Hazard Index
Semi-Volatile Organic Compounds		
Carbazole	NA	NA
Total Hazard Index	**1.95E+00**	**2.0E+00**

Abbreviations:
bgs = Below ground surface
NA = Not applicable or no toxicity value available for inhalation pathway.

ATTACHMENT B2

Cut-Sheet for DustTrak Instrument

Knowledge Beyond Measure.

DustTrak™ DRX Aerosol Monitors

Models 8533, 8533EP and 8534

Only DustTrak™ DRX Aerosol Monitors can simultaneously measure both mass and size fraction—no other monitor can do both.

DustTrak™ DRX monitors are battery-operated, data-logging, light-scattering laser photometers that give you real-time aerosol mass readings. They use a sheath air system that isolates the aerosol in the optics chamber to keep the optics clean for improved reliability and low maintenance. From desktop with external pump models to a handheld model, the DustTrak DRX offers a suitable solution for harsh industrial workplaces, construction and environmental sites and other outdoor applications, as well as clean office settings. DustTrak DRX monitors measure aerosol contaminants such as dust, smoke, fumes and mists.

Features and Benefits

All Models

- Real-time mass concentration and size fraction readings, as well as data-logging allow for data analysis during and after sampling.
- Simultaneously measure size-segregated mass fraction concentrations corresponding to PM1, PM2.5, Respirable,PM10, and Total PM size fractions
- Easy-to-use graphical user interface with color touch-screen for effortless operation

Handheld Model (8534)

- Long life internal pump for continuous sampling
- Single-point data collection for walk through surveys
- Lightweight design with ergonomic handle for portable applications

Desktop Models (8533 and 8533EP)

- Energy-efficient, long lasting external pump for continuous, unattended, 24/7, outdoor monitoring applications (Model 8533EP only)
- Long life internal pump for shorter work-shift or IAQ sampling applications (Model 8533)
- Gravimetric reference sampling capability for custom reference calibrations
- Automatic zeroing (with optional zero module) to minimize the effect of zero drift
- STEL alarm setpoint for tracking 15-minute average mass concentrations
- Standard and advanced calibration capabilities for consistent accuracy
- Environmental protected and tamper-proof secure (with an optional environmental enclosure)
- Inlet sample conditioning (with optional heated inlet sample conditioner) to reduce the effect of humidity on photometric mass measurements (for use with an environmental enclosure)
- Cloud Data Management System hosted by Netronix™

Unsurpassed Technology and Performance

DustTrak™ DRX monitors are laser photometers that simultaneously measure five size segregated mass fraction concentrations at once—something no other monitor can do. The desktop, desktop with external pump and handheld monitors are continuous, real-time, 90°, light-scattering laser photometers that simultaneously measure size-segregated mass fraction concentrations corresponding to PM1, PM2.5, Respirable, PM10, and Total PM fractions. They combine both particle cloud (total area of scattered light) and single particle detection to achieve mass fraction measurements.

This size-segregated mass fraction measurement technique is superior to either a basic photometer or optical particle counter (OPC). It delivers the mass concentration of a photometer and the size resolution of an OPC. Typically, photometers can be used at high mass concentration, but they do not give any size information (unless used with size selective inlet conditioners) and significantly underestimate large particle mass concentrations. OPC's provide size and count information; however, they do not provide any mass concentration information and cannot be used in high mass concentration environments. The DustTrak™ DRX can do both.

Handheld Models: Perfect for Walk-Through Surveys and Single-Point Data Collection Applications

The DustTrak™ DRX handheld Model 8534 is lightweight and portable. It is perfect for industrial hygiene surveys, point source location monitoring, indoor air quality investigations, engineering control evaluations/validation, and for baseline trending and screening. Like the desktop models, it has manual and programmable data logging functions. In addition, the handheld model also has a single-point data logging capability for walk-through industrial hygiene surveys and indoor air quality investigations.

Desktop Models: Ideal for Long-Term Surveys and Remote Monitoring Applications

The DustTrak DRX is also offered as a standard desktop (Model 8533), as well as a desktop with external pump (Model 8533EP.) Both models have manual and programmable data logging functions, making them ideal for unattended applications. The standard desktop model is most suitable for indoor, continuous monitoring, while the desktop with external pump is designed for 24/7 unattended, remote monitoring outdoors.

The DustTrak DRX desktop models come with USB (device and host), Ethernet, and analog and alarm outputs allowing remote access to data. User adjustable alarm setpoints for instantaneous or 15-minute short-term excursion limit (STEL) are also available on desktop models. The alarm output with user-defined setpoint alerts you when upset or changing conditions occur.

The DustTrak DRX Desktop Monitors have several unique features:

- External pump (Model 8533EP) with low power consumption for continuous, unattended monitoring in remote outdoor locations.
- Gravimetric sampling capability using a 37-mm filter cassette which can be inserted in-line with the aerosol stream allowing you to perform an integral gravimetric analysis for custom reference calibrations.
- Zeros automatically using the external zeroing module. This optional accessory is used when sampling over extended periods of time. By zeroing the monitor during sampling, the effect of zero drift is minimized.
- STEL alarm feature for tracking 15-minute average mass concentrations when alarm setpoint has been reached for applications like monitoring fugitive emissions at hazardous waste sites.
- Provide for environmental protection and tamper-proof security using an environmental enclosure. This optional accessory encloses the instrument within a waterproof, lockable, custom-designed case.
- Condition the sample air stream before entering the instrument optics using a heated inlet sample conditioner (designed for use with the environmental enclosure.) This optional accessory is used in humid environments. By conditioning the sample, the humidity and water vapor are minimized.
- Standard and advanced calibration capabilities. The DustTrak DRX Aerosol Monitor has two calibration factors: a photometric calibration factor (PCF) and a size calibration factor (SCF). The PCF accounts for the photometric response difference between A1 Test Dust and the aerosol under measurement, while the SCF accounts for the aerodynamic size difference.
  - The primary goal of the standard calibration is to obtain the SCF for the aerosol of interest. The standard calibration process is very easy and does not require comparison to gravimetric samples. Measure with and without a PM2.5 impactor, and the instrument takes the ratio of these two size distributions and compares this reading to the PM2.5 impactor transmission efficiency curve to calculate the SCF. However, the absolute mass concentration may not be as accurate as the advanced calibration.
  - The advanced calibration method yields high size segregated mass concentration accuracy. It involves two separate gravimetric measurements to obtain PCF and SCF in sequence. The advanced calibration will accurately measure size segregated mass concentrations.

Applications	Desktop	Handheld
Aerosol research studies	▪	▪
Baseline trending and screening	▪	▪
Engineering control evaluations		▪
Engineering studies		▪
Epidemiology studies	▪	▪
Indoor air quality investigations	▪	▪
Industrial/occupational hygiene surveys	▪	▪
Point source monitoring		▪
Outdoor environmental monitoring	▪	
Process monitoring	▪	▪
Remote monitoring	▪	

DustTrak™ DRX Aerosol Monitor Features

All Models

- Li-Ion rechargeable batteries
- Internal and external battery charging capabilities
- Outlet port for isokinetic sampling applications
- User serviceable sheath flow and pump filters
- Logged test pause and restart feature
- Logged test programming
  - Color touch screen—either manual mode or program mode
  - TRAKPRO™ Data Analysis Software via a PC
- User adjustable custom calibration settings
- Instantaneous alarm settings with visual and audible warnings
- Real-time graph display
- View statistical information during and after sampling
- On-screen instrument status indicators: FLOW, LASER and FILTER
- Filter service indicator for user preventative maintenance

Desktop Models (8533 and 8533EP)

- Long life external pump (8533EP)
- Internal pump (8533)
- Hot swappable batteries
- Gravimetric reference sample capability
- STEL alarm setpoint

Optional Accessories

- Auto zeroing module
- Protective environmental enclosure (8535)
- Heated inlet sample conditioner (for use with an environmental enclosure)
- Cloud Data Management System as hosted by Netronix™

Handheld Model (8534)

- Long life internal pump
- Single-point data collection for walk through surveys

Easy to Program and Operate

The graphical user interface with color touch-screen puts everything at your fingertips. The easy-to-read display shows real-time mass concentration and graphical data, as well as other statistical information along with instrument pump, laser and flow status, and much more. Perform quick walk-through surveys or program the instrument's advanced logging modes for long-term sampling investigations. Program start times, total sampling times, logging intervals, alarm setpoints and many other parameters. You can even set up the instrument for continuous unattended operation.

TrakPro™ Software Makes Monitoring Easier than Ever

TrakPro™ Data Analysis Software allows you to set up and program directly from a PC. It even features the ability for remote programming and data acquisition from your PC via wireless communication options or over an Ethernet network. As always, you can print graphs, raw data tables, and statistical and comprehensive reports for recordkeeping purposes.

Battery Performance		
Models 8533 and 8533EP (Typical) 6600 mAH Li-Ion Battery Pack (P/N 801680)	1 Battery	2 Batteries
Battery runtime (hours)	Up to 6	Up to 12
Charge time* (hours) in DustTrak™	4	8
Charge time* (hours) in external battery charger (P/N 801685)	4	8
Model 8534 (Typical) 3600 mAH Li-Ion Battery Pack (P/N 801681)	Battery	
Battery runtime (hours)	Up to 6	
Charge time* (hours) in DustTrak™	4	
Charge time* (hours) in external battery charger (P/N 801686)	4	

*Of a fully depleted battery

Cloud Data Management System for 24/7 remote dust monitoring

Specifications

DustTrak™ DRX Aerosol Monitors

Models 8533, 8533EP and 8534

Sensor Type

90° light scattering

Particle Size Range

0.1 to 15 µm

Aerosol Concentration Range

8533 Desktop	0.001 to 150 mg/m^3
8533EP Desktop with External Pump	0.001 to 150 mg/m^3
8534 Handheld	0.001 to 150 mg/m^3

Display

Size Segregated Mass Fractions for PM1, PM2.5, Respirable, PM10 and Total. All displayed

Resolution

±0.1% of reading or 0.001 mg/m^3, whichever is greater

Zero Stability

±0.002 mg/m^3 per 24 hours at 10 sec time constant

Flow Rate

3.0 L/min

Flow Accuracy

±5% of factory set point, internal flow controlled

Temperature Coefficient

+0.001 mg/m^3 per °C

Operational Temp

32 to 120°F (0 to 50°C)

Storage Temp

-4 to 140°F (-20 to 60°C)

Operational Humidity

0 to 95% RH, non-condensing

Time Constant

User adjustable, 1 to 60 seconds

Data Logging

5 MB of on-board memory (>60,000 data points)

45 days at 1 minute logging interval

Log Interval

User adjustable, 1 second to 1 hour

Physical Size (H x W x D)

Handheld	4.9 x 4.8 x 12.5 in. (12.5 x 12.1 x 31.6 cm)
Desktop	5.3 x 8.5 x 8.8 in. (13.5 x 21.6 x 22.4 cm)
External Pump	4.0 x 7.0 x 3.5 in. (10.0 x 18.0 x 9.0 cm)

Weight

Handheld	2.9 lb (1.3 kg), 3.3 lb (1.5 kg) with battery
Desktop	3.5 lb (1.6 kg), 4.5 lb (2.0 kg) – 1 battery, 5.5 lb (2.5 kg) – 2 batteries
External Pump	3.0 lb (1.4 kg)

Communications

8533	USB (host and device) and Ethernet. Stored data accessible using flash memory drive
8533EP	USB (host and device) and Ethernet. Stored data accessible using flash memory drive plus, cable assembly for external pump
8534	USB (host and device). Stored data accessible using flash memory drive

Power–AC

Switching AC power adapter with universal line cord included,115–240 VAC

Analog Out

8533/8533EP	User selectable output, 0 to 5 V or 4 to 20 mA. User selectable scaling range

Alarm Out

8533/8533EP	Relay or audible buzzer Relay Non-latching MOSFET switch ▪ User selectable set point ▪ –5% deadband ▪ Connector 4-pin, Mini-DIN connectors
8534	Audible buzzer

Screen

8533/8533EP	5.7 in. VGA color touchscreen
8534	3.5 in. VGA color touchscreen

Gravimetric Sampling

8533/8533EP	Removable 37 mm cartridge (user supplied)

CE Rating

Immunity	EN61236-1:2006
Emissions	EN61236-1:2006

Specifications are subject to change without notice.

Knowledge Beyond Measure.

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ATTACHMENT B1

Dust Monitoring Action Level Calculations

Development of Dust Monitoring Action Levels

This appendix provides documentation for the derivation of action levels for use in monitoring dust that that may be generated during the remedial activities for soil at the NMI Site.

At a minimum, the USEPA National Ambient Air Quality Standard (NAAQS) value for PM_{10} equal to 150 microgram per cubic meter ($\mu g/m^3$) based on a 24-hour time weighted average (TWA) is required as a dust monitoring action level. The NAAQS PM_{10} represents the maximum permissible concentration of dust that is allowed in the air, regardless of any specific compounds that are within the dust (for example, if clean beach sand was being excavated, the NAAQS PM_{10} of 150 microgram per cubic meter [$\mu g/m^3$] would apply).

If the PM_{10} that is generated from soil at a Site contains chemicals of potential concern (COPCs), then an evaluation must be completed to determine if a PM_{10} concentration of 150 $\mu g/m^3$ is protective of potential exposures to nearby receptors. Based on the outcome of that evaluation, a lower PM_{10} may be proposed as an action level to ensure that risks to nearby receptors remain within acceptable levels. When the concentration of COPCs in the PM_{10} are accounted for, monitoring for PM_{10} is widely accepted as a perimeter air monitoring method. The following subsections describe the methodology that has been used to evaluate whether a PM_{10} concentration of 150 $\mu g/m^3$ is protective as a perimeter air monitoring action level.

APPROACH

To determine whether using the PM_{10} NAAQS as a dust monitoring action level is appropriately protective of potential exposure to the COPCs identified in the Final Human Health Risk Assessment (HHRA; Haley and Aldrich, 2013) during the proposed removal activities, concentrations of the COPCs in air were calculated, hypothetical exposures to the COPCs were quantified, and risks were estimated. If the estimated risks were higher than a cancer risk of 1×10^{-4} or a hazard index of 1, PM10 concentrations protective for lower risks were calculated.

EXPOSURE ASSESSMENT

Air concentrations of COPCs were calculated based on an assumption that the total dust concentration in air at the PM_{10} NAAQS level of 150 $\mu g/m^3$, the COPCs in the soil at exposure areas (EAs) within the Site would become airborne in dust, and that the constituent concentrations in dust would be the same as the constituent concentrations in soil. Predicted dust concentrations were calculated based on the highest of the COPC exposure point concentrations (EPCs) in surface and subsurface soil from the future land use EAs evaluated in the HHRA. The EPCs were divided by the particulate emission factor (PEF) to estimate the airborne particulate concentration. A PEF of 6.67×10^6 cubic meter per kilogram (m^3/kg) was derived for residential receptors based on a dust concentration of 150 $\mu g/m^3$. The highest EPCs in surface and subsurface soil from the future land use EAs and the respective predictive dust concentrations are summarized in Table 1.

The exposure pathway considered in this evaluation was inhalation exposure to COPCs in soil via dust inhalation. The primary receptors exposed to the COPCs in the soil were nearby residents assumed to be present at the perimeter of the Site where removal areas have been identified, for the duration of removal activities. For the evaluation of inhalation exposures, the exposure duration was assumed to be 6 years of onsite soil removal activity for an exposure time of 8 hours per day and an exposure frequency of 350 days per year. The six years of exposure was assumed to occur to a young child (ages 1 through 6). This provides a conservative estimate of potential exposures because excavation activities are anticipated to occur fewer than 350 days per year, and the dust action level will be applied at the edge of the excavation areas, meaning that actual dust concentrations at the site perimeter will be lower than at the edge of the excavations.

RISK CHARACTERIZATION

Calculating child resident's exposure is a common and conservative approach to represent risks for residential exposures. Hence, the non-cancer hazard index (HI) and the incremental lifetime excess cancer risk (ILECR) for child receptors were calculated using the following approach:

- Risk and Hazard Index Calculation for dust inhalation: Cancer risks associated with the inhalation of airborne particulates of COPCs, except uranium and thorium, in soil were calculated by multiplying the dust inhalation exposure concentration (EC) with the inhalation unit risk (IUR), as presented below:

  $$EC\ (\mu g/m^3)\ X\ IUR\ (\mu g/m^3)^{-1} = ELCR \qquad (Equation\ 1)$$

  The calculated value is an Excess Lifetime Cancer Risk (ELCR) and represents an upper bound of the probability of an individual developing cancer over a lifetime as the result of exposure to a COPC. Chemical-specific ELCR values were then summed for all COPCs to produce a total ELCR. ECs and ELCRs associated with the carcinogenic effects of the COPCs in the dust at the Site are presented in Table 2 and 4, respectively.

  Non- cancer hazards associated with the inhalation of airborne particulates of COPCs, in soil are calculated by dividing the dust inhalation EC by its reference concentration (RfC), as presented below:

  $$EC\ (\mu g/m^3)\ /\ RfC\ (\mu g/m^3) = HQ \qquad (Equation\ 2)$$

  The calculated value is a hazard quotient (HQ). Chemical-specific HQs were then summed for all COPCs to produce a hazard index (HI). ECs and HIs associated with non-carcinogenic effects of the COPCs in the dust at the Site are presented in Table 3 and 6, respectively.

- Risk Calculation for inhalation exposure to uranium and thorium: Methodology for calculating carcinogenic risks associated with the radionuclides, specifically uranium, thorium, and their isotopes, was presented in the final HHRA (Haley and Aldrich, 2013) and assumed an exposure time of 18 hours per day, an exposure frequency of 161 days per year, and a PEF of 3.35 x 10^6 m^3/kg. The risks associated with uranium and thorium at a PM_{10} of 150 µg/m^3 and the highest soil EPCs were derived using an equality that accounts for the differences in the PEFs and receptor exposure assumptions between the HHRA and those applied to evaluation of the dust monitoring action level. Following equation was used for calculating the radionuclide inhalation exposure concentration in the final HHRA (Haley and Aldrich, 2013):

  $$[EPC_i\ X\ 1/PEF\ (m^3/kg)\ X\ 1000\ (g/kg)\ X\ IR\ X\ EF\ X\ ET\ X\ ED]\ X\ IUR = ELCR \qquad (Equation\ 3)$$

  In the final HHRA (Haley and Aldrich, 2013), the highest EPCs for uranium (793 mg/kg) and thorium (7.35 mg/kg) resulted in ELCRs of 8E-9 and 4-10, respectively. Assuming all other exposure factors for exposure to the radionuclides at the Site for residential receptors are the same, ELCRs for uranium and thorium are calculated as follows:

$$8E\text{-}9 / [(161 \times 18)/3.35E{+}06] = ELCR_{uranium} / [(350 \times 8)/6.67E{+}06] \text{ and}$$

$$4E\text{-}10 / [(161 \times 18)/3.35E{+}06] = ELCR_{thorium} / [(350 \times 8)/6.67E{+}06]$$

For this evaluation, ELCR for uranium and thorium were calculated using the equality presented above, and the calculations are presented in Table 5.

RISK AND HAZARD RESULTS

HI and ELCR values were compared to acceptable risk levels established in the National Contingency Plan (NCP; USEPA, 1990). According to the NCP and USEPA (1991) guidance "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions," USEPA uses an HI of unity (i.e., 1) and a 10^{-4} (one in ten thousand) to 10^{-6} (one in one million) risk range as a "target range" within which the USEPA strives to manage risks as part of a Superfund cleanup.

The cumulative ELCR of 5 x 10^{-6} is within the "target range" for the offsite child resident that may potentially have indirect exposure to the onsite COPCs from inhalation of dust. Total HI of 2 is above the target HI of 1, with manganese as the highest contributor with HQ of 1.6.

MANGANESE HAZARD

A soil concentration of 1,043 mg/kg manganese was calculated for a target HQ of 1, assuming an exposure duration of 6 years, an exposure time of 8 hours per day, an exposure frequency of 350 days per year, and total dust concentration in air at the PM_{10} NAAQS level of 150 µg/m^3. This manganese concentration in soil, for target HQ of 1 was then compared with the manganese EPCs in all future land use EAs. Two future land use EAs were identified where the EPCs for manganese were above the calculated manganese concentration of 1,043 mg/kg in soil for the target HQ of 1: Future A-8 (AOI 14-Off-property) and Future B5 (AOI 1-Holding Basin). The Future A-8 area is not an area where soil remediation is required because the risks calculated in the HHRA were within acceptable levels. Therefore, a corresponding dust concentration for a target HQ of 1 was estimated for Future B-5, as presented in the table below:

Soil Depth Interval	Exposure Area	Manganese EPC (mg/kg)	Dust Concentration Level (µg/m^3)
Subsurface Soil	Future B5- AOI 1 Holding Basin	1,180	133

SUMMARY

These results indicate that the NAAQS PM10 value is protective for the Site COPCs for all future land use EAs except B5. Therefore, an Action Level for PM10 of 150 µg/m^3, equal to the NAAQS for PM10, is protective of potential exposure to Site COPCs which could become airborne during removal activities and is appropriate as a perimeter air monitoring action level for the Site for all remediation areas except the Holding Basin. For the Holding Basin, a dust monitoring action level of 133 µg/m^3 is protective of potential exposure to Site COPCs which could become airborne during removal activities.

References

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4. USEPA. 1991. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER 9655.0-30. April. 1991.

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6. USEPA. 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation

Enclosures:

Table 1 – Soil and Predicted Outdoor Air Concentrations for Chemicals of Potential Concern: On-Site Receptors
Table 2 – Exposure Concentrations and Chronic Daily Intakes for Carcinogenic Chemicals of Potential Concern in Dust: Residents
Table 3 – Exposure Concentrations and Chronic Daily Intakes for Noncarcinogenic Chemicals of Potential Concern in Dust: Residents
Table 4 – Estimated ILECRs for Chemicals of Potential Concern in Dust: Residents
Table 5 – Estimated ILECRs for Uranium and Thorium from External Exposure to Ionizing Radiation: Residents
Table 6 – Estimated Noncancer HQs/His for Chemicals of Potential Concern in Dust: Residents

TABLES

TABLE 1
SOIL AND PREDICTED OUTDOOR AIR CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN : ON-SITE RECEPTORS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Soil Exposure Point Concentration (mg/kg) [a]	Outdoor Airborne Particulate Exposure Point Concentration [a] (mg/m^3) [b]
Volatile Organic Compounds		
Tetrachloroethene (PCE)	9.3E-04	1.4E-10
Trichloroethene	6.1E-01	9.2E-08
Polycyclic Aromatic Hydrocarbons		
Benzo(a)anthracene	2.1E+00	3.2E-07
Benzo(a)pyrene	2.2E+00	3.4E-07
Benzo(b)fluoranthene	3.5E+00	5.2E-07
Benzo(k)fluoranthene	4.7E-01	7.0E-08
Indeno(1,2,3-cd)pyrene	1.0E+00	1.5E-07
Total Petroleum Hydrocarbons		
TPH (C11-C22) Aromatic	1.8E+02	2.6E-05
Metals		
Aluminum	1.3E+04	1.9E-03
Antimony	1.0E+00	1.5E-07
Arsenic	1.8E+01	2.7E-06
Beryllium	3.5E+00	5.2E-07
Chromium (total)	2.7E+01	4.1E-06
Cobalt	5.6E+00	8.4E-07
Copper	4.6E+02	7.0E-05
Iron	2.0E+04	2.9E-03
Lead	4.9E+01	7.4E-06
Manganese	1.7E+03	2.5E-04
Mercury (inorganic)	3.7E-01	5.5E-08
Molybdenum	1.5E+02	2.2E-05
Thallium	1.5E+00	2.3E-07
Thorium	7.3E+00	1.1E-06
Titanium	7.3E+02	1.1E-04
Tungsten	2.3E+01	3.5E-06
Uranium, soluble salts	7.9E+02	1.2E-04
Vanadium	3.1E+01	4.7E-06
Zirconium	1.9E+01	2.8E-06
Polychlorinated Biphenyls		
Aroclor-1254 (PCB-1254)	1.8E+01	2.7E-06
Aroclor-1260 (PCB-1260)	2.8E+01	4.3E-06

TABLE 1
SOIL AND PREDICTED OUTDOOR AIR CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN : ON-SITE RECEPTORS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Soil Exposure Point Concentration (mg/kg) [a]	Outdoor Airborne Particulate Exposure Point Concentration [a] (mg/m^3) [b]
Semi-Volatile Organic Compounds		
Carbazole	2.7E-01	4.0E-08

Abbreviations:
bgs = Below ground surface
m^3/kg = Cubic meters per kilogram
mg/kg = Milligrams per kilogram
mg/m^3 = Milligrams per cubic meter

Notes:
[a] Highest exposure point concentration (EPC) between surface and subsurface soil for future land use EAs is selected as the EPC for this evaluation.
[b] Outdoor airborne particulate concentration is calculated by dividing the soil EPCs by the particulate emission factor (PEF). For residential receptors, a PEF of 6.7×10^6 m^3/kg was estimated for a dust concentration of 150 $\mu g/m^3$.

TABLE 2
EXPOSURE CONCENTRATIONS AND CHRONIC DAILY INTAKES FOR CARCINOGENIC CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future On-Site Resident, Child
	Soil Pathway
	EC: Particulate Inhalation (mg/m^3)
Volatile Organic Compounds	
Tetrachloroethene (PCE)	3.8E-12
Trichloroethene	3.3E-09
Polycyclic Aromatic Hydrocarbons	
Benzo(a)anthracene	4.6E-08
Benzo(a)pyrene	4.9E-08
Benzo(b)fluoranthene	7.6E-08
Benzo(k)fluoranthene	1.0E-08
Indeno(1,2,3-cd)pyrene	2.2E-08
Total Petroleum Hydrocarbons	
TPH (C11-C22) Aromatic	NC
Metals	
Aluminum	NC
Antimony	NC
Arsenic	7.5E-08
Beryllium	1.4E-08
Chromium (total)	NC
Cobalt	2.3E-08
Copper	NC
Iron	NC
Lead	NA
Manganese	NC
Mercury (inorganic)	NC
Molybdenum	NC
Thallium	NC
Thorium	NA
Titanium	NC
Tungsten	NC
Uranium, soluble salts	NA
Vanadium	NC
Zirconium	NC
Polychlorinated Biphenyls	
Aroclor-1254 (PCB-1254)	7.5E-08
Aroclor-1260 (PCB-1260)	1.2E-07

TABLE 2
EXPOSURE CONCENTRATIONS AND CHRONIC DAILY INTAKES FOR CARCINOGENIC CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future On-Site Resident, Child
	Soil Pathway
	EC: Particulate Inhalation (mg/m^3)
Semi-Volatile Organic Compounds	
Carbazole	NC

Abbreviations:
bgs = Below ground surface
EC = Exposure concentration
mg/m^3 = Milligrams per cubic meter
NA = Not applicable.
NC = Not considered a carcinogen

TABLE 3

EXPOSURE CONCENTRATIONS AND CHRONIC DAILY INTAKES FOR NONCARCINOGENIC CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS

NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child
	Soil Pathway
	EC: Particulate Inhalation (mg/m^3)
Volatile Organic Compounds	
Tetrachloroethene (PCE)	4.5E-11
Trichloroethene	2.9E-08
Polycyclic Aromatic Hydrocarbons	
Benzo(a)anthracene	NA
Benzo(a)pyrene	1.1E-07
Benzo(b)fluoranthene	NA
Benzo(k)fluoranthene	NA
Indeno(1,2,3-cd)pyrene	NA
Total Petroleum Hydrocarbons	
TPH (C11-C22) Aromatic	NA
Metals	
Aluminum	6.1E-04
Antimony	4.8E-08
Arsenic	8.7E-07
Beryllium	1.7E-07
Chromium (total)	NA
Cobalt	2.7E-07
Copper	NA
Iron	NA
Lead	na
Manganese	8.0E-05
Mercury (inorganic)	1.8E-08
Molybdenum	7.0E-06
Thallium	NA
Thorium	NA
Titanium	NA
Tungsten	NA
Uranium, soluble salts	3.8E-05
Vanadium	1.5E-06
Zirconium	NA
Polychlorinated Biphenyls	
Aroclor-1254 (PCB-1254)	NA
Aroclor-1260 (PCB-1260)	NA

TABLE 3

EXPOSURE CONCENTRATIONS AND CHRONIC DAILY INTAKES FOR NONCARCINOGENIC CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS

NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child
	Soil Pathway
	EC: Particulate Inhalation (mg/m^3)
Semi-Volatile Organic Compounds	
Carbazole	NA

Abbreviations:

bgs = Below ground surface
EC = Exposure concentration
mg/m^3 = Milligrams per cubic meter
NA = Not applicable or no toxicity value available for inhalation pathway.

TABLE 4
ESTIMATED ILECRS FOR CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical		Hypothetical Future on-Site Resident, Child	
		Soil Pathway	
		Particulate Inhalation	Cumulative ILECR
Volatile Organic Compounds			
Tetrachloroethene (PCE)		9.9E-16	9.9E-16
Trichloroethene		1.3E-11	1.3E-11
Polycyclic Aromatic Hydrocarbons			
Benzo(a)anthracene		2.8E-09	2.8E-09
Benzo(a)pyrene		3.0E-08	3.0E-08
Benzo(b)fluoranthene		4.6E-09	4.6E-09
Benzo(k)fluoranthene		6.2E-11	6.2E-11
Indeno(1,2,3-cd)pyrene		1.3E-09	1.3E-09
Total Petroleum Hydrocarbons			
TPH (C11-C22) Aromatic		NC	NC
Metals			
Aluminum		NC	NC
Antimony		NC	NC
Arsenic		3.2E-07	3.2E-07
Beryllium		3.4E-08	3.4E-08
Chromium (total)		NC	NC
Cobalt		2.1E-07	2.1E-07
Copper		NC	NC
Iron		NC	NC
Lead		NA	NA
Manganese		NC	NC
Mercury (inorganic)		NC	NC
Molybdenum		NC	NC
Thallium		NC	NC
Thorium	[a]	1.9E-07	1.9E-07
Titanium		NC	NC
Tungsten		NC	NC
Uranium, soluble salts	[a]	3.9E-06	3.9E-06
Vanadium		NC	NC
Zirconium		NC	NC
Polychlorinated Biphenyls			
Aroclor-1254 (PCB-1254)		4.3E-08	4.3E-08
Aroclor-1260 (PCB-1260)		6.6E-08	6.6E-08

TABLE 4
ESTIMATED ILECRS FOR CHEMICALS OF POTENTIAL CONCERN IN DUST:
RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child	
	Soil Pathway	
	Particulate Inhalation	Cumulative ILECR
Semi-Volatile Organic Compounds		
Carbazole	NC	NC
Cumulative ILECR	**4.8E-06**	**5E-06**

Abbreviations:
bgs = Below ground surface
ILECR = Incremental lifetime excess cancer risk
NA = Not applicable.
NC = Not considered a carcinogen.

Notes:
[a] Inhalation risks for uranium and thorium are calculated in Table 5.

TABLE 5
ESTIMATED ILECRS FOR URANIUM AND THORIUM FROM EXTERNAL EXPOSURE TO IONIZING RADIATION: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

For Exposure factors:	**EF=161 days/yr; ET=18 hrs/day; PEF=3.35E+09 m^3/kg**
	ILCR
Uranium (EPC = 793 mg/kg)	8E-09
Thorium (EPC = 7.35 mg/kg)	4E-10

For Exposure factors:	**EF=350 days/yr; ET=8 hours/day; PEF = 6.67E+06 m^3/kg**
	ILCR
Uranium (EPC = 793 mg/kg)	4E-06
Thorium (EPC = 7.35 mg/kg)	2E-07

Abbreviations:
days/yr = Days per year
EF = Exposure frequency
ET = Exposure time
hrs/day = Hours per day
m^3/kg = Meters cubed per kilogram
PEF = Particulate emission factor

TABLE 6
ESTIMATED NONCANCER HQS/HIS FOR CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child	
	Soil Pathway	
	Particulate Inhalation	Total Hazard Index
Volatile Organic Compounds		
Tetrachloroethene (PCE)	1.1E-09	1.1E-09
Trichloroethene	1.5E-05	1.5E-05
Polycyclic Aromatic Hydrocarbons		
Benzo(a)anthracene	NA	NA
Benzo(a)pyrene	5.4E-02	5.4E-02
Benzo(b)fluoranthene	NA	NA
Benzo(k)fluoranthene	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA
Total Petroleum Hydrocarbons		
TPH (C11-C22) Aromatic	NA	NA
Metals		
Aluminum	1.2E-01	1.2E-01
Antimony	1.6E-04	1.6E-04
Arsenic	5.8E-02	5.8E-02
Beryllium	8.3E-03	8.3E-03
Chromium (total)	NA	NA
Cobalt	4.5E-02	4.5E-02
Copper	NA	NA
Iron	NA	NA
Lead	NA	NA
Manganese	1.6E+00	1.6E+00
Mercury (inorganic)	5.9E-05	5.9E-05
Molybdenum	3.5E-03	3.5E-03
Thallium	NA	NA
Thorium	NA	NA
Titanium	NA	NA
Tungsten	NA	NA
Uranium, soluble salts	4.5E-02	4.5E-02
Vanadium	1.5E-02	1.5E-02
Zirconium	NA	NA
Polychlorinated Biphenyls		
Aroclor-1254 (PCB-1254)	NA	NA
Aroclor-1260 (PCB-1260)	NA	NA

TABLE 6
ESTIMATED NONCANCER HQS/HIS FOR CHEMICALS OF POTENTIAL CONCERN IN DUST: RESIDENTS
NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Chemical	Hypothetical Future on-Site Resident, Child	
	Soil Pathway	
	Particulate Inhalation	Total Hazard Index
Semi-Volatile Organic Compounds		
Carbazole	NA	NA
Total Hazard Index	**1.95E+00**	**2.0E+00**

Abbreviations:
bgs = Below ground surface
NA = Not applicable or no toxicity value available for inhalation pathway.

ATTACHMENT B2

Cut-Sheet for DustTrak Instrument

Knowledge Beyond Measure.

DustTrak™ DRX Aerosol Monitors

Models 8533, 8533EP and 8534

Only DustTrak™ DRX Aerosol Monitors can simultaneously measure both mass and size fraction—no other monitor can do both.

DustTrak™ DRX monitors are battery-operated, data-logging, light-scattering laser photometers that give you real-time aerosol mass readings. They use a sheath air system that isolates the aerosol in the optics chamber to keep the optics clean for improved reliability and low maintenance. From desktop with external pump models to a handheld model, the DustTrak DRX offers a suitable solution for harsh industrial workplaces, construction and environmental sites and other outdoor applications, as well as clean office settings. DustTrak DRX monitors measure aerosol contaminants such as dust, smoke, fumes and mists.

Features and Benefits

All Models

- Real-time mass concentration and size fraction readings, as well as data-logging allow for data analysis during and after sampling.
- Simultaneously measure size-segregated mass fraction concentrations corresponding to PM1, PM2.5, Respirable,PM10, and Total PM size fractions
- Easy-to-use graphical user interface with color touch-screen for effortless operation

Handheld Model (8534)

- Long life internal pump for continuous sampling
- Single-point data collection for walk through surveys
- Lightweight design with ergonomic handle for portable applications

Desktop Models (8533 and 8533EP)

- Energy-efficient, long lasting external pump for continuous, unattended, 24/7, outdoor monitoring applications (Model 8533EP only)
- Long life internal pump for shorter work-shift or IAQ sampling applications (Model 8533)
- Gravimetric reference sampling capability for custom reference calibrations
- Automatic zeroing (with optional zero module) to minimize the effect of zero drift
- STEL alarm setpoint for tracking 15-minute average mass concentrations
- Standard and advanced calibration capabilities for consistent accuracy
- Environmental protected and tamper-proof secure (with an optional environmental enclosure)
- Inlet sample conditioning (with optional heated inlet sample conditioner) to reduce the effect of humidity on photometric mass measurements (for use with an environmental enclosure)
- Cloud Data Management System hosted by Netronix™

Unsurpassed Technology and Performance
DustTrak™ DRX monitors are laser photometers that simultaneously measure five size segregated mass fraction concentrations at once—something no other monitor can do. The desktop, desktop with external pump and handheld monitors are continuous, real-time, 90°, light-scattering laser photometers that simultaneously measure size-segregated mass fraction concentrations corresponding to PM1, PM2.5, Respirable, PM10, and Total PM fractions. They combine both particle cloud (total area of scattered light) and single particle detection to achieve mass fraction measurements.

This size-segregated mass fraction measurement technique is superior to either a basic photometer or optical particle counter (OPC). It delivers the mass concentration of a photometer and the size resolution of an OPC. Typically, photometers can be used at high mass concentration, but they do not give any size information (unless used with size selective inlet conditioners) and significantly underestimate large particle mass concentrations. OPC's provide size and count information; however, they do not provide any mass concentration information and cannot be used in high mass concentration environments. The DustTrak™ DRX can do both.

Handheld Models: Perfect for Walk-Through Surveys and Single-Point Data Collection Applications
The DustTrak™ DRX handheld Model 8534 is lightweight and portable. It is perfect for industrial hygiene surveys, point source location monitoring, indoor air quality investigations, engineering control evaluations/validation, and for baseline trending and screening. Like the desktop models, it has manual and programmable data logging functions. In addition, the handheld model also has a single-point data logging capability for walk-through industrial hygiene surveys and indoor air quality investigations.

Desktop Models: Ideal for Long-Term Surveys and Remote Monitoring Applications
The DustTrak DRX is also offered as a standard desktop (Model 8533), as well as a desktop with external pump (Model 8533EP.) Both models have manual and programmable data logging functions, making them ideal for unattended applications. The standard desktop model is most suitable for indoor, continuous monitoring, while the desktop with external pump is designed for 24/7 unattended, remote monitoring outdoors.

The DustTrak DRX desktop models come with USB (device and host), Ethernet, and analog and alarm outputs allowing remote access to data. User adjustable alarm setpoints for instantaneous or 15-minute short-term excursion limit (STEL) are also available on desktop models. The alarm output with user-defined setpoint alerts you when upset or changing conditions occur.

The DustTrak DRX Desktop Monitors have several unique features:

- External pump (Model 8533EP) with low power consumption for continuous, unattended monitoring in remote outdoor locations.
- Gravimetric sampling capability using a 37-mm filter cassette which can be inserted in-line with the aerosol stream allowing you to perform an integral gravimetric analysis for custom reference calibrations.
- Zeros automatically using the external zeroing module. This optional accessory is used when sampling over extended periods of time. By zeroing the monitor during sampling, the effect of zero drift is minimized.
- STEL alarm feature for tracking 15-minute average mass concentrations when alarm setpoint has been reached for applications like monitoring fugitive emissions at hazardous waste sites.
- Provide for environmental protection and tamper-proof security using an environmental enclosure. This optional accessory encloses the instrument within a waterproof, lockable, custom-designed case.
- Condition the sample air stream before entering the instrument optics using a heated inlet sample conditioner (designed for use with the environmental enclosure.) This optional accessory is used in humid environments. By conditioning the sample, the humidity and water vapor are minimized.
- Standard and advanced calibration capabilities. The DustTrak DRX Aerosol Monitor has two calibration factors: a photometric calibration factor (PCF) and a size calibration factor (SCF). The PCF accounts for the photometric response difference between A1 Test Dust and the aerosol under measurement, while the SCF accounts for the aerodynamic size difference.
  - The primary goal of the standard calibration is to obtain the SCF for the aerosol of interest. The standard calibration process is very easy and does not require comparison to gravimetric samples. Measure with and without a PM2.5 impactor, and the instrument takes the ratio of these two size distributions and compares this reading to the PM2.5 impactor transmission efficiency curve to calculate the SCF. However, the absolute mass concentration may not be as accurate as the advanced calibration.
  - The advanced calibration method yields high size segregated mass concentration accuracy. It involves two separate gravimetric measurements to obtain PCF and SCF in sequence. The advanced calibration will accurately measure size segregated mass concentrations.

Applications	Desktop	Handheld
Aerosol research studies	▪	▪
Baseline trending and screening	▪	▪
Engineering control evaluations		▪
Engineering studies		▪
Epidemiology studies	▪	▪
Indoor air quality investigations	▪	▪
Industrial/occupational hygiene surveys	▪	▪
Point source monitoring		▪
Outdoor environmental monitoring	▪	
Process monitoring	▪	▪
Remote monitoring	▪	

DustTrak™ DRX Aerosol Monitor Features

All Models

- Li-Ion rechargeable batteries
- Internal and external battery charging capabilities
- Outlet port for isokinetic sampling applications
- User serviceable sheath flow and pump filters
- Logged test pause and restart feature
- Logged test programming
  - Color touch screen—either manual mode or program mode
  - TRAKPRO™ Data Analysis Software via a PC
- User adjustable custom calibration settings
- Instantaneous alarm settings with visual and audible warnings
- Real-time graph display
- View statistical information during and after sampling
- On-screen instrument status indicators: FLOW, LASER and FILTER
- Filter service indicator for user preventative maintenance

Desktop Models (8533 and 8533EP)

- Long life external pump (8533EP)
- Internal pump (8533)
- Hot swappable batteries
- Gravimetric reference sample capability
- STEL alarm setpoint

Optional Accessories

- Auto zeroing module
- Protective environmental enclosure (8535)
- Heated inlet sample conditioner (for use with an environmental enclosure)
- Cloud Data Management System as hosted by Netronix™

Handheld Model (8534)

- Long life internal pump
- Single-point data collection for walk through surveys

Easy to Program and Operate

The graphical user interface with color touch-screen puts everything at your fingertips. The easy-to-read display shows real-time mass concentration and graphical data, as well as other statistical information along with instrument pump, laser and flow status, and much more. Perform quick walk-through surveys or program the instrument's advanced logging modes for long-term sampling investigations. Program start times, total sampling times, logging intervals, alarm setpoints and many other parameters. You can even set up the instrument for continuous unattended operation.

TrakPro™ Software Makes Monitoring Easier than Ever

TrakPro™ Data Analysis Software allows you to set up and program directly from a PC. It even features the ability for remote programming and data acquisition from your PC via wireless communication options or over an Ethernet network. As always, you can print graphs, raw data tables, and statistical and comprehensive reports for recordkeeping purposes.

Battery Performance

Models 8533 and 8533EP (Typical) 6600 mAH Li-Ion Battery Pack (P/N 801680)	1 Battery	2 Batteries
Battery runtime (hours)	Up to 6	Up to 12
Charge time* (hours) in DustTrak™	4	8
Charge time* (hours) in external battery charger (P/N 801685)	4	8

Model 8534 (Typical) 3600 mAH Li-Ion Battery Pack (P/N 801681)	Battery
Battery runtime (hours)	Up to 6
Charge time* (hours) in DustTrak™	4
Charge time* (hours) in external battery charger (P/N 801686)	4

*Of a fully depleted battery

Cloud Data Management System for 24/7 remote dust monitoring

Specifications

DustTrak™ DRX Aerosol Monitors

Models 8533, 8533EP and 8534

Sensor Type

90° light scattering

Particle Size Range

0.1 to 15 µm

Aerosol Concentration Range

8533 Desktop	0.001 to 150 mg/m^3
8533EP Desktop with External Pump	0.001 to 150 mg/m^3
8534 Handheld	0.001 to 150 mg/m^3

Display

Size Segregated Mass Fractions for PM1, PM2.5, Respirable, PM10 and Total. All displayed

Resolution

±0.1% of reading or 0.001 mg/m^3, whichever is greater

Zero Stability

±0.002 mg/m^3 per 24 hours at 10 sec time constant

Flow Rate

3.0 L/min

Flow Accuracy

±5% of factory set point, internal flow controlled

Temperature Coefficient

+0.001 mg/m^3 per °C

Operational Temp

32 to 120°F (0 to 50°C)

Storage Temp

-4 to 140°F (-20 to 60°C)

Operational Humidity

0 to 95% RH, non-condensing

Time Constant

User adjustable, 1 to 60 seconds

Data Logging

5 MB of on-board memory (>60,000 data points)

45 days at 1 minute logging interval

Log Interval

User adjustable, 1 second to 1 hour

Physical Size (H x W x D)

Handheld	4.9 x 4.8 x 12.5 in. (12.5 x 12.1 x 31.6 cm)
Desktop	5.3 x 8.5 x 8.8 in. (13.5 x 21.6 x 22.4 cm)
External Pump	4.0 x 7.0 x 3.5 in. (10.0 x 18.0 x 9.0 cm)

Weight

Handheld	2.9 lb (1.3 kg), 3.3 lb (1.5 kg) with battery
Desktop	3.5 lb (1.6 kg), 4.5 lb (2.0 kg) – 1 battery, 5.5 lb (2.5 kg) – 2 batteries
External Pump	3.0 lb (1.4 kg)

Communications

8533	USB (host and device) and Ethernet. Stored data accessible using flash memory drive
8533EP	USB (host and device) and Ethernet. Stored data accessible using flash memory drive plus, cable assembly for external pump
8534	USB (host and device). Stored data accessible using flash memory drive

Power–AC

Switching AC power adapter with universal line cord included,115–240 VAC

Analog Out

8533/8533EP	User selectable output, 0 to 5 V or 4 to 20 mA. User selectable scaling range

Alarm Out

8533/8533EP	Relay or audible buzzer Relay Non-latching MOSFET switch ▪ User selectable set point ▪ –5% deadband ▪ Connector 4-pin, Mini-DIN connectors
8534	Audible buzzer

Screen

8533/8533EP	5.7 in. VGA color touchscreen
8534	3.5 in. VGA color touchscreen

Gravimetric Sampling

8533/8533EP	Removable 37 mm cartridge (user supplied)

CE Rating

Immunity	EN61236-1:2006
Emissions	EN61236-1:2006

Specifications are subject to change without notice.

Knowledge Beyond Measure.

TSI Incorporated - Visit our website **www.tsi.com** for more information.

USA	Tel: +1 800 874 2811	**India**	Tel: +91 80 67877200
UK	Tel: +44 149 4 459200	**China**	Tel: +86 10 8219 7688
France	Tel: +33 1 41 19 21 99	**Singapore**	Tel: +65 6595 6388
Germany	Tel: +49 241 523030		

P/N 6001981 Rev H Printed in U.S.A.

ATTACHMENT B3

On-Site Laboratory

HALEY & ALDRICH, INC.
465 Medford St.
Suite 2200
Boston, MA 02129
617.886.7400

TECHNICAL MEMORANDUM

11 November 2022
File No. 131884-004

TO: *de maximis, inc.*
Bruce Thompson

FROM: Haley & Aldrich, Inc.
Mark D. Kelley, P.E., Senior Hydrogeologist
Maris Mann-Stadt, Senior Technical Specialist

SUBJECT: Nuclear Metals, Inc. (NMI)
Amendment to Field Sampling Plan
On-Site Field Laboratory
Concord, Massachusetts

The purpose of this Memorandum is to provide a supplement to the Field Sampling Plan (FSP) prepared as part of the Remedial Design Work Plan that was approved by the Environmental Protection Agency (EPA) in September 2020. This supplement is for the use of an on-Site field laboratory during active construction at the NMI Site (Site) and was prepared for the construction of Area of Interest (AOI) 8 and AOI 9. This document will be reviewed and updated as necessary as construction progresses.

The use of the on-Site lab is intended as a screening tool during confirmation sampling, as described herein, and not a substitute for final analytical confirmation sample analyses.

USE OF ON-SITE LABORATORY FOR SCREENING PURPOSES

A Perkin Elmer Avio 200 ICP Optical Emission Spectrometer (ICP OES) will be operated on-Site by Decontamination Decommissioning and Environmental Services, LLC (DDES) as a screening tool during remedial activities. Confirmatory samples collected during excavation activities will be analyzed in the on-Site laboratory for uranium and concentrations will then be compared to the uranium Remedial Action Level (RAL). Attachment E1 includes the bottom and sidewall RALs for the proposed AOI-8 and AOI-9 limits of excavation. Confirmatory soil samples with concentrations above RALs will be indicative of areas that require additional excavation. In areas requiring additional excavation, the excavations will advance, and new confirmatory samples will be collected, analyzed on-Site for uranium, and compared to the RALs. The process will be repeated until the confirmatory sampling results do not exceed RALs. Once confirmatory soil samples meet the uranium RALs using the on-Site lab, the confirmatory samples will be submitted for analysis of the relevant contaminants of concern (COCs) at the relevant off-Site laboratory.

ON-SITE LABORATORY DESCRIPTION

The on-Site ICP OES will be housed in a trailer separate from other field activities. Use of the ICP OES during AOI 8 and AOI 9 work is considered a pilot program and as such, the on-Site analytical process may continue to evolve and be updated. A description of the current on-Site analytical process is included as Attachment E2: AVIO-220 ICP-OES Operation Manual, Procedure No: LP-NMI-005.

The detection limit (DL) for any ICP-OES system analyzing Uranium is 10 parts per billion (ppb). However, the sample matrix will affect the DL and on-Site calibration is required to verify the true Site-related DL. This work is ongoing and updates to the reporting limit will be included in future versions of the AVIO-220 ICP-OES Operation Manual, Procedure No: LP-NMI-005.

An overview of a Perkin Elmer Avio ICP Optical Emission Spectrometer (OES) is included as Attachment E3 for the.

Attachment E1 – Remedial Action Limits for Uranium
Attachment E2 – AVIO 220 ICP-OES Operation Manual, Procedure No: LP-NMI-005
Attachment E3 – Avio® ICP Optical Emission Spectrometer Overview

\\haleyaldrich.com\share\bos_common\131884-NMI\Deliverables\AOI 8 and 9 Remedial Action Work Plan\Appendices\Appendix E - On Site Lab\2022-1111-HAI-Appendix E- On-Site Lab-FSP-RAWP.docx

ATTACHMENT E1

Remedial Action Limits for Uranium

Attachment E1 *(CQAP Table C1)*
Remedial Action Levels for Uranium
Nuclear Metals
Concord, Massachusetts
File No. 131884

Excavation Area	Confirmatory Samples and Remedial Action Levels					
	Bottom (number samples)	RAL (mg/kg) [a]	Rationale	Sidewall (number samples)	RAL (mg/kg) [a]	Rationale
AOI 8 [b]	62	4.0	Highest that can remain in all bottom confirmatory samples and achieve residual EPC that does not exceed cleanup goal	28	6.4	Highest concentration in samples bordering exposure area
AOI 9 [c]	16	2.7	Cleanup goal; highest anticipated to remain based on design cut lines is 1.9 mg/kg	12	3.6	Highest concentration in samples bordering exposure area

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
RAL - Remedial Action Level
[a] RALs are identified in the CQAP, Appendix C of the 100% AOI 8 and AOI 9 Remedial Design, Attachment C-1, Part 2.
[b] Numbers of bottom and sidewall samples are defined by the confirmatory soil sampling grids (Figure C-4) of the CQAP.
[c] Numbers of bottom and sidewall samples are defined by the confirmatory soil sampling grids (Figure C-5) of the CQAP.

ATTACHMENT E2

AVIO 220 ICP-OES Operation Manual, Procedure No: LP-NMI-005

Nuclear Metals, Inc. Superfund Site
Health Physics Procedures

AVIO-220 ICP-OES OPERATION

PROCEDURE NO: LP-NMI-005

October 2022

Prepared by:		Date:	
Technical Review:		Date:	
RSO Approval:		Date:	

1.0 PURPOSE

This procedure is applicable to the evaluation of soluble Depleted Uranium (DU) in aqueous samples. DU metal is insoluble unless combined with a strong acid. This SOP describes the preparation of soil samples for total Uranium analyses. Soil samples are treated with concentrated acids and heated to dissolve Uranium for analysis. These acidic solutions shall be brought to a neutral pH to precipitate the Uranium in solution after analysis.

From the activity in the sample, the activity of the suspended solids can be determined in mg/kg and a concentration in mg/L can be calculated. This procedure provides laboratory personnel guidelines and precautions for the use of Perkin Elmer AVIO-220 plus ICP-OES.

2.0 APPLICABILITY

This program applies to the onsite analysis of aqueous samples for soluble Uranium in support of soil clearance for the Remedial Design and Remedial Action (RD/RA) at the Nuclear Metals Inc. (NMI) Site in Concord, MA. This procedure is applicable to all personnel involved with preparing and processing soil samples for analysis using the Perkin Elmer AVIO-220 MAX ICP-OES in the onsite laboratory.

3.0 PREREQUISITES

The handling and processing of samples that are corrosive or potentially radioactive in nature shall be conducted by trained and qualified personnel only. These individuals will have been trained and authorized for the use of these materials by the Chemical Hygiene Officer and the following plans and procedures:

- Nuclear Metals Superfund Site-Specific Chemical Hygiene Plan
- LP-NMI-001: Gross Alpha and Beta Measurements of Liquids
- LP-NMI-002: Gross Alpha and Beta Measurements of Solids
- LP-NMI-003: Radiation Lab Procedures and Safety Guidelines
- LP-NMI-004: Working with Corrosive Materials
- NMI Health Physics Procedures

4.0 SAFETY

4.1 Health and Safety

For specific hazards, consult the SDS for compounds listed in section 7.0 of this SOP (SDS on file).

4.1.1 Use, store, and dispose of chemicals in accordance with the NMI Chemical Hygiene Plan.

4.1.2 Reagents used are potentially caustic or corrosive, avoid ingestion or inhalation and direct contact with the skin.

4.1.3 Digestion is to be performed under a hood. Hoods must be checked prior to sample prep, as reflected by the streamer on the glass hood face. Do not prep if hoods are not working properly.

4.2 Protective Equipment

Wear appropriate Personal Protective Equipment (PPE) in accordance with NMI CHP and applicable SOP. Minimum PPE for laboratory work is safety glasses, lab coat, disposable nitrile gloves and closed toed shoes.

4.3 Spills and Contamination

Cleanup Spills immediately. A Spill Kit is located in the laboratory and shall be readily accessible.

5.0 APPARATUS AND EQUIPMENT

5.1 Heater Block Plates

The temperatures of all hot plates will be recorded when in use. The temperature will be between 85-90 degrees Celsius, using 50 ml DI placed on heated hot plate to measure. Record hot plate temperatures in Sample Prep Book daily. If hot plate temperatures are not within range, report this immediately. Corrective action will be taken before continuing use.

5.2 Hoods

Air flow checks will be conducted on a monthly basis by personnel to ensure the laminar flow containment is operating properly. Contact the Lab Supervisor if flow rates are substandard.

6.0 REAGENTS AND STANDARDS

6.1 Chemicals/Reagents

6.1.1 All chemicals and reagents will be transported in secondary containment and stored in designated areas.

6.1.2 ASTM Type I deionized water will be used for analysis.

6.1.3 Ultra Pure chemicals and Ultra High Purity gases or better will be used for all metals analyses. Standards will be supplied with a Certificate of Analysis showing Manufacturer's number, Description, Lot number, Expiration date, Labeled and Measured values and Traceability to NIST SRM's. Individual analytical approved methods may specify additional requirements for the reagents to be used. All reagents will be logged and dated as to the date received and date opened with the analyst's initials, follow all SOP's for chemical receiving. No chemical/reagent will be used past its expiration date. All expired reagents will be disposed of in the proper manner.

6.1.3.1 **HN03 -** Ultrapure or Ultrexgrade or equivalent. For blanks and dilutions, mix I% in reagent water to make I% HNO3 solution. For ICP-OES blanks and dilutions, mix 2% in reagent water to make 2% HNO3 solution.

6.1.3.2 **HCl** - Ultrapure or Ultrexgrade or equivalent. Mix I to I with reagent water as required by procedure.

6.1.3.3 **H202 30% -** Ultrapure or Ultrexgrade or equivalent.

6.1.4 Standard stock solutions: All standard stock solutions used will be NIST traceable for standard solutions. If NIST traceable stock solutions are not available, the solutions can be made from the pure materials.

6.1.5 ICP spike solutions

6.1.5.1 Table 6.1.5-1 lists elements and recommended spike concentrations for the Spike Stock Solution and the final spiked concentrations for QC samples for ICP analyses. Prepare the Spike Stock Solution by adding sufficient primary stock solutions for each element (either individually or in any combination) to create the Spike Stock Solution concentration indicated in the table.

Table 6.1.5-1

Recommended ICP Spike Concentrations for Pretreatment		
Elements	**Spike Stock Solution Concentration**	**Spike Concentration in QC Samples**
U	100mg/L	1.0mg/L

6.1.5.2 For each batch of pretreatment samples add 500 µL of CP Spike Stock Solution to 50 mL of sample to create the final spike concentrations given in Table 6.6-1. This Spike Stock Solution must be added to the Matrix Spike, Matrix Spike Duplicate, Laboratory Control Sample, and Laboratory Control Sample Duplicate for each batch. It is acceptable to adjust the volume of spike added for samples and control samples prepared at other volumes, or to use stock solutions with different concentrations, to create the same final spiked concentrations.

6.1.5.3 Table 6.1.5-2 lists elements and recommended spike concentrations for the Spike Stock Solutions I through 4 and the final spiked concentrations for QC samples for undigested ICP analyses. Prepare the Spike Stock Solution by adding sufficient primary stock solutions for each element (either individually or in any combination) to create the Spike Stock Solution concentration indicated in the table.

Table 6.1.5-2 Recommended ICP Spike Concentrations for Waters (undigested)			
Standard ID	**Elements**	**Spike Stock Solution Concentration**	**Final Spiked Concentration in QC Samples**
1	U	10 mg/L	0.77 mg/L

6.1.5.4 In addition, for the Si QC samples, prepare a separate set of QC samples (Matrix Spike, Matrix Spike Duplicate, Laboratory Control Sample, and Laboratory Control Sample Duplicate) by adding 500 µL of ICP Spike Stock Solution 4 (Si spike standard) to 50 mL to achieve 10 mg/L final spiked concentration.

6.1.5.5 Table 6.1.5-3 lists elements and recommended spike concentrations for the Spike Stock Solutions 1 through 4 and the final spiked concentrations for QC samples for digested ICP analyses. Prepare the Spike Stock Solution by adding sufficient primary stock solutions for each element (either individually or in any combination) to create the Spike Stock Solution concentration indicated in the table.

Table 6.1.5-3
Recommended ICP Spike Concentrations for Waters (digested)

Standard ID	Elements	Spike Stock Solution Concentration	Final Spiked Concentration in QC Samples
1	U	10 mg/L	0.5 mg/L

6.1.5.6 For each batch add 2,500 µL of each ICP Spike Stock Solutions 1 listed in Table 6.7-3 to a final volume of 50 mL for the preparation of the MS, MSD, LCS, and LCSD. This will provide the final spike concentrations given in Table 6.7-3. It is acceptable to adjust the volume of spike added for samples and control samples prepared at other volumes, or to use stock solutions with different concentrations, to create the same final spiked concentrations.

7.0 QUALITY ASSURANCE/ QUALITY CONTROL

7.1 Quality Assurance

7.1.1 **Analyst Training:** Analysts must follow the steps outlined in the PerkinElmer Training.

7.1.2 **Quality Control Requirements:** The quality control requirements section covers the following topics: I) Quality control limits 2) Quality control - instrument performance 3) Laboratory (Method).

7.1.3 **Data Evaluation:** The Data Evaluation section covers the following topics: I) Internal audits 2) Control charts procedures 3) performance audits 4) Method detection limit procedures.

7.1.4 **Contamination:** The following precautions contribute to avoid inorganic contaminants.

7.1.4.1 **Safety Practices:** General and customary safety practices as well as those included in instrument manufacturer's manuals and approved methods will be strictly followed. Safety Data Sheets will be consulted before using any new or unknown chemical/reagent.

7.1.4.2 All glassware used for metals analyses will be separate from all other in the Lab and be specified as such. Only Class A Volumetric glassware will be used. All glassware will be cleaned according to the following procedure:

7.1.4.2.1 **Between Sample Transfers:**

- Rinse with 1:1 nitric acid.
- Rinse with filtered DI water.

7.1.4.2.2 **After use:**

- Wash with detergent (Alconox or Contrad), by hand or in pipet washer, as appropriate.

- Rinse with tap water.
- Rinse with 1:1 nitric acid.
- Rinse with filtered DI water 2X.

7.1.4.3 **Acid Testing:** Analysis of a HN03 and HCl blank will be analyzed with every new lot of acid prior to usage. Upon receipt, a sample of each new acid lot is tested for metals content using ICP, as appropriate before being used for preparations for analysis on these instruments. This will evaluate any possible contamination due to the acids used. Record this testing in the Acids Logbook before placing the new lot of acid into use.

7.1.4.4 **Containers:** Use metal free containers for all prepped samples. Certification provided by the supplier indicating the containers are metal free must be stored in the QA files.

7.2 Quality Control:

7.2.1 **Quality Control Requirements:** The minimum requirements of this QC program consist of an initial demonstration of laboratory capability, and periodic analysis of laboratory reagent blanks, fortified blanks and other laboratory solutions as a continuing check on performance. Tue laboratory is required to maintain performance records that define the quality of the data thus generated.

7.2.2 Sample matrix spike/matrix duplicate analyses:

7.2.2.1 Prepare sample, sample matrix spike (MS) and sample matrix spike duplicate (MSD) as described in Section 6 for the appropriate analysis.

7.2.2.2 Control limits:

- 75% to 125% recovery
- 20% RPD

7.2.2.3 **Frequency-** One each per batch of 20 samples

7.2.2.4 **Check-** Spike prep, sample prep, and documentation

7.2.2.5 **Record-** Text affected samples with MS/MSD

7.2.3 Laboratory Reagent (Method) Blank (LRB)

7.2.3.1 Reagent water.

7.2.3.2 **Control Limits-** Concentration should be less than MDL.

7.2.3.3 **Frequency-** Each batch of 20 or fewer samples.

7.2.3.4 **Corrective Action** - When LRB values constitute 10% or more of the analyte level determination for a sample or is greater than the Reporting Limit, whichever is greater (essentially the LRB result must be less than 10% of the lowest sample result for the associated batch or less than the reporting limit), fresh aliquots of the samples must be prepared and analyzed for the affected analytes after the source of contamination has been corrected and acceptable LRB values have been obtained.

7.2.3.5 **Check -** Laboratory or reagent contamination should be suspected.

7.2.3.6 **Record -** Corrective actions in logbook.

7.2.4 Laboratory Control Sample (LCS)

7.2.4.1 **Control Limits -** Recovery 70-130%, or as determined by control charts.

7.2.4.2 **Frequency-** One LCS per batch.

7.2.4.3 **Corrective Action -** Rerun LCS/LCSD one time to determine if second analysis meets criteria. If not, implement corrective action procedure to identify root cause.

7.2.4.4 **Check -** Spike solution and sample prep technique

7.2.4.5 **Record -** Corrective Action Response Report must be initiated for all LCS failures.

7.2.5 Laboratory Control Sample Duplication (LCSD)

7.2.5.1 Analyte concentration must be the same as that used in the LCS.

7.2.5.2 **Control Limits -** Percent difference of +/-20% between LCS & LCSD and Recovery 70-130%, or as determined by control charts.

7.2.5.3 **Frequency-** One per batch of 20 samples or less

7.2.5.4 **Corrective Action -** Rerun LCS/LCSD one time to determine if second analysis meets criteria. If not, implement corrective action procedure to identify root cause.

7.2.5.5 **Check -** Spike solution and sample prep technique

7.2.5.6 **Record -** Corrective Action Response Report must be initiated for all LCS failures.

7.2.6 Low-level Standard (LLS)

7.2.6.1 Analyte concentrations should be ± 50% or± the reporting limit of true value, whichever is greater.

7.2.6.2 **Corrective action-** Text all results between the reporting limit and the low standard as estimated due to inaccuracy in the LLS.

8.0 PROCEDURE

8.1 Sample Handling

8.1.1 **Preservation-** All samples will be prepared following Standard Operating Procedures Sample Preparation Manual. Soil or other solid samples will be stored in the in the sample preparation area, until analysis.

8.1.2 **Sample Holding Time-** Holding time for soil samples are six months.

8.1.3 Record the following on the Sample Preparation Log sheet for each sample.

8.1.3.1 Date of preparation.

8.1.3.2 Name of analyst prepping.

8.1.3.3 Lot numbers of HNO3

8.1.3.4 Standard reference numbers.

8.1.3.5 All Uranium analytical results will be reported as DISSOLVED.

8.2 Solid Sample Total Recoverable Metals Preparation Procedure for ICP-OES

8.2.1 Reference: Online Edition of Standard Methods, Part 3030, PRELIMINARY TREATMENT OF SAMPLES.

8.2.2 Prepare batch QC samples as described in section 6.2 using the instrument-specific spiking solutions described in sections 6.5 ICP-OES.

8.2.3 The entire volume of the soil sample shall be homogenized and passed through a #10 screen. A representative sample (10-20 grams) is placed in a pre-weighed aluminum dish and dried at 60°C until any moisture or liquid portion has completely evaporated which can be determined by the sample's consistent weight.

8.2.4 The entire dried solid fraction is ground in a GLASS mortar to achieve homogeneity and then transferred to a, capped, and labeled container. Do not use porcelain mortar as they have shown to be contaminated with lead and cadmium.

8.2.5 A 1.0 gram sample of the ground dried soil sample is then transferred to a 50 ml disposable DigiTube, 10 ml of ultrapure Nitric Acid added, covered and placed on a hot plate at 95 degrees C and refluxed WITHOUT BOILING for 10 minutes.

8.2.6 Remove from the hot plate and allow to cool, add 5 ml of concentrated ultrapure Nitric Acid, cover and again reflux WITHOUT BOILING for 30 minutes.

8.2.7 Remove from the hot plate and allow to cool, add an additional 5 ml of concentrated ultrapure Nitric Acid and again reflux and evaporate WITHOUT BOILING or allowing the sample to go to dryness to approximately 5 ml.

8.2.8 Remove from the hot plate and allow to cool, add 2 ml of filtered DI water and 3 ml of ultrapure 30% Hydrogen Peroxide, cover, and return to the hot plate and heat until any effervescence subsides.

8.2.9 Bring the total volume up to 40 mL with DI Water. Affix 0.45 micron DigiFilter to the DigiTube and insert plug into opening closest to the DigiTube. Affix a new 50 mL DigiTube to the other end of the filter and secure. Invert the assembly and place onto the vacuum rack empty tube down. Insert vacuum port into the LOWEST opening and open the vacuum valve. Remove the previously inserted plug. The vacuum will draw the filtrate into the bottom DigiTube. Discard filter and top DigiTube. Bring the total volume of the sample to 50 ml with filtered DI water using.

8.2.10 Mix the sample well and transfer DigiTube to the ICP-OES analyses.

9.0 DATA REPORTING

9.1 Requirements

9.1.1 Calculations - Provide a list of calculations used in this method

9.1.2 Logbook entry- Describe the information written on the logbook form. Refer to the logbook attachment

9.1.3 The corrective actions section covers the following topics: 1) Out of control data procedures 2) Corrective action logbooks

ATTACHMENT E3

Avio® ICP Optical Emission Spectrometer Overview

Avio® 200 ICP Optical Emission Spectrometer

For research use only. Not for use in diagnostic procedures.

PerkinElmer®
For the Better

PERFORMANCE VALUE AND EASE OF USE IN ONE COMPACT PACKAGE

Capable of handling even the most difficult, high-matrix samples without dilution, the Avio® 200 system brings a whole new level of performance and flexibility to ICP.

What's more, that unprecedented performance comes with unparalleled ease-of-use. Unique hardware features and the industry's most intuitive software combine to make multi-element measurements as easy as single-element analyses.

The smallest ICP on the market, Avio 200 offers efficient operation, reliable data, and low cost of ownership by delivering:

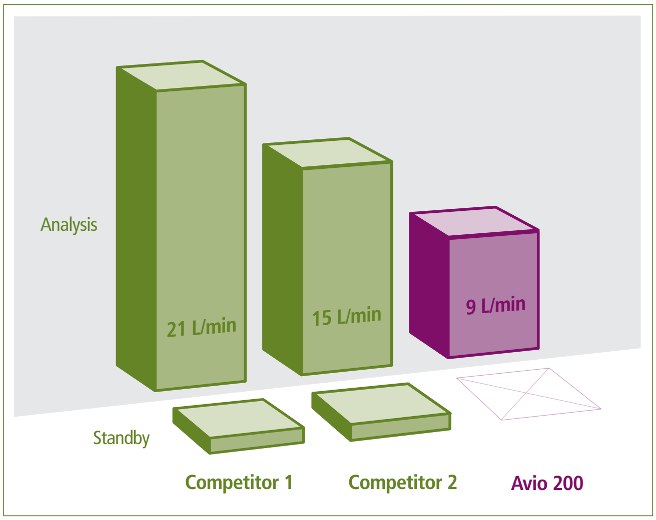
- The lowest argon consumption of any ICP
- The fastest ICP startup (spectrometer ready in just minutes from power on)
- Superior sensitivity and resolution for all elements of interest
- Extended linear range with dual viewing technology

Reliable. Capable. Affordable. The Avio 200 is everything you're looking for in an ICP.

Avio 200 ICP-OES

WHY JUST ENGINEER WHEN YOU CAN PIONEER

Designed to meet the most challenging of customer needs – and exceed them – the Avio 200 ICP allows you to run more samples more cost-efficiently than ever before with an array of unique and proprietary features.



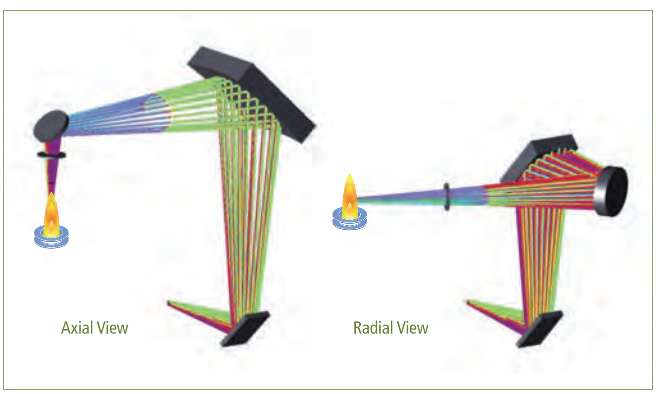
The Avio 200 operates with a plasma flow of 8 L/min and a total argon gas flow of 9 L/min, compared to 21 L/min required by other systems.

Low cost of ownership

Avio's proprietary Flat Plate™ plasma technology generates a robust, matrix-tolerant plasma using half the argon of other systems, giving you:

- Faster return on investment
- Superior uptime and productivity by eliminating the need for cooling and maintenance associated with traditional load coils

Plus, for added efficiencies, PerkinElmer's Dynamic Wavelength Stabilization feature lets you go from power on to analysis in just minutes, allowing you to freely turn off the instrument when not in use.



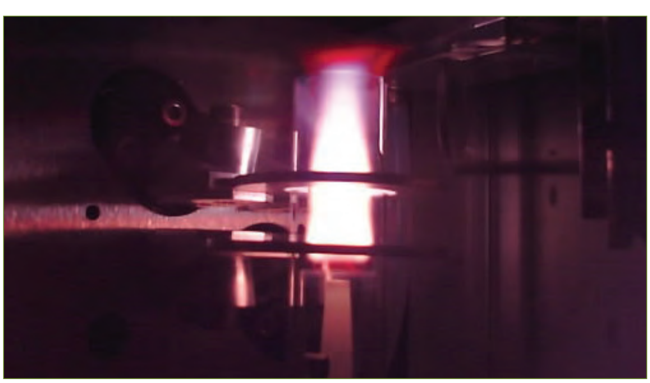
Avio's unique vertical Dual View optical system ensures the widest working range and excellent detection limits.

Uncompromising Dual View capability

Unlike synchronous vertical Dual View ICP systems that compromise performance in order to provide axial and radial viewing, the Avio 200 system's Dual View capability measures every wavelength with no loss of light or sensitivity. Even elements at high (>500 nm) or low (<200 nm) wavelengths can be measured with complete confidence, no matter the concentrations.

The Avio system's unique Dual View design also offers an extended linear dynamic range, enabling:

- Minimized sample preparation and dilution
- High and low concentrations measured in the same run
- Better quality control and more accurate results
- Fewer reruns



PlasmaCam allows easy viewing of the plasma and surrounding components for easy method development and troubleshooting.

Integrated plasma viewing camera

Simplify your method development and enjoy the convenience of being able to monitor your plasma remotely with the Avio 200 system's PlasmaCam™ technology. An industry first, the color camera lets you:

- View the plasma in real time
- Perform remote diagnostics
- See sample introduction components

Revolutionary PlasmaShear system for argon-free interference removal

To remove interferences during axial viewing, you need to eliminate the cool tail plume of the plasma. No instrument does it more effectively, reliably, or economically than the Avio 200.

While other ICPs use as much as 4 L/min of argon to remove the plume, the Avio system's unique PlasmaShear™ technology runs on air. No need for ionization suppressants. No high-maintenance, high-extraction systems or cones. Just a fully integrated, fully automated interference-removal system that delivers problem-free axial analysis.

CCD detector for unmatched accuracy and precision

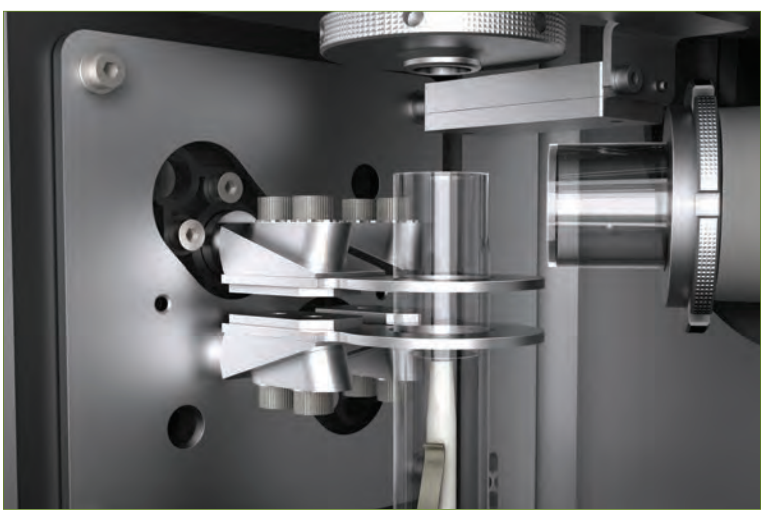
With its full wavelength capability, the powerful charge-coupled device (CCD) detector on the Avio 200 system delivers exactly the right answer, time after time.

Unlike traditional sequential systems featured in other instruments, the Avio system's CCD detector measures the wavelength range around the emission line of interest – **simultaneously** – for superior precision. It also performs simultaneous background correction measurements during an analysis to further enhance accuracy and sensitivity.

Vertical plasma with quick-change torch mount for unsurpassed matrix flexibility

Quickly and easily adjusted without tools, even when the ICP is running, the Avio 200 system's vertical torch delivers greater sample flexibility and simplified maintenance. Uniquely designed, the torch mount features:

- A removable injector that is independent of the torch for less maintenance and potential for breakage
- Automatic self-alignment to provide consistent depth setting even after removal
- Compatibility with a variety of nebulizers and spray chambers for added flexibility



Avio's proprietary Flat Plate plasma technology provides a more compact, robust, and stable plasma than traditional helical coil systems.

Avio's vertical torch design delivers greater sample flexibility and simplified maintenance.

MULTI-ELEMENT ANALYSIS MADE EASY

Avio is the ideal ICP platform for AA users requiring multi-element capabilities. Not only does it allow you to measure more elements at lower levels, it does so without added complexity or cost. In fact, the Avio 200 can shorten your analysis times by eliminating the need to dilute samples. Step up to the superior all-around performance of a solution that is:

- As easy to use as your AA with no flammable gases
- As cost-efficient as your AA (with no lamps to buy when you run new elements)
- The same size as your AA

Plus, it utilizes the intuitive, cross-platform Syngistix™ software package unique to PerkinElmer atomic spectroscopy instruments.

ENHANCING PERFORMANCE FROM THE INSIDE OUT

Flat Plate Plasma Technology

- More robust and stable plasma
- Unsurpassed matrix tolerance
- Lowest argon consumption (half that of traditional load coils)
- Less maintenance

Vertical Torch

- Optimal performance for any sample type
- Quick and easy to adjust for simple maintenance
- Torch mount ensures easy, accurate realignment after removal

Small Footprint

- 65 x 76 x 81 cm (W x D x H)
- Saves valuable laboratory bench space

Color PlasmaCam

- Simplifies method development by allowing continuous viewing of the plasma
- Remote diagnostic capabilities for superior uptime

Dual View

- Optimizes plasma viewing – both axial and radial
- Measures elements with high and low concentrations in the same run, regardless of wavelength

New 4-Channel, 12-Roller Peristaltic Pump

- Delivers greater sample-introduction flexibility
- Enhances and optimizes stability

PlasmaShear System

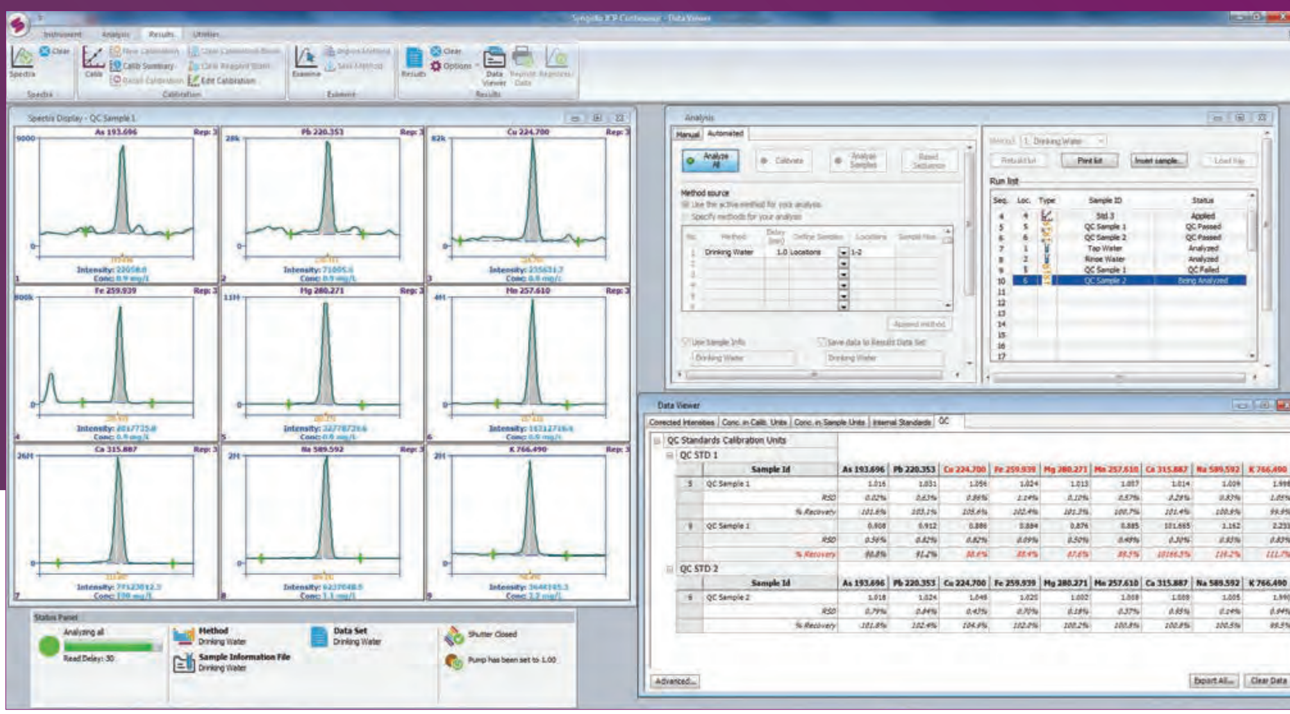
- Argon-free interference removal
- Maintenance-free design (no cones to clean or high extraction systems)

INTERACT WITH A MORE INTUITIVE INTERFACE

The Avio 200 runs using Syngistix for ICP software. Powerful, flexible, and simple, this cross-platform package offers:

- An intuitive, left-to-right, icon-based design
- Built-in, preset methods for faster, easier operation, requiring minimal training
- Extensive QC options to ensure quality data

Designed to mirror your workflow, the Syngistix interface walks you through every step of an analysis – from instrument setup to results – for consistent, efficient, reliable operation. Enjoy more functionality with fewer clicks from start to finish.



Instrument Startup/ Optimization

Status Panel displays real-time information on key instrument components so you can monitor the entire system at a glance.

Continuous Graphics allows real-time monitoring of instrument performance while optimizing instrument parameters.

Simple Method Development

Preset Methods offer faster, simpler operation and accurate, reliable data.

Method Editor organizes parameters into logical groups – spectrometer, sampler, processing, calibration, checks, and QC – and allows measurement times to be selected for optimum speed and productivity.

Enhanced Productivity

Multicomponent Spectral Fitting (MSF) offers simple, reliable interference removal by letting you isolate the analytical signal from the measured spectra for superior accuracy, precision, and detection limits.

Cross-Tab Data Viewer displays results in an easy-to-read, elements-across format for simpler review and analysis.

Data Analysis

Data Reprocessing lets you adjust everything from background correction points to your calibration curve after data collection to optimize the measurement of a particular sample without having to re-run it.

Status Panel features a graphic progress bar showing the percentage of an analysis that has been completed. Managing your system – and your time – has never been easier.

INconX™ Mobile Status App

This feature allows you to monitor and manage your Avio 200 from anywhere, any time, using your mobile device. Check an ongoing analysis, manage multiple users, even control functions like turning the plasma on and off.

ACCESSORIZE YOUR SYSTEM OPTIMIZE YOUR RESULTS

PerkinElmer makes it easy to get the most out of your Avio 200 system with a full range of accessories and consumables designed to optimize performance, streamline your workflow, and generate faster, more accurate results.

Titan MPS™ microwave sample preparation system

Easy to load and easy to use, the Titan MPS delivers simple, safe, cost-effective microwave sample preparation, optimizing performance by constantly monitoring and adjusting digestion conditions during operation.

SPB digestion blocks

When conducting routine sample preparation, PerkinElmer's SPB blocks are ideal for any open-vessel digestion/heating method requiring a temperature below 180 °C.

S10 Autosampler

Turn your Avio 200 ICP-OES into an efficient, fully automated analytical workstation with the addition of an S10 Autosampler. Ruggedly designed, the S10 features corrosion-resistant components to ensure long-term reliability, reproducibility, and precise performance.

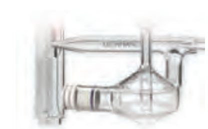
ICP consumables and supplies

Nebulizers/Spray Chambers – Scott/Cross Flow and Cyclonic/Meinhard options available.

Injectors – Full selection of alumina, quartz, and sapphire versions.

PerkinElmer Pure Standards – More than 300 single- and multi-element standards, each with a certificate of analysis documenting quality, stability, and reliability.

Torches – Exclusive, one-piece, demountable quartz models designed for quick, easy replacement.



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Optimize your Avio 200 ICP-OES with our comprehensive suite of services from PerkinElmer OneSource® Laboratory Services. From instrument service and repair to analytics and optimized scientific workflows, OneSource Laboratory Services provides all the tools you need to increase your lab efficiencies and get more out of your ICP. Far beyond the traditional model of a laboratory services company, OneSource Laboratory Services becomes an integral part of your business, providing a high level of technical support and scientific expertise. Expect more from your laboratory services provider and discover our comprehensive set of tools to help empower your science and drive your business.

APPENDIX C

Construction Quality Assurance Plan

www.haleyaldrich.com

REPORT ON

NUCLEAR METALS, INC. SUPERFUND SITE CONSTRUCTION QUALITY ASSURANCE/ QUALITY CONTROL PLAN PHASE 1 – COURTYARD, LANDFILL, SPAGNUM BOG, AND COOLING POND SITE-WIDE SOILS AND SEDIMENT CONCORD, MASSACHUSETTS

by
Haley & Aldrich, Inc.
Boston, Massachusetts

for

de maximis, inc.

200 Day Hill Road, Suite 200
Windsor, Connecticut

Disclaimer*: This document was prepared by the Settling Defendants under a government Consent Decree. This document has not undergone formal review by the U.S. Environmental Protection Agency or the Massachusetts Department of Environmental Protection. The opinions, findings, and conclusions expressed are those of the author and not those of the U.S. Environmental Protection Agency or the Massachusetts Department of Environmental Protection.*

File No. 131884-003
September 2023

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List of Acronyms

AOI	Area of Interest
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
BMP	best management practice
CD	Consent Decree
CIP	Community Involvement Plan
CM	Construction Manager
CMR	Code of Massachusetts Regulations
COC	Contaminant/Constituent/Chemical of Concern
COPC	Chemical of Potential Concern
CQA	Construction Quality Assurance
CQC	Construction Quality Control
ddms, inc.	*de maximis* data management solutions
de maximis	*de maximis, inc.*
DETS	Decontamination Effluent Treatment System
DU	depleted uranium
EDD	Electronic Data Deliverable
EME	USEPA Metadata Editor
EOR	Engineer-of-Record
EPC	exposure point concentration
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
FSP	Field Sampling Plan
GC	General Contractor
GIS	geographic information system
GSI	Geosynthetic Institute
Haley & Aldrich	Haley & Aldrich, Inc.
HASP	Health and Safety Plan
HB	Holding Basin
HHRA	Human Health Risk Assessment
HI	Hazard Index
HP	Health Physicist
ILCR	Incremental Lifetime Cancer Risk
MassDEP	Massachusetts Department of Environmental Protection
$\mu g/m^3$	micrograms per cubic meter
mg/kg	milligrams per kilogram
MPR	Monthly Progress Report

MQA	Manufacturing Quality Assurance
MQC	Manufacturing Quality Control
NAAQS	National Ambient Air Quality Standard
NAD83	North American Datum 1983
NAUL	Notice of Activity and Use Limitation
NMI	Nuclear Metals, Inc.
NTCRA	non-time-critical removal action
PAH	polycyclic aromatic hydrocarbon
PC	Project Coordinator
PCB	polychlorinated biphenyl
pCi/g	picoCuries per gram
PDI	Pre-Remedial Design Investigation
PE	Professional Engineer
PM_{10}	particulate matter less than or equal to 10 microns
PRG	preliminary remediation goal
PS	performance standard
QA	quality assurance
QAO	Quality Assurance Official
QAPP	Quality Assurance Project Plan
QC	quality control
QCP	Quality Control Plan
RA	remedial action
RAC	Remediation Action Contractor
RAL	remedial action level
RAO	Remedial Action Objective
RAWP	Remedial Action Work Plan
RD	remedial design
RDWP	Remedial Design Work Plan
RFP	Request for Proposal
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level
RSO	Radiation Safety Officer
SD	Settling Defendant
SFA	Settling Federal Agency
Site	Nuclear Metals, Inc. Superfund Site in Concord, Massachusetts
SLERA	Screening-Level Ecological Risk Assessment
SOE	support of excavation
SOP	standard operating procedure
SOW	Statement of Work
SSO	Site Safety Officer
SSS	Site-wide Soil and Sediments
SWMP	Site-Wide Monitoring Plan

TS	Treatability Study
TSCA	Toxic Substances Control Act
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WGS84	World Geodetic System 1984

1. Introduction

On October 17, 2019, the United States Environmental Protection Agency (USEPA) lodged a Consent Decree (CD) with the United States District Court for the District of Massachusetts Eastern Division in connection with Civil Action No. 1:19-cv-12097-RGS. The CD was entered by the Court on December 6, 2019. The CD and the Statement of Work (SOW), provided as Appendix B to the CD, describe the Remedial Design/Remedial Action (RD/RA) activities to be performed for the Nuclear Metals, Inc. (NMI) Superfund Site (Site) in Concord, Massachusetts. The RD/RA activities are to be undertaken by the Settling Defendants (SDs) to the CD, with funding contributions from the Settling Federal Agencies (SFAs).

1.1 PURPOSE AND SCOPE

This Construction Quality Assurance/Quality Control Plan (CQA/QCP) has been prepared by Haley & Aldrich, Inc. (Haley & Aldrich) on behalf of *de maximis, inc.* (de maximis) for the Site, USEPA ID: MAD062166335) in Concord, Massachusetts. This CQA/QCP was prepared consistent with the requirements of Section 6.7(f) of the SOW provided as Appendix B to the RD/RA CD filed May 3, 2018.

This CQA/QCP supports the design and construction for the SSS 100% RD Phase 1 encompassing the Courtyard, Landfill, Sphagnum Bog, and Cooling Pond design. The purpose of the CQA/QCP is to describe planned and systemic activities that provide confidence that the RA construction will satisfy all plans, specifications, and related requirements, including quality objectives, and demonstrate that cleanup objectives have been met.

The SOW states that the CQA/QCP must:

- Identify and describe the responsibilities of the organizations and personnel implementing the CQA/QCP;
- Describe the Cleanup Levels and Performance Standards required to be met to achieve Completion of the RA;
- Describe the activities to be performed: (i) to provide confidence that Cleanup Levels and Performance Standards will be met; and (ii) to determine whether Cleanup Levels and Performance Standards have been met;
- Describe verification activities, such as inspections, sampling, testing, monitoring, and production controls, under the CQA/QCP;
- Describe industry standards and technical specifications used in implementing the CQA/QCP;
- Describe procedures for tracking construction deficiencies from identification through corrective action;
- Describe procedures for documenting all CQA/QCP activities; and
- Describe procedures for retention of documents and for final storage of documents.

This CQA/CQP therefore describes the activities that will be implemented to verify that RA construction has satisfied the SOW requirements listed above, including additional State standards, specific stormwater management, flood, erosion, and sediment control plans, and quality objectives. SOW paragraph 6.7 defines other key supporting deliverables included with the 100% RD for approval by USEPA. CQA/QCP sampling and analysis will be performed consistent with the procedures provided inthe Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Site-Wide Monitoring Plan (SWMP).

The FSP addresses all sample collection activities. The FSP is written so that a field sampling team unfamiliar with the project would be able to gather the samples and field information required. The QAPP augments the FSP and documents a quality system for the collection of field samples, sample analyses, and data reporting to ensure that the data generated are of known and documented quality. The QAPP includes a detailed explanation of the SDs' quality assurance, quality control, and sample custody procedures for all treatability, design, compliance, and monitoring samples. USEPA's relevant guidance states:

> *"Construction Quality Assurance and Quality Control are widely recognized as critically important factors in overall quality management. The best of designs and regulatory requirements will not necessarily translate toremedial actions that are protective of human health and the environment unless the waste containment and closure facilities are properly constructed. Additionally, for geosynthetic materials, manufacturing quality assurance (MQA) and manufacturing quality control (MQC) of the manufactured product is equally important."*[1]

This CQA/QCP sets forth a program of observations and testing that will be implemented to verify that the work completed by the Remediation Action Contractor (RAC) conforms to the requirements of the USEPA-approved 100% RD and Contract Documents. The Contract Documents include the Contract, USEPA-approved 100% RD, General and Supplemental Conditions, Specifications, Drawings, all Addenda, and Supplemental Documents referenced by or attached to any of the aforementioned instruments.

1.2 NAME AND LOCATION

The Site includes the property located at 2229 Main Street in Concord, Massachusetts, and downgradient properties where groundwater contamination is located (see Figure 1 of the 100% Design – Site-wide Soils and Sediment Document of which this is an Appendix). The areal extent of contaminants in groundwater extends beyond the Assabet River and includes properties west of the river in the Town of Acton, Massachusetts. The NMI property is bordered by residential and woodland areas to the east and south, light commercial and industrial areas to the west, and Main Street (Route 62) and the Assabet River to the north.

Additional information regarding the Site location and setting is provided in the Remedial Design Work Plan (RDWP).

1.3 REMEDY COMPONENTS

The overall purpose of RD/RA activities is to design and implement the remedial approach for the Site. The Scope of the Remedy includes the following actions described in Section L of the Record of Decision (ROD), including:

- Excavation and off-site disposal of approximately 82,500 cubic yards of contaminated sediments, underground drain lines and debris, and non-Holding Basin (non-HB) soils

[1] Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182. September 1993.

(contaminated with depleted uranium [DU], polychlorinated biphenyls [PCBs], and other Contaminants/ Constituents/Chemicals of Concern (COCs) found in ROD Tables L-2 through L-4) in various areas of the Site (See Figure 3 of the RDWP).

- In-situ stabilization of DU-contaminated soils in the Holding Basin via injection of a stabilization agent such as apatite (e.g., Apatite IITM) or other comparable stabilization agent to prevent leaching of contaminants to groundwater, and in-situ treatment of DU in overburden groundwater and natural uranium in bedrock groundwater (See Figure 4 of the RDWP).
- Containment of HB stabilized soils with a low-permeability vertical wall and a low-permeability horizontal sub-grade cover to isolate the stabilized soils and further limit mobility of contaminants by removing the flow of groundwater (See Figure 5 of the RDWP).
- Extraction and ex-situ treatment of volatile organic compounds (VOCs), 1,4-dioxane, and other contaminants found in the ROD Tables.

This CQA/CQP focuses only on activities related to the excavation and off-Site disposal of contaminated soils and sediment, underground drain lines and debris, and non-HB soils.

1.4 ORGANIZATION AND CONTENT OF THIS CQA/QCP

The report includes the following sections:

- Section 2.0 describes the project team organization and responsibilities.
- Section 3.0 describes performance standards and cleanup levels.
- Section 4.0 describes project communications, documentation, and record retention.
- Section 5.0 describes construction activities.
- Section 6.0 describes Quality Assurance (QA) activities, including documentation, visual inspections, sampling, and testing that will be completed by QA staff and the methodology used to verify that the construction has met the cleanup objectives.
- Section 7.0 describes the procedure to modify this plan.

The CQA/QCP is a planned system of activities that provides confirmation and documentation that a project is constructed in accordance with the intent of the approved 100% RD, Contract Drawings, and Technical Specifications. It includes assessments, verifications, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed work. The basic components of the CQA program are:

- Preparation of this CQA/QCP.
- Retention of project team (Project Coordinator [PC], Construction Manager [CM], Engineer-of-Record [EOR], and RAC).
- Pre-construction review of RAC submittals for project components.
- Confirming and documenting satisfactory completion of and/or final grades and excavation depths/elevations of the various construction components (surficial debris removal, soil and waste excavation, and pond sediment dredging), stormwater management system, access roads, and other ancillary components of the construction.

- Collecting confirmatory soil and sediment samples and evaluating them to verify compliance with cleanup objectives.
- Collecting treated construction dewatering samples.
- Confirming and documenting that the required Construction Quality Control (CQC) field testing is being performed and meets the Technical Specifications; including, but not limited to the following:
  - Confirming and documenting CQC measuring/testing of soil components during placement and compaction;
  - Review of geosynthetic manufacturers' quality control (QC) test data and certifications;
  - Review of geotechnical laboratory test data submitted by the RAC; and
  - Confirming and documenting the construction of stormwater management features.
- Confirming and documenting construction of wetlands or restoration seeding and planting.
- Preparation of daily and other CQA reports.
- Review of geotechnical laboratory test data submitted by the RAC.
- Assessments to support the determination of substantial completion and final acceptance of the completed work.
- Compilation and presentation of applicable data, logs, RAC-generated record documents and certifications, photographs, and comments into a RA Report, which certifies that the construction was completed in accordance with the intent of the 100% RD, Contract Drawings, and Technical Specifications.

2. Project Team Organization and Responsibilities

This section describes the organization and individual responsibilities and relationships during the RA. An organizational chart is presented in Figure 2 of the 100% Design – Site-wide Soils and Sediment Document. This chart will be updated as the various parties are identified.

de maximis will serve as the PC and Supervising Contractor (as defined in the CD), and General Contractor (GC) for the performance of all Work required by the CD. de maximis will execute subcontracts with consultants, contractors, laboratories, and waste transporters and disposal facilities, as necessary, to implement the Work.

As the GC, de maximis personnel will act as the Site Project Manager and CM(s) during the Pre-Remedial Design Investigation (PDI)/Treatability Study (TS) work. For the RA, we anticipate adding a Site Operations Manager, Health and Safety Manager, and Shipping Coordinator.

de maximis data management solutions (ddms, inc.) will provide database management, data validation, lab coordination, file management (Project Portal), geographic information system (GIS), and website maintenance (see www.nmisite.org). In addition, de maximis has retained O & M Inc. to continue to perform the operations and maintenance of the Groundwater Extraction System installed to perform the ex-situ treatment of 1,4-dioxane in downgradient groundwater.

Prior to development of the RDWP, de maximis issued Requests for Proposals (RFPs) that allowed them to:

- retain consultants to prepare and implement the PDIs. We expect those firm(s) will subsequently prepare the RD, act as the EOR during the implementation of the RA, and then prepare the RA Report for their RA projects; and
- retain analytical laboratories to support QAPP development and perform PDI analysis. After submission of the RDWP and review of the projected off-Site disposal waste types and volumes, de maximis will issue an RFP for transportation and disposal services.

Co-incident with submission of each 60% RD deliverable for USEPA review (if used, at the 95% RD point if not), de maximis expects to issue RFPs for contracting services associated with that RA project.

2.1 RESPONSIBILITY AND AUTHORITY OF ORGANIZATIONS AND KEY PERSONNEL

The key management personnel for the RD are presented below, followed by a description and communication roles of each person or party in Sections 2.2 through 2.12. Regulatory entities involved in the project include USEPA and the Massachusetts Department of Environmental Protection (MassDEP), as well as local authorities. USEPA is the lead regulatory agency.

2.2 SETTLING DEFENDANTS

The SDs are the signatories to the CD. All formal communication from the SDs regarding the Site will be directed to the PC and the Agencies, as provided in the CD.

2.3 REGULATORY AGENCIES

All formal communication from the Agencies (USEPA and MassDEP) regarding the Site will be directed to the PC and the SDs, as provided in the CD.

2.3.1 United States Environmental Protection Agency

The USEPA is the lead agency responsible for observing and monitoring progress of the RD/RA for the Site pursuant to the CD, and exercises approval authority over all RD/RA deliverables prepared by the SDs.

2.3.2 Massachusetts Department of Environmental Protection

MassDEP is a party to the CD and is a supporting agency involved with this Site. MassDEP will have a reasonable opportunity for review and comment on every deliverable prior to any USEPA approval or disapproval under SOW Section 6.6 (Approval of Deliverables) of any deliverables that are required to be submitted for USEPA approval.

2.4 GENERAL CONTRACTOR

The SDs have retained de maximis to function as the GC.

2.5 GENERAL/SUPERVISING CONTRACTOR

On December 12, 2019, the SDs designated de maximis as their General and Supervising Contractor. On December 31, 2019, USEPA approved de maximis for this role. All RD/RA-related work performed by the SDs pursuant to the CD will be carried out under the direction and supervision of de maximis.

2.6 PROJECT COORDINATOR

On behalf of the SDs, Mr. Bruce Thompson will serve as the PC. The Respondents designated Mr. Thompson as their PC in a December 12, 2019 letter to USEPA. On December 31, 2019, USEPA approved Mr. Thompson. The PC will coordinate and supervise all Work under the RD/RA CD. In accordance with Paragraph 5.1 of the SOW, Monthly Progress Reports (MPRs) will be compiled and submitted to the Agencies by the PC on behalf of the Respondents. The PC is the primary contact for the SDs with USEPA, MassDEP, and the community.

2.7 REMEDIAL DESIGNER / ENGINEER-OF-RECORD

Haley & Aldrich has been retained as the EOR for the aspects of the RD described within this document. Other subcontractors for the RD have been and will continue to be procured based on specific scopes of work. These are anticipated to include analytical laboratory services and soil transportation and disposal. Subcontractors will report directly to the PC or appropriate contractor, who in turn will report to the PC.

2.8 REMEDIAL ACTION CONTRACTOR

The RAC will be responsible for implementing the RA, which includes the management of all phases of this project as described in the Contract Drawings, Technical Specifications, and other contract documents. The RAC will assign a Project Superintendent (or Project Manager) as the responsible person in charge of all aspects of the project. The Project Superintendent will have a background in construction supervision of remedial construction and landfill closure projects. The RAC will be responsible for constructing the work in accordance with the intent of the RD, Contract Drawings, Technical Specifications, and Remedial Action Work Plan (RAWP), including development and implementation of a site-specific Health and Safety Plan (HASP).

The RAC may engage various subcontractors to implement parts of the Work. Each subcontractor will provide a field supervisor who will report directly to the RAC's Project Superintendent. Testing laboratory services for geotechnical and environmental testing will be subcontracted by the RAC or its subcontractors to perform testing (both field and laboratory) as required by the Technical Specifications.

Upon completion of the project, the RAC will provide Record Drawings to the EOR for review.

2.9 CONSTRUCTION QUALITY ASSURANCE OFFICIAL

CQA Officials (QAOs, or CQA Technicians) will be responsible for implementing this CQA/CQP. The QAOs will perform the CQA tasks required by this CQA/QCP and will confirm and document that the construction has been completed in general conformance with the RD, Contract Drawings, and Technical Specifications.

QAOs will be representatives of the EOR. Some tasks will be completed by a QAO; however, most will be performed by the RAC and observed by the QAO(s). QAO reports will be reviewed by the EOR.

A QAO via the EOR will have the authority to recommend that the CM reject materials and workmanship provided by the RAC that are not in compliance with the Contract Drawings and Technical Specifications. Responsibilities of the QAO for construction activities identified in this CQA/QCP include the following:

- Work with the PC, CM, EOR, and RAC to review construction activities;
- Be familiar with the basic concepts used to develop the RD;
- Evaluate the conformance of material and construction to verify compliance with the intent of the requirements of the RD;
- Be familiar with other Site-specific documentation, including the RAC's bid;
- Attend regular project status meetings;
- Coordinate and schedule CQA observations, sampling, and testing with construction activities;
- Monitor the CQC activities and review CQC testing performed by the RAC and its subcontractors;
- Review, in conjunction with the PC, CM, EOR, and RAC, corrective measures to be implemented during construction when deviations from the Contract Drawings and Technical Specifications occur;
- Observe CQC activities for completeness and accuracy in general accordance with the Contract Drawings and Technical Specifications;
- Monitor and document placement of fill materials;
- Monitor and document geosynthetic material placement, non-destructive and destructive seam testing, and seaming and repair activities;

- Obtain and ship destructive seam test samples to a Geosynthetic Institute (GSI)-certified testing laboratory and review results for compliance with the Technical Specifications;
- Monitor and document construction of stormwater management systems;
- Work with the EOR to determine that testing equipment used and tests performed are in accordance with the Technical Specifications and industry standards;
- Report observed deficiencies to the PC, CM, EOR and RAC and document repairs;
- Prepare daily CQA reports;
- Coordinate with the EOR to review QA activities and data;
- Verify performance of as-built surveying by the RAC in accordance with the Contract Drawings and Technical Specifications;
- Oversee the ongoing preparation of as-built drawings by the RAC; and
- Prepare documentation for inclusion in the RA Report in collaboration with the EOR.

2.10 CQA TECHNICIAN(S)

The CQA Technicians will be responsible for performing on-site CQA activities. The general duties of the CQATechnicians will include the following:

- Be familiar with the CQA requirements for the project;
- Perform daily CQA activities;
- Attend CQA-related meetings discussed in this CQA Plan;
- Verify the calibration and condition of on-Site CQA equipment;
- Assign locations for testing and sampling;
- Coordinate collection and shipping of laboratory test samples;
- Review and report results of laboratory testing and Manufacturer and Contractor testing;
- Review the RAC's submittals;
- Prepare CQA daily field reports that include descriptions of the construction progress and any relevant observations;
- Provide daily field reports and logs upon request;
- Report any unresolved deviations from the RD to the EOR;
- Observe that erosion and sediment controls are in place and performing properly; and
- Assist in preparing the Final CQA Report.

Relative to earthwork construction, a Lead Earthworks CQA Technician will be designated and additional CQA Technicians will be used as needed.

The duties of the CQA Technicians related to earthwork construction will include the following:

- Check stockpile or borrow sources periodically for variability of the soils, and verify that the required QC testing is carried out;
- Monitor moisture conditioning activities;
- Monitor in-place moisture and density testing;
- Collect soil samples for laboratory conformance testing (at source or at the Site);
- Examine soil surfaces for signs of excessive wetting, desiccation, or other defects prior to placement of overlying materials;
- Monitor scarification between lifts (if required) and before re-compaction or proof-rolling that is required to repair deteriorated areas;
- Review soil CQC data;
- Establish, with the EOR, additional test requirements beyond those in the Technical Specifications and/or CQA/QCP, when necessary;
- Monitor excavation and collect post-excavation samples, if and when required; and
- Check stockpile or borrow sources periodically for variability of the soils and verify that conformance testing is carried out and acceptable results are obtained.

A Lead CQA Wetland Restoration Technician will be designated and additional CQA technicians will be used as needed. The duties of these CQA personnel related to wetland restoration will include the following:

- Confirm areas to be planted have been identified/flagged;
- Check stockpiles periodically for variability of the soils, and verify that on-Site soil has been approved by the EOR;
- Monitor soil placement activities;
- Observe vegetation activities (i.e., planting); and
- Establish, with the EOR, additional test requirements beyond those in the project Specifications and/or CQA/QCP, when necessary.

In addition to these duties, the CQA Technicians will take note of on-Site activities that could result in damage to the soils, wetlands, or other components of the project. Observations so noted will be reported as soon as possible to the EOR.

2.11 CQA SURVEYOR

The CQA Surveyor will provide periodic survey data to verify the RAC's work and check as-built documentation as required by the Contract Documents. The RAC is required to meet the surveying layout and as-built drawing requirements set forth in the project Specifications. However, to provide independent verification and documentation, the CQA Surveyor will be a subcontractor to the EOR and will conduct QA surveys at the direction of the EOR.

3. Performance Standards and Cleanup Levels

The ROD provided Remedial Action Objectives (RAOs), which are medium-specific goals that define the objective of remedial actions to protect human health and the environment. RAOs specify the COCs, potential exposure routes and receptors, and provide a general description of what the cleanup will accomplish. The RAOs that are relevant for the Site-wide Soil and Sediments (SSS) remedial design are:

1. Prevent direct human exposure by a future resident (by dermal contact, ingestion, inhalation, or ionizing radiation) to soil or sediment with contaminants (DU, PCBs, polycyclic aromatic hydrocarbons [PAHs], and other inorganics) that exceed risk-based standards.
2. Protect ecological receptors from exposure to contaminants (PCBs and copper) in sediments indicative of adverse effects at the Cooling Water Recharge Pond.
3. Protect ecological receptors from exposure to contaminants (PCBs, copper, mercury, and lead) in sediments indicative of adverse effects at the Sphagnum Bog while maintaining the physical and ecological integrity of the bog.

Achieving the RAOs is guided by cleanup levels for COCs which were specified in Tables L-2, L-3, and L-4 of the ROD for soil and sediment, respectively. The cleanup levels are summarized in Tables 3-1 through 3-3 below.

Table 3-1
Soil Cleanup Levels for the Protection of Human Health

CHEMICAL OF CONCERN	CLEANUP LEVEL	
	mg/kg	pCi/g
Benzo(a)anthracene	0.34	NA
Benzo(a)pyrene	0.22	NA
Benzo(b)fluoranthene	0.34	NA
Indeno(1,2,3-cd)pyrene	0.34	NA
Polychlorinated Biphenyls	1	NA
Arsenic	13.7	NA
Uranium	2.7	1.1
U-238	NA	0.9
U-235	NA	0.01
U-234	NA	0.15
Thorium	7.4	0.81
Th-232	NA	0.81

Notes:

1. *Refer to Table L-2 of ROD for cancer classification, target endpoints, and cleanup level basis.*
2. *NA = not applicable*
3. *mg/kg = milligrams per kilogram; pCi/g = picoCuries per gram*

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Table 3-2 Sediment Cleanup Levels for the Protection of Human Health	
CHEMICAL OF CONCERN	**CLEANUP LEVEL mg/kg**
Polychlorinated Biphenyls	1

***Notes*:**
1. *Refer to Table L-3 of ROD for cancer classification, target endpoints, and cleanup level basis.*

Table 3-3 Sediment Cleanup Levels for the Protection of Ecological Receptors			
HABITAT TYPE/NAME	**EXPOSURE MEDIUM**	**CHEMICAL OF CONCERN**	**PROTECTIVE LEVEL (mg/kg)**
Sphagnum Bog	Sediment	Polychlorinated Biphenyls	1.08
		Copper	176
		Lead	97.3
		Mercury	1.3

***Notes*:**
1. *Refer to Table L-4 of ROD for cleanup level basis and assessment endpoint.*

3.1 PERFORMANCE STANDARDS (PS) AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

The ARARs are included in the RDWP.

3.2 OVERVIEW OF APPROACH FOR DEMONSTRATION OF COMPLIANCE WITH CLEANUP LEVELS

This section provides a description of the approach that will be used to document that the RAO for soils and sediments outside of the HB (non-HB soils and sediments) will be met after remediation.

As identified in the ROD for the Site, the RAO for non-HB soils and sediments is to “prevent direct human exposure by a future resident (by dermal contact, ingestion, inhalation, or ionizing radiation) to soils or sediments with contaminants (DU, PCBs, PAHs, and other inorganics) that exceed risk-based standards.” The response action identified in the ROD for achieving this RAO is excavation and off-Site disposal of contaminated sediments and soil with COCs that exceed cleanup levels published in Table L-2 of the ROD, which are provided in subsection 3.1 above.

USEPA has published guidance which clarifies that the goal of remedial actions, and of achieving cleanup levels (also referred to as preliminary remediation goals [PRGs]), is to ensure that residual risks that remain after site cleanup will be within some specified limit of acceptability. More specifically, USEPA states that:

> *“A key concept is that a PRG is the average concentration of a chemical in an exposure area that will yield the specified target risk in an individual who is exposed at random within the exposure area. Thus, if an exposure area has an average concentration above the PRG, some level of remediation is needed. However, it is not necessary that all concentration values above the PRG be remediated. Rather, all that is required is that the average concentration be reduced to the*

PRG or below. Thus, some concentration values may remain that are above the PRG. The concentration value that is to be removed in order to reduce the mean to the PRG or below is often referred to as the remedial action level (RAL)."[2]

The Remedial Investigation (RI) Human Health Risk Assessment (HHRA) evaluated potential risks by exposure area, and exposure areas where risks exceeded an incremental lifetime cancer risk (ILCR) of 1E-04 and/or a hazard index (HI) of 1 were identified in the ROD as areas that required remediation. Other areas of the Site were also designated for remediation in the ROD based on other factors, such as the presence of buried material (Area of Interest [AOI] 3) and the presence of DU penetrators (areas adjacent to buildings including portions of Exposure Area A7), and soil beneath the buildings (which was not characterized during the RI). The ROD included a figure illustrating areas where soil and sediment excavation were estimated to be required within the exposure areas. The PDI further characterized those areas to enable development of the RD (excavation cut lines).

Within the exposure areas where risks exceeded an ILCR of 1E-04 and/or a HI of 1, the COCs that contributed most significantly to the health risks were PCBs and uranium (i.e., if PCBs and uranium were not present at the Site, risks in soil and sediment would not have exceeded an ILCR of 1E-04 or a HI of 1). The other COCs in soil contributed to total risks, but are not the primary drivers for remediation:

- Arsenic and thorium contributed ILCR values above 1E-05; however, they were determined to be attributable to naturally occurring background conditions. Nevertheless, cleanup levels were established based on background values, and compliance with the cleanup levels will be evaluated for arsenic and thorium.
- PAHs contributed risks above 1E-06 in some of the areas and were therefore incorporated as COCs. Cleanup levels were established based on a combination of background values and risk-based concentrations, and compliance with the cleanup levels will be evaluated for PAHs.

The areas designated for remediation are bordered by areas associated with risks that are within a range of 1E-06 to 1E-04 and which have exposure point concentrations (EPCs) of uranium that sometimes exceed the cleanup levels. Therefore, it is likely that some confirmatory soil samples collected during remedial excavation activities, particularly those defining the horizontal extent of remediation, will identify COC concentrations above cleanup levels. Consequently, implementing the RA for soils and sediments will necessitate an approach that focuses on achieving an acceptable level of residual risk as articulated in the USEPA guidance described above, as opposed to a sample-by-sample/point-by-point compliance with a cleanup level approach.

USEPA Region 1 has clarified that the approach for achieving an acceptable level of residual risk as a mechanism for demonstrating compliance is acceptable, providing that:

a. The cleanup levels described in the ROD will be achieved within exposure areas where remediation is required; cleanup level compliance may use averaging approaches.

b. Where averaging approaches (as opposed to a point-by-point approach) are used to demonstrate compliance with cleanup levels, an EPC defined as the 95% upper confidence limit (UCL, as opposed to average concentration) should be used to demonstrate that the cleanup level has been achieved.

[2] https://www.epa.gov/risk/calculating-preliminary-remediation-goals-prgs

c. Where averaging approaches are used to demonstrate compliance with cleanup levels, variables of volume and depth must be adequately factored into the averaging approach and UCL calculations.

Figure C-1 provides a graphical depiction of the general approach that will be used to evaluate and demonstrate compliance with cleanup goals at the areas of the Site where remediation of soils and sediments will occur. As indicated in Figure C-1, the approach integrates remedial construction (excavation) with confirmatory sampling and RALs in an iterative process designed to advance excavation to the point where a demonstration of compliance with cleanup levels can be made. This CQA/QCP describes the process that will be used to evaluate compliance with cleanup objectives and how confirmatory sampling data will be integrated with existing RI and PDI data to demonstrate compliance. The report also applies the process in an *a priori* fashion to demonstrate that the RD will achieve the cleanup objectives. The main components of the process are described below, with details specific to the investigation areas provided in Sections 5 and 6.

1) Excavate soil in accordance with the RD. The Remedial Design Report provides the horizontal and vertical boundaries of excavation (design cut lines) for each of the areas requiring remediation, as well as the volume of material estimated to be removed, the volume of clean backfill estimated to be required, and the residual concentrations of COCs that are anticipated to remain in soil based on design cut lines. The residual concentrations that are anticipated to remain outside of the design cut lines are used as the starting point for evaluating compliance with cleanup levels.

   Attachment C-1 provides documentation of the datasets that are representative of anticipated post-remedial conditions based on the design cut lines.

2) Collect confirmatory soil samples and compare to RALs to determine if excavation is complete. Confirmatory soil samples will be collected on the bottoms and sidewalls of the excavations as follows:

   - Bottom samples: Samples collected from a 0 to 6-inch depth on a 30-foot grid. The sample collected at each grid node will be a five-part composite, with one part of the composite at the grid node, and each of the other four parts of the composite at 10 feet from the grid node, 90-degrees off-set from each other (Figure C-2).
   - Sidewall samples: Samples collected as 1-foot vertical composites at 30-foot linear spacing. The sample collected at each grid node will be a three-part composite, with one part of the composite at the grid node, and each of the other two parts of the composite at 10 feet from the grid node. Sidewall sample locations where the sidewall is more than 1 foot high will have a sample collected at each 1-foot vertical interval (Figure C-3).
   - For small, discrete excavation areas of 30 feet by 30 feet or less that are outside of the main excavation footprints (e.g., excavation of soil associated with a PCB concentration above 1 mg/kg at a single isolated sample location), confirmatory soil samples will be collected as follows: A single five-part composite soil sample will be collected from the excavation bottom using the approach described above. A single three-part composite sample will be collected from each sidewall using the approach described above.

   Sample collection methodology is provided in the FSP.

   Confirmatory samples will be analyzed in an on-Site laboratory for uranium and concentrations will be compared to the uranium RALs. RALs represent the highest concentrations of COCs that can remain in soil within the excavation area, but still allow for the area to be compliant with cleanup objectives. At locations where RALs are exceeded, the excavation will be advanced and confirmatory soil samples will be re-collected and compared to the RAL; the process will be repeated until confirmatory soil sample concentrations of uranium do not exceed RALs. Section 6 provides documentation for the development of the uranium RALs and includes a demonstration that meeting the RALs will ensure that EPC will meet the cleanup level.

The RALs for PCBs will be the cleanup level of 1 mg/kg. Review of the analytical dataset for soils at the Site indicates that when uranium concentrations are equal to or lower than the uranium RALs (which are generally expected to be 15 mg/kg or lower), PCB concentrations are likely to be below the PCB RAL. Therefore, confirmatory soil samples representing soil that does not exceed the uranium RALs will be sent to an off-Site laboratory for analysis of PCBs. If PCB concentrations exceed the RAL, the excavation will be advanced and confirmatory soil samples will be re-collected, analyzed for uranium and PCBs, and compared to the RALs; the process will be repeated until confirmatory soil sample concentrations of uranium and PCBs do not exceed RALs.

Since PAHs are not significant contributors to risk at the Site, RALs will not be established for PAHs. However, the confirmatory soil samples will also be analyzed for the PAH COCs at the off-Site laboratory. RI, PDI, and confirmatory soil sampling data will be used to verify that residual PAH concentrations will meet the cleanup objectives. Additional excavation activities will be performed if necessary to address soil with PAH concentrations that is non-compliant with cleanup objectives.

The PCB and PAH analytical data will be validated in accordance with the validation procedures described in the QAPP and used to represent final verification sampling results for those COCs.

3) Final verification for arsenic, uranium, and thorium. Verification samples will be collected on a 60-foot grid and 60-foot linear wall spacing using the approach described in Step 2 and submitted for off-Site laboratory analysis of arsenic, thorium, and uranium. The analytical data will be validated in accordance with the validation procedures described in the QAPP.

4) Document that cleanup goals have been met. The validated analytical data from RI, PDI, and confirmatory/verification soil samples representative of soil that remains at the Site will be used to demonstrate that cleanup objectives have been met. The procedure for making this determination will include the following steps:

    a. Define exposure areas within excavation areas. The purpose of defining exposure areas is to ensure that the cleanup objectives are met within areas where exposures may hypothetically occur when the Site is re-developed. The exposure areas may be the same exposure areas that were evaluated in the HHRA, or they may be re-defined (for example, segregating an HHRA exposure area into smaller exposure areas that coincide with the boundaries of the remediation areas).

    b. Define EPC for soils remaining within the exposure area (residual EPC). The EPCs will be defined as the lesser of the maximum or 95% UCL concentrations of the RI, PDI, and confirmatory/verification soil samples that remain within the exposure area.

c. Define the volume of soil that remains within the exposure area (residual volume). The volume of soil remaining in the exposure area will generally be calculated as:

(horizontal boundary of exposure area x depth of soil within exposure area) – volume of soil excavated within exposure area

The depth of soil within the exposure area will be represented by the contour of the RI and PDI soil samples beneath the excavation, or 10 feet below ground surface (bgs), whichever is shallower.

a. Define volume of clean soil that will be used to backfill exposure area (backfill volume), considering both granular or common fill and topsoil.

b. Define EPC of clean backfill soil (backfill EPC). The backfill EPCs will be derived separately for granular or common fill and topsoil. The EPCs will be the average or 95% UCL concentration of samples used to verify the suitability of the soil as backfill material. The approach that will be used to verify the suitability of soil as backfill material is provided in Section 5.1.5 of this document.

The variables defined in this process will be used in the following equation to derive the final volume weighted residual EPCs (final residual EPCs) of COCs for each exposure area:

$$\frac{[(\text{Residual EPC}) \times (\text{Residual volume})] + [(\text{Fill EPC}) \times (\text{Fill volume})] + [(\text{Topsoil EPC}) \times (\text{Topsoil volume})]}{(\text{Residual volume} + \text{Fill volume} + \text{Topsoil volume})}$$

The final residual EPCs will be compared to the cleanup goals, and residual risks will also be calculated to demonstrate that cleanup objectives have been met. As documented in Section 6, the RALs are set at concentrations that, when met, will ensure that the final residual EPCs will meet the cleanup goals. When used with the process described herein, there is high confidence that confirmatory soil samples that meet the RAL will ensure that the cleanup objectives will be met.

It is not necessary that all analytical results for uranium in verification samples meet the RALs; rather, it is necessary that the final residual EPCs meet the cleanup objectives. Consequently, verification sample analytical results for uranium that exhibit variability around the RAL (e.g., some results above the RAL and some results below the RAL) are acceptable, provided that the final residual EPC meets the cleanup objectives. Regardless, a concentration of 27 mg/kg uranium (which corresponds to 10 times the cleanup level and to an ILCR of 1E-05) will be used as a threshold limit in evaluation of verification samples. If the uranium final residual EPC exceeds the cleanup objectives or if any single verification soil sample result for uranium exceeds the threshold limit, then additional excavation will be performed, verification samples collected, and residual concentrations re-evaluated using the process described herein. This process will be completed iteratively until final residual EPCs meet cleanup objectives and threshold limits are not exceeded.

4. Project Communications and Documentation

4.1 MEETINGS

4.1.1 Pre-Construction

Prior to initiating construction activities at the Site, requirements set forth in the 100% RD and Contract Documents for the project will be addressed in a Pre-Construction Meeting. At a minimum, the meeting will be attended by the PC, CM, EOR, RAC, and representatives of SDs. The meeting also may be attended by USEPA and/or MassDEP representatives.

The purpose of this meeting is to plan for coordination of tasks, to present the schedule and sequence of work, to discuss anticipated problems that might cause difficulties and delays in construction, and present the procedures for clarifications and changes to the 100% RD and Contract Documents.

The Pre-Construction Meeting will include discussion of the following activities:

- Review the responsibilities of each party;
- Confirm the lines of authority and communication, and update/finalize project personnel organization charts;
- Distribute relevant documents to all parties;
- Review critical design details of the project;
- Address approved modifications to the CQA/QCP;
- Address approved modifications to the 100% RD and Contract Documents so that the fulfillment of design specifications or Performance Standards (PSs) can be achieved;
- Establish an understanding by the parties of the CQA/QCP, and QA and QC procedures;
- Establish work area security and safety protocol in accordance with the RAC's HASP;
- Describe soil borrow source locations and haul routes;
- Establish soil, geosynthetic, and other material stockpiling locations;
- Confirm the methods for documenting and reporting, and for distributing documents and reports;
- Confirm acceptance and approval process for task completion prior to schedule sequence advancement; and
- Establish procedures for processing applications for payment.

Items discussed during the Pre-Construction Meeting will be documented by a person designated at the beginning of the meeting, and minutes will be distributed after the meeting.

4.1.2 Daily

A daily tailgate safety meeting will be conducted to discuss Site-related safety concerns/issues and work activities.The RAC will address safety and logics of specific tasks at the daily meetings.

4.1.3 Periodic

During construction of the RA, the PC shall meet regularly, in-person or via conference call at least once per week with USEPA, MassDEP, and others as directed or determined by USEPA, to discuss construction issues. The CM will distribute an agenda and list of attendees to all Parties prior to each meeting. The CM or designee will prepare and distribute minutes of the meetings to all Parties. These meetings will satisfy the CD requirement that the PC will meet with the USEPA and MassDEP project managers at least monthly.

4.1.4 Problem or Work Deficiency Meetings

Special meetings will be held when and if problems or deficiencies are present or judged likely to occur. At a minimum, these meetings will be attended by the CM, EOR, and RAC. Other project personnel will be involved asnecessary. The purpose of these meetings will be to define and resolve the problem or work deficiency as follows:

- Define and discuss the problem or deficiency;
- Review solutions; and
- Implement an action plan to resolve the problem or deficiency.

Items discussed during these meetings will be documented by the EOR, and if deemed necessary, the minutes will be transmitted to affected Parties.

4.2 DOCUMENTATION

4.2.1 Introduction

An effective CQA/QC program depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of CQA activities. The EOR will document that the QA requirements set forth in this CQA/QCP have been addressed and satisfied.

The EOR will maintain, at the Site, a complete electronic and/or hard copy file of the 100% RD (Specifications, Drawings, etc.), the CQA/QCP test procedures, daily reports, testing logs, and other pertinent forms and documents. Blank forms to be used for CQA documentation will be prepared prior to construction and kept in a file at the Site so that they may be readily used as needed during the project.

4.2.2 Recordkeeping

Daily records will be completed in the field, documenting the CQA activities. The forms to be completed that pertain to each of these categories of records are discussed below. The discussion includes the person(s) responsible for completing each form, and form submittal time frames.

4.2.3 Project Administration Records

Most project administration records will be completed daily by the EOR. These forms are briefly described below.

4.2.4 Personnel Log

The Personnel Log will be used if necessary by the EOR to document dates when key personnel are on Site. This log will provide a summary of the regulatory agency representatives, SDs, the PC, CM, RAC managers/ supervisors, surveyors, their titles, and list the time periods of involvement with Site work. This log will be available for review at the Site.

4.2.5 Daily Summary Report

The CM will prepare a Daily Summary Report with input from the EOR and RAC. Typical content will include the following, as applicable:

- Date and project name; personnel on Site, including time of arrival and time of departure;
- CQA and CQC personnel on Site;
- Weather conditions, including daily high and low temperature, wind conditions, and precipitation;
- Health and safety issues and resolutions reached, if any;
- General description of work activities performed at the Site;
- Identification of areas worked;
- Reduced-scale drawings or sketches as necessary to show areas worked;
- List of materials received by the RAC;
- Estimate of materials placed or installed;
- Problems encountered and resolutions reached, if any.

4.2.6 Monthly Progress Report

The PC will prepare a MPR to USEPA with input from the CM, EOR, and RAC. MPRs will include:

- The actions that have been taken toward achieving compliance with the CD;
- A summary of all results of sampling, tests, and all other data received or generated by SDs;
- A description of all deliverables that SDs submitted to USEPA and MassDEP;
- A description of all activities relating to RA Construction that are scheduled for the next six weeks;
- An updated RA Construction Schedule, together with information regarding percentage of completion, delays encountered or anticipated that may affect the future schedule for implementation of the Work, and a description of efforts made to mitigate those delays or anticipated delays;

- A description of any modifications to the work plans or other schedules that SDs have proposed or that have been approved by USEPA; and
- A description of all activities undertaken in support of the Community Involvement Plan (CIP, as may be required by USEPA) during the reporting period and those to be undertaken in the next six weeks.

4.2.7 RA Report

Following the RA Completion inspection, the SDs will submit a RA Report to USEPA requesting USEPA's Certification of RA Completion. The RA Report must include:

- Certifications by a registered Professional Engineer (PE) and by the SDs' PC that the RA is complete;
- Include as-built drawings signed and stamped by a registered PE and/or land surveyor;
- Be prepared in accordance with Chapter 2 (Remedial Action Completion) of USEPA's Close Out Procedures for NPL Sites guidance (May 2011);
- Contain monitoring data to demonstrate that PSs have been achieved; and
- Be certified in accordance with Section 6.5 (Certification) of the SOW.

Note that the PC and PE will certify that the RA Report was prepared under their direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Accordingly, the certifiers will be able to rely on all data collected in accordance with the USEPA-approved FSP, QAPP, and this CQA/QCP, regardless of which firm (PC, CM, EOR, or RAC) collects the data. Critical data collection will be overseen by one or more of the project team members.

4.3 CONTRACT DRAWINGS

The RAC and EOR will each maintain one complete set of the Contract Drawings and other plans and documents relevant to construction of the remedy, along with a record of all proposed, pending, and approved changes and clarifications to the Contract Drawings and Technical Specifications at the Site. Additionally, the RAC will maintain at all times, marked-up (hard copy and/or electronic red line) Record Drawings indicating progress of construction, including any changes made at the Site. The EOR will confirm that the RAC's as-built drawings agree with the CQA conformance data and QAO observations in the field.

The CQA Surveyor shall conduct sufficient surveying to confirm the as-built drawings submitted by the RAC's Surveyor including, but not limited to:

- Abandoned well locations;
- New, repaired, or replaced monitoring wells (locations and elevations at ground surface and top of riser);
- Permanent stormwater management structures;
- The top of waste surface prior to placement of grading fill;
- Top of vegetative support soil layer (i.e., final grade);

- Extents of sediment excavation areas and sediment restoration areas (i.e., ponds, bog);
- Extent of contaminated soil excavation and restoration areas (i.e., soil remediation zones);
- Extents of created/restored wetlands; and
- Post-construction topographic survey showing as-constructed contours of disturbed/restored areas and showing final surface features but not limited to fencing, monitoring wells, access roads, etc.

As previously stated, the above items shall be confirmed by surveying at select times and locations, along with frequent intervals along alignments, grade breaks, and the perimeter of the work area. The as-built drawings provided by the RAC will be included in the RA Report. The CQA Surveyor shall provide written certification (signed and stamped by the Professional Land Surveyor) within 30 days of completion that the above drawings have been checked.

4.4 CONTRACT SUBMITTALS

Submittals required by the Contract Drawings and Technical Specifications will be logged in at the time of receipt by the EOR. The EOR will review submittals for compliance with the Contract Drawings and Technical Specifications. A copy of the submittal review form prepared by the EOR indicating the final status of the reviewed submittal will be returned to the RAC. A record of the submittal and review form indicating review status will be kept on file by the EOR if an electronic logging system is not maintained by the RAC.

4.5 CHANGE ORDERS

A Change Order is used whenever a change in drawings, specifications, and/or a supporting plan is deemed necessary for the following reasons:

- Changed site conditions;
- Changed materials conditions;
- Alternate design procedures proposed;
- Alternate materials proposed; and/or
- Changes which result in modification to the Contract Price and/or Contract Time.

4.6 PHOTOGRAPHIC RECORDS

The CM, EOR, and RAC will maintain a photographic log of major elements of construction. To the greatest extent possible, each photo will include a readily understandable scale reference. The photographic log will include the following information:

- The date and location where the photograph was taken;
- The orientation of the subject matter photographed; and
- Description of the work.

Additional details regarding photographs are included in Specification 01 33 00.

4.7 ELECTRONIC DATA SUBMISSION TECHNICAL SPECIFICATIONS

SOW Section 6.4 requires the following:

- Sampling and monitoring data should be submitted to USEPA in standard Electronic Data Deliverable (EDD) format. Other delivery methods may be allowed if electronic direct submission presents a significant burden or as technology changes.
- Spatial data, including spatially referenced data and geospatial data, should be submitted: (1) in the Environmental Systems Research Institute (ESRI) File Geodatabase format; and (2) as unprojected geographic coordinates in decimal degree format using North American Datum 1983 (NAD83) or World Geodetic System 1984 (WGS84) as the datum. If applicable, submissions should include the collection method(s). Projected coordinates may optionally be included but must be documented. Spatial data should be accompanied by metadata, and such metadata should be compliant with the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata and its USEPA profile and the USEPA Geospatial Metadata Technical Specification. An add-on metadata editor for ESRI software, the USEPA Metadata Editor (EME), complies with these FGDC and USEPA metadata requirements and is available at https://edg.epa.gov/EME/.
- Each file must include an attribute name for each site unit or sub-unit submitted. Consult https://www.epa.gov/geospatial/geospatial-policies-and-standards for any further available guidance on attribute identification and naming.

5. Construction Activities or Remedial Actions and Activities

5.1 ENABLING PHASE

Provide access to facilitate remedial and other activities discussed below, including demolition of existing structures as necessary, clearing trees, removal of existing utilities, and grading to facilitate improved drainage and completion of other remedial activities.

5.1.1 Tree Removal

Clearing trees and vegetation to allow access for remedial excavations.

5.1.2 Courtyard Utility Capping

Locating and capping of existing utilities present in the Courtyard area.

5.1.3 Site-wide Utility Capping and Removal

Locating and capping and/or removal of existing utilities present across the Site.

5.1.4 Drainage Improvements – Buildings and Holding Basin

Installation of new utilities facilitating proposed remedial activities associated with the HB and other Site remediation areas.

5.1.5 Off-Site Soil Import and Stockpile

Imported on-Site management and stockpiling of soil from approved off-Site sources that is to be used for general backfilling material at various areas of the Site as part of remedial activities. Up to 12 samples will be collected from soil proposed for reuse. Soil samples will be analyzed for Site COCs and results will be compared against Site-specific background criteria to evaluate suitability for on-Site reuse. The frequency of representative sampling from proposed reuse material will be one sample every 5,000 cubic yards.

Samples with non-detections or detections below MassDEP criteria for background conditions and within the Site-specific background criteria for Site COCs will be considered chemically suitable for reuse. The laboratory detection limits to meet these criteria is discussed in the QAPP.

- Samples will be tested in accordance with the guidelines in the Technical Specifications.

5.2 AOI 8 AND 9

5.2.1 Excavation

Exposure Area A5 (AOI 8 Sweepings Area) and Exposure Area A4 (AOI 9) were identified in the ROD as requiring remediation because ILCR and/or HI values determined in the HHRA exceeded acceptable levels as defined by USEPA. The excavation cut lines for AOI 8 and AOI 9 are designed to remove soil within a portion of each exposure area to reduce the EPCs of COCs to levels that will not exceed the ROD cleanup levels.

At AOI 8, benzo(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene were not retained as Chemicals of Potential Concern (COPCs) in the RI HHRA and were not detected in any of the PDI samples outside of the design cut lines at concentrations that would include them as COPCs (i.e., they were detected at concentrations below USEPA residential soil Regional Screening Levels [RSLs] and the ROD cleanup levels; See Table 5.2-1). Excavation to the design cut lines is anticipated to reduce the EPCs for PCBs and uranium in the HHRA Exposure Area A5 (AOI 8 – Sweepings Area) to below the ROD cleanup levels, as follows (Table 5.2-1):

- PCB EPC reduced from 18.6 mg/kg to well below 1 mg/kg, and no concentrations above 1 mg/kg in soil remaining at the exposure area.
- Uranium EPC reduced from 82 mg/kg to 1.8 mg/kg in soil beneath the excavation and 2.4 mg/kg in soil within the overall exposure area, with a maximum concentration of 10.7 mg/kg in soil remaining at the exposure area.

At AOI 9, benzo(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene were not retained as COPCs in the RI HHRA. During the PDI, concentrations of PAHs above cleanup levels were identified in sample SS-PD-09011. That sample location is included in the planned excavation (i.e., within the excavation cut lines), and with removal of that sample, none of the PAH COCs were detected in any of the PDI samples outside of the design cut lines at concentrations that would include them as COPCs (Table 5.2-2). The confirmatory sampling will be used to ensure that PAHs associated with location SS-PD-09011 have been reduced to acceptable levels. Excavation to the design cut lines is anticipated to reduce the EPCs for PCBs and uranium in the HHRA Exposure Area A4 (AOI 9) to below the ROD cleanup levels, as follows (Table 5.2-2):

- PCB EPC reduced from 4.4 mg/kg to well below 1 mg/kg, and no concentrations above 1 mg/kg in soil remaining at the exposure area.
- Uranium EPC reduced from 17.4 mg/kg to 1.7 mg/kg in soil beneath the excavation and 1.9 mg/kg in soil within the overall exposure area, with a maximum concentration of 2.8 mg/kg in soil remaining at the exposure area.

As documented in Section 6, when volume-weighting is factored into the compliance evaluation, final residual EPCs for PCBs and uranium are anticipated to meet cleanup objectives.

5.2.2 Confirmatory Sampling

Confirmatory sampling will be performed within the excavation footprints to verify that remediation has reduced COCs to EPCs that will achieve compliance with the cleanup levels, using the approach described in Section 3. Confirmatory sampling grids are provided in Figures C-4 and C-5. With the exception of the boundary between AOI 8 and Exposure Area A7, excavation of soil will continue until uranium and PCB concentrations in confirmatory soil samples do not exceed the RALs. Verification sampling for uranium, arsenic, and thorium will then be completed using the approach described in Section 3. At the boundary between AOI 8 and Exposure Area A7, confirmatory and verification samples collected from the excavation wall will be used to identify locations where additional remediation is required. That remediation will be completed as a component of the remediation at Exposure Area A7.

5.3 COURTYARD

AOIs 15 and 11, referred to as the Courtyard Area (Courtyard) and located within Exposure Area A6, were identified in the ROD as requiring remediation because ILCR and/or HI values determined in the HHRA exceeded acceptable levels as defined by USEPA, primarily for AOI 11. The excavation cut lines for Courtyard are designed to remove soil to reduce the EPCs of COCs to levels that will not exceed the ROD cleanup levels within the top 10 feet of the final Site grade.

5.3.1 SOE Installation

Installation of support of excavation (SOE) to facilitate deeper remedial excavations will be implemented as needed for deeper excavations, assuming slabs at Buildings D and E are still in place at the time of the Courtyard remedial excavations. SOE will be completed in accordance with the Technical Specifications (provided in Appendix A of the Phase 1 design report).

5.3.2 Courtyard Excavations

PDI data collected indicated AOI 15, the Transformer Pad section of the Courtyard, contained total PCBs ranging from non-detect to 53.5 mg/kg. Consequently, this area was demarcated as a Toxic Substances Control Act (TSCA) area and TSCA material was excavated during the Enabling Phase remedial activities.

The remainder of the Courtyard area (AOI 11) was not characterized as a part of the original PDI. Sampling data from the RI investigation and recent investigations are used as the basis for design. An excavation extending to an approximate depth of 10 feet is planned for the majority of the Courtyard area, with select deeper locations. Confirmatory samples will be used to identify the final cut boundary prior to backfill and Site restoration.

5.3.3 Utility Excavation

As noted in the ROD, one of the primary objectives of remediation within AOI 11 is to remove the drain lines that run through the Courtyard. Lines will be removed within the designated excavation depths as part of remedial activities.

5.3.4 Confirmatory Sampling

Confirmatory sampling will be performed within the excavation footprint to verify that remediation has reduced COCs to EPCs that will achieve compliance with the cleanup levels, using the approach described in Section 3.2. A preliminary confirmatory grid is shown on Drawing C-501 included in Appendix A, Attachment A2 of the Phase 1 design report.

5.3.5 Pump House and Additional Drainage Improvements

With ongoing modifications to the HB wall design, the pump house demolition is not currently included as part of the Courtyard RA. If the pump house needs to be demolished, that work will be covered in future HB design documents.

Additional drainage improvements on the eastern edge of the Courtyard will be completed as part of the Enabling Phase and HB Work. Excavations completed to support these activities will include confirmatory sampling and barrier layers placed as needed to demarcate areas where additional RA will be needed.

5.3.6 Courtyard Area Restoration

Following remedial excavations, restoration of the Courtyard, including grading to maintain slopes and placement of planting material and plantings will be implemented as needed. Restoration will include filling excavated areas with clean soils to return the area to the pre-existing conditions, and applying seed, mulch, and/or soil amendments to restore the disturbed areas as needed. Drainage improvements will be included to the extent shown in the Contract Drawings.

5.4 LANDFILL AND SPHAGNUM BOG

5.4.1 Erosion Control Placement to Protect the Sphagnum Bog

Prior to soil disturbance activities, placement of erosion control measures will be placed between limits of work and the adjacent Sphagnum Bog as detailed in Appendix A of the Phase 1 design report.

5.4.2 Landfill Excavation

AOI 3, referred to as the Landfill and located within Exposure Areas B1 and A2, was identified in the ROD as requiring remediation because buried debris is located within the Landfill. ILCR and HI values determined in the HHRA did not exceed acceptable levels as defined by USEPA. Remedial excavations in this area as defined in the ROD are anticipated to be reduced in areal extent to the south and east, given the results of the PDI sampling results that show no exceedances of cleanup levels in those areas. Additional delineation is proposed to refine the limits of impacted soil adjacent to the Sphagnum Bog following excavation and removal of the Landfill. Buried metallic debris at the Landfill, which appears to be small pieces of metal fencing as identified during PDI SSS-4, will be removed as a part of the earthwork activities.

5.4.2.1 Confirmatory Sampling

Confirmatory sampling will be performed within the Landfill excavation footprints to verify that remediation has reduced COCs to EPCs that will achieve compliance with the cleanup levels using the approach described in Section 3.2. A preliminary confirmatory grid is shown on Drawing C-500 included in Appendix A, Attachment A2 of the Phase 1 design report.

5.4.3 Sphagnum Bog Remediation (Sediment)

Remedial excavation of sediment material is currently based on the ROD proposed excavation depth of 2 feet on the southern and western edges of the Sphagnum Bog. The excavation within the Sphagnum Bog will be minimized to protect the sensitive ecosystem, and incudes only the wetland portion at the toe of the Landfill slope and the western boundary of the bog along the toe of slope as shown on the drawings included in Appendix A of the Phase 1 design report.

5.4.3.1 Pre-Excavation Activities

In order to perform excavation of Sphagnum Bog sediments adjacent to the western boundary, the slope descending to the bog will need to have geotechnical improvements to create a safe work surface for excavators. Specifically, timber mats will be placed along the toe of the slope to allow access to the sediment to be excavated using a long-stick excavator. A bench to the slope will be constructed to allow for the removal of the excavated sediment along the western edge of the bog. Details of the timber mats and slope bench are shown on the Contract Drawings. These areas impacted to facilitate the sediment excavation and removal are intended to be constructed with limited tree removal to the extent possible due to the sensitivity of the slope to erosion and the sensitivity of the Sphagnum Bog ecosystem.

5.4.3.2 Confirmatory Sampling

Confirmation sampling will be used to document post-remedial conditions in sediment; however, no additional excavation will be performed in the Sphagnum Bog to minimize damage from construction to the greater ecosystem. Confirmatory sampling locations for the Sphagnum Bog are shown on Drawing C-500 included in Appendix A, Attachment A2 of the Phase 1 design report.

5.4.4 Landfill and Sphagnum Bog Area Restoration

Following remedial excavations, restoration of disturbed Sphagnum Bog and Landfill areas, including grading to maintain slopes and placement of planting material and plantings will be implemented. Restoration would include filling excavated areas with clean soils to return the area to the pre-existing conditions, and applying seed, mulch, and/or soil amendments to restore the disturbed areas. Portions of the bog where sediment is removed will be backfilled with clean material (wetland soil mix) and restored to return wetland areas to pre-remediation conditions, to the maximum extent practicable, as described in the Phase 1 design report. A seed mix and planting schedule are included in the Contract Drawings for the restoration of the wetland and Sphagnum Bog area.

5.5 COOLING POND AND GABION WALL, NORTH PARKING LOT

5.5.1 Cooling Pond Excavations

5.5.1.1 B2 (AOI 2 and AOI 4) Cooling Pond Soil

Exposure Area B2, which comprised portions of AOI 2 and AOI 4, was identified in the ROD as requiring remediation because ILCR and/or HI values determined in the HHRA exceeded acceptable levels as defined by USEPA. The ROD provided estimated depths and cutlines for soil associated with Exposure Area B2. The results of the PDI translated to an expansion of the area requiring remediation of Exposure Area B2 to the south, as well as to an area on the north side of the Cooling Pond where PCBs were detected above 1 mg/kg. Three isolated areas on the western slope of the Cooling Pond, in Exposure Area B1, were also identified for remediation due to uranium detections above 27 mg/kg and/or detections of PCBs above 1 mg/kg.

As shown on Drawing C-405 (Attachment 2, Appendix A of the Phase 1 design report), remedial excavation will generally be focused on the eastern and northern half of the exposure area. This area is planned to be excavated to a depth of up to 12 feet with proposed post-excavation confirmatory samples. Point excavations for shallow uranium and/or PCB impacts will be required in the western half of the area. Additional areas surrounding the Cooling Pond that are outside of the areas requiring remediation, as shown in grey shading in Drawing C-405 (Attachment 2, Appendix A of Phase 1 design report), will be stabilized as described in Section 5.5.3.

At the Gabion Wall, PCB impacts above cleanup levels were detected in samples collected at depth from the deep (>16 feet) direct-push locations and in shallow soil samples collected from the toe of the Gabion Wall. Remedial excavation will extend from the pond footprint north to the Gabion Wall. Additional delineation of PCBs in soil at the Gabion Wall (in the vicinity of location SS-PD-04068) will be performed during remediation.

The excavation cut lines for soil around the Cooling Pond include the southern portion of the pond area that was classified as sediment during the RI (the pond has contracted due to reduction in stormwater flow to the pond). The cut lines are physically limited by the proposed alignment of the HB cutoff wall, and designed to remove soil to reduce the EPCs of COCs to levels that will not exceed the ROD cleanup levels within the top 10 feet bgs using the approach described in Section 3.2. However, the depth of excavation within the former pond footprint is anticipated to be limited by the depth of groundwater, which is approximately 6 to 7 feet bgs, if soil containing uranium or PCBs above bottom RALs still remains at that depth.

5.5.1.2 Sediment Dredge

Sediment (i.e., solid material beneath the current water line) will be dredged to a depth of approximately 3 to 4 feet below current surface in the Cooling Pond as part of the RA. The sediment excavation is intended to mitigate ecological risk. Based on confirmation sampling, the vertical limit of the sediment excavation may be extended an additional 3 feet but will not extend deeper than encountered groundwater. Dewatering of the Cooling Pond will be necessary to facilitate sediment excavations. The pump intake for dewatering will be placed in the northern portion of the Cooling Pond. Additional sumps within the sediment may be required to adequately stabilize the subgrade to adequately excavate to the proposed depth of 3 to 4 feet. Water will be pumped to a Decontamination Effluent Treatment System (DETS) located northwest of the Cooling Pond on the paved area. Treated effluent will be discharged to a septic tank and existing leach fields in the North Parking Lot as described in the Phase 1 design report.

5.5.2 Confirmatory Sampling

Confirmatory sampling will be performed within the remedial excavation footprints to verify that remediation has reduced COCs to EPCs that will achieve compliance with the cleanup levels, using the approach described in Section 3.2. A preliminary confirmatory grid is shown on Drawing C-502 included in Attachment 2, Appendix A of the Phase 1 design report.

5.5.3 Slope Stability and Gabion Wall Repair

Slopes around the Cooling Pond will be cut, regraded, and filled as necessary to facilitate a factor of safety at or above the existing slope stability factor of safety. Soil that that does not require remediation but is removed from areas in order to create slope stability will be disposed off Site.

As part of the slope stabilization work, lower portions of the Gabion Wall will be adjusted to facilitate the reduction of slope grade as detailed in Drawings C-406 and C-407 of Attachment 2, Appendix A of the Phase 1 design report. Gabion Baskets may be removed to facilitate excavation at the toe of the slope and to implement slope stability improvements. In the event Gabion Baskets cannot be reused after removal, riprap from the baskets may be reused on Site (either in new baskets or independently) as necessary and applicable.

Adjustments to the top of the Gabion Wall, the area of the wall reached from the North Parking Lot, will be completed in conjunction with North Parking Lot work and not as part of the Cooling Pond RA.

5.5.4 Soil and Sediment Restoration

After remediation, soil excavations within the Cooling Pond area will be backfilled with sand borrow as defined in the Earthwork specification (31 00 00). Areas where sediment was dredged will be backfilled with the sand borrow within the pond area with riprap and Gabion Baskets on the banks adjacent to deeper excavation areas. The toe of the existing slopes will be stabilized with geotextile, crushed stone, and either riprap or Gabion Baskets as shown on the Contract Drawings. The proposed grading of the side slope will be at a 2:1 slope, with loam and seed above the riprap or Gabion Basket toe.

5.5.5 Final Drainage Improvements

Abandonment of existing North Parking Lot septic system will be completed after remediation is completed in the Cooling Pond, Sphagnum Bog areas, and Landfill, as the septic system will be used as part of the proposed construction DETS for those activities. Abandonment will be completed with North Parking Lot activities and will include removal of existing pavement, septic system structures if necessary, backfilling and regrading of excavated areas, and restoration for use as open space.

Installation of drainage improvements to facilitate Site stormwater management following remedial excavations will be completed. Improvements include change of surficial flow/runoff patterns for discharge to the Cooling Pond. Based on the performance of the septic system for infiltration of treated water from the DETS, the system may be able to function as a Best Management Practice (BMP) stormwater management system for future reuse.

6. Quality Assurance Documentation

The following sections present minimum requirements of the CQA monitoring and testing documentation program to be performed by the EOR in conjunction with the RA. This monitoring and testing program is intended to supplement the QC requirements of the Technical Specifications. Changes to the Contract Drawings and Technical Specifications must be favorably reviewed by the Remedial Designer.

6.1 HEALTH AND SAFETY

While the health and safety of on-Site personnel is not the responsibility of the EOR, the EOR will be an active participant in the Site safety program that is to be established by the RAC in accordance with the Technical Specifications. The QAO will alert the Site Safety Officer (SSO) or other personnel if the QAO observes an unsafe condition or near-miss so that the SSO can address the condition or behavior. The 100% RD and its supporting deliverables, including this CQA/QCP, provide the details of how the SDs will demonstrate to USEPA that PS, cleanup levels, and/or ARAR requirements will be met. During the RA, pre-construction, qualifying, and conformance testing of imported materials; confirmatory and verification sampling; and verification of cover thicknesses will be the primary methods to demonstrate that 100% RD requirements have been met.

6.2 FENCE LINE/WORK AREA PERIMETER MONITORING

The Engineer will monitor air quality at the fence line/work area perimeter as described in the RAWP, including all soil excavationsand sediment excavation activities.

In no instance shall the airborne dust levels at any location on the perimeter surrounding the limits of Work exceed the lower of 150 micrograms per cubic meter (µg/m^3) measured as particulate matter with a diameter less than or equal to 10 microns (PM_{10}) as defined by 310 Code of Massachusetts Regulations (CMR) 6.04 and the values provided in the Table 6-1 below (presented by Work Area). It is anticipated that MIE Data RAM Portable Real-Time Aerosol Monitor or an equivalent instrument will be used to monitor the perimeter air to determine dust levels during construction activities. Based on the available soil and sediment quality data and an evaluation of exposure scenarios, the action levels for dust at the perimeter of the RA work areas are as follows, and when implemented will ensure that receptors outside of the fence line will not experience unacceptable exposures or risks:

Table 6-1
Perimeter Dust Thresholds by Work Area

Work Area	Dust*
• Holding Basin Area (Earthwork and Containment Wall Construction)	130 µg/m^3
• AOI-8 and 9 • Courtyard, Landfill, Cooling Pond, and Sediment	150 µg/m^{3**}

Notes:
** Dust levels at the downwind location are "corrected" by subtracting the upwind dust levels, which represents background ambient air quality, with comparison to the noted criteria. The Contractor shall implement active dust control measures before the dust action level in this table is exceeded. The value in this table represents a stop work threshold that, once exceeded, dust generating activities must stop pending the Contractor's resolution of work practices and dust*

control measures. Work may continue when the work practices and dust control is corrected to the satisfaction of the SD Representative and Engineer.
*** This value represents USEPA's National Ambient Air Quality Standard (NAAQS) for particulates (PM_{10}) and, consequently, dust levels cannot exceed this value during the remedial activities (i.e., the 150 µg/m^3 value is a ceiling dust concentration).*

The SDs Representative or Engineer will conduct continuous quantitative dust monitoring at selected upwind and downwind locations (total of two) to monitor effectiveness of the Contractor's dust control measures for the duration of the earthwork operations. Such quantitative dust monitoring will be conducted during the normal eight-hour workday, except during wet weather, moist ground conditions, or when construction activities and traffic on exposed ground surfaces are limited such that visible nuisance dust conditions are not evident. The location of the dust monitoring stations will be coordinated with the Contractor. Additional dust monitoring may be required in connection with the Contractor's HASP.

Standard operating procedures (SOPs) and the HASP include instrumentation calibration requirements, a description of the monitoring requirements, and the corresponding action levels. At a minimum, perimeter monitoring stations will be located upwind and downwind of each work area.

6.3 DUST AND ODOR CONTROL

Mitigation of dust and odor will be performed in accordance with Technical Specification Section 01 57 19 – Temporary Environmental Controls. The QAO will periodically check during intrusive activities involving soil, sediment and/or waste movement that the RAC is actively monitoring for fugitive dust and vapors in the work area and at the Site perimeter and that the RAC is implementing appropriate and effective dust and odor control measures. The QAO will immediately report observations of visible dust or detection of noticeable odors at the Site perimeter to the EOR and the RAC. The QAO will monitor the area after the RAC implements dust and/or odor control measures to confirm the effectiveness of the measures. Mitigation measures will be implemented to reduce perimeter dust if the action level is approached for any remedial area. The following measures will be implemented as necessary:

1. Wet suppression shall be used to provide temporary control of dust. Several applications per day may be necessary to control dust, depending upon meteorological conditions and work activity. The Contractor shall apply we suppression on a routine basis, as necessary or directed by the Engineer, to control dust.
2. The wet suppression equipment shall consist of sprinkler pipelines, tanks, tank trucks, or other devises capable of providing regulated flow, uniform spray, and positive shut-off. During freezing temperatures, calcium chloride shall be used for dust suppression if necessary.

The Contractor is responsible for performing dust monitoring for worker protection in accordance with the Technical Specification Section 01 35 29 – Health and Safety.

6.4 INSPECTIONS

6.4.1 Periodic

USEPA, its representative, and MassDEP will conduct periodic inspections, and may have a daily on-Site presence at key phases during the Work. At USEPA or MassDEP's request, the Supervising Contractor or other designee shall accompany USEPA, its representative, and MassDEP during inspections.

6.4.2 RA Completion

The RA is "Complete" for purposes of the SOW when it has been fully performed and the PSs have been achieved. The SDs shall schedule an inspection for the purpose of obtaining USEPA's Certification of RA Completion. The inspection must be attended by the SDs, USEPA, MassDEP, and/or their representatives.

6.5 SAMPLING AND TESTING

Sampling and testing of materials and testing of in-progress and completed work will be completed on an ongoing basis during the project following methods described herein and in the Technical Specifications.

6.5.1 Visual Observations

Visual observations of the RAC's work will be completed on an ongoing basis during the project with observations reported in daily reports, which will include photographs.

6.5.2 Excavation and Earthworks

The earthworks CQA program consists of verifying the RAC is providing approved materials and placing materials to the thicknesses as required by the Contract Drawings, confirming that the RAC is compacting materials as required in the Technical Specifications, and confirming the RAC is performing and recording the required field QC tests and that the results meet the Technical Specifications.

The RAC will provide analytical and geotechnical laboratory test data for imported materials, such as grading fill, bedding soil, protective cover soil, vegetative support layer, and aggregates in compliance with the requirementsof the Technical Specifications. Test methods are provided in the FSP. The EOR will review and approve these data provided through the submittal process for compliance with the requirements of the Technical Specifications.

The EOR will also review borrow source use and history and supporting documentation provided by the RAC as part of the review process. Materials will only be accepted for use at the Site after favorable review by the EOR.

The EOR/QAO will obtain one pre-construction sample (per source) of the materials listed below at the source or from the Contractor and will, during the RA, obtain samples of earthen materials at the source or upon delivery to the Site at the frequencies indicated in Section 5.1.5 above.

6.5.3 Field Evaluation/Construction Monitoring of Earthwork

During construction, the QAO will confirm that the RAC is verifying the thickness of the various cap components, either by completion of a topographic survey or by direct measurement, as required by the Technical Specifications.

The QAO may also verify thicknesses using manual means (e.g., digging shallow test pits or using a hand probe) but that shall not relieve the RAC of its responsibilities to perform QC measurements required by the Technical Specifications. The QAO will also confirm that the RAC is meeting the performance requirements for material placement based on visual observations and confirm that the RAC is conducting in-place density and moisture content tests as required by the Technical Specifications. In addition to the RAC's tests, the QAO may also perform in-place density and moisture content tests as independent verification. In-place density testing performed by the QAO shall not relieve the RAC of its responsibilities to perform the QC tests required by the Technical Specifications.

Earthwork will be monitored by the QAO to confirm and document that the construction is performed in general accordance with the Remedial Design, Contract Drawings, and Technical Specifications. The QAO will identify inadequate construction methodologies or materials that may adversely impact the performance of the remedy orexisting features and facilities. The RAC will be responsible for establishing the design lines and grades.

Surveying by the RAC, as appropriate throughout the construction process, will be conducted and submitted forreview by the EOR and QAO to evaluate whether the materials are placed to the lines and grades shown on the Contract Documents.

Monitoring the construction work for the placement of grading fill, bedding soil layer, protective cover soil layer, access roads, and stormwater management system will include the following:

- Monitoring the thickness of lifts as loosely placed and as compacted;
- Documenting the construction equipment used to place and compact the material;
- Observing the action of the compaction and heavy hauling equipment on the construction surface (i.e., penetration, cracking, etc.) to detect inadequate compaction;
- Verifying that proper equipment and methods are used to place soil or stone over geosynthetic components of the final cover system, and that wrinkles or excess tensile stresses to underlying geosynthetics are minimized;
- Monitoring material placement techniques to verify that the underlying materials are not damaged;
- Observing installation of gas management system and stormwater management system components; and
- Verifying that only low-ground pressure equipment traverses over geosynthetics unless the approved thickness of protective soil is first placed.

6.5.4 Routine Field Testing

Field testing (i.e., density and moisture content testing and thickness verification) of the placed/ compacted soil layer will be performed by the EOR during construction to evaluate the RAC's work product with respect to the requirements of the Technical Specifications. The test methods and frequencies for CQA field testing are given in Technical Specification Section 31 00 00 – Earthwork. Sampling and test locations will be selected by the EOR. In-situ moisture/density testing will be performed primarily using a nuclear gauge in accordance with ASTM D 6938. The EOR will verify that the in-place thicknesses of the cap bedding layer, protective cover layer, and vegetative support layer and soil placed in the floodplain areas are as specified on the Contract Drawings. This will be done by carefully hand-excavating test pits (holes) approximately 100 feet on-center.

6.5.5 Special Testing

A special testing frequency will be used at the discretion of the EOR when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the lift thickness is greater than specified
- the material is at improper and/or highly variable moisture content
- fewer than the specified number of compactor passes are made
- the fill materials differ substantially from those specified
- the degree of compaction is doubtful
- as directed by the EOR.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions
- breakdown of equipment
- at the start and finish of grading
- if the material fails to meet specification requirements
- the work area is reduced.

6.6 SEDIMENT DREDGING/EXCAVATION

6.6.1 Field Evaluation/Construction Monitoring

The removal of sediment will be completed to the elevations indicated on the Contract Drawings. The QAO will periodically (at least daily) review the output (either on-screen in the cab of the dredging/ excavation equipment or, in an electronic file or hard copy provided by the RAC, or by other means acceptable to the QAO) from the excavator-mounted guidance system to confirm the target excavation elevations shown on the Contract Drawings or indicated in the Technical Specifications have been achieved. If a pond is dry at the time the work is completed, the QAO may view grade stakes established by the RAC to confirm target dredge/excavation depths have been achieved.

The RAC will provide a final dredge/excavation plan for review by the EOR. The EOR will compare this plan to the required dredge/excavation shown on the Contract Drawings and/or indicated in the Technical Specifications. If the EOR discovers that the target dredge/excavation depth has not been achieved, the EOR will notify the RAC of the need to continue dredging/excavating in order to meet the requirements of the RD. The EOR will check the expanded excavation documentation for conformance with the RD.

6.7 COMPLIANCE WITH CLEANUP OBJECTIVES PROCESS AND EXAMPLES

In accordance with the process described in Section 3, confirmatory soil sampling data will be evaluated by: A) comparing confirmatory soil sample analytical results for individual samples to the RALs to determine if the remediation has achieved its objectives or if additional excavation is required; B) conducting final verification sampling; and C) calculating final residual EPCs that incorporate the RI, PDI, and confirmatory/verification sampling data, along with EPCs for clean backfill soil and soil volumes, to determine if cleanup objectives have been met for each of the exposure areas. In addition, total residual risk for all COCs and COPCs in soil remaining within the exposure area will be calculated.

This section provides details of the evaluation approach for each of the excavation areas using AOI 8 and AOI 9 as examples. Section 6.8 provides the key aspects of this process that are specific to the evaluation of confirmatory soil and sediment samples at the other areas of the Site.

6.7.1 Confirmatory Sample Data Evaluation

The confirmatory sampling plan for each of the excavation areas is provided in Section 5. As described in Section 3, confirmatory soil samples analyzed for uranium in the on-Site laboratory will be compared to RALs for uranium. Confirmatory soil samples with concentrations above RALs will be indicative of areas that require additional excavation. In areas requiring additional excavation, the excavations will advance, and new confirmatory samples will be collected and compared to the RALs. The process will be repeated until the confirmatory sampling results do not exceed RALs.

Once all confirmatory soil samples meet the uranium RALs, the confirmatory samples will be submitted for analysis of PCBs and the PAH COCs at an off-Site laboratory. Analytical data for PCBs will be compared to the RALs. Confirmatory soil samples with concentrations above RALs will be indicative of areas that require additional excavation. In areas requiring additional excavation, the excavations will advance, and new confirmatory samples will be collected, analyzed, and compared to RALs. The process will be repeated until the confirmatory sampling results do not exceed RALs. Confirmatory sample locations and excavation cutlines will be documented after each sampling round throughout the process via electronic survey collection.

Confirmatory soil sample analytical results for PAHs will be compared to the ROD cleanup levels. If PAHs are detected in confirmatory soil samples at concentrations above the cleanup levels, then the 95% UCL concentrations of the samples representative of the soils remaining in the exposure area (confirmatory, PDI, and RI samples) will be calculated and compared to the cleanup levels. If the 95% UCL concentrations are below cleanup levels, the excavation will be considered complete. If the 95% UCL concentrations are above the cleanup levels, then areas requiring further excavation to reduce the 95% UCL concentration will be identified, excavation advanced, and the process of collecting, analyzing, and evaluating confirmatory soil samples repeated until the 95% UCL concentrations of PAHs do not exceed the cleanup levels.

Once it has been confirmed that confirmatory soil samples do not exceed RALs for uranium and PCBs, and that residual EPCs for PAHs will be compliant with cleanup levels, verification samples will be collected. The verification samples will be used to provide analytical data for uranium that is of suitable quality for validation. Because arsenic and thorium are analyzed using the same analytical methods as uranium, the confirmatory sampling data for arsenic and thorium will be represented by the verification samples. Since a larger sampling grid will be used for verification samples, the number of validated analytical results for uranium, arsenic, and thorium that represent soil conditions in the final excavation footprint will be approximately half the number for PCBs and PAHs. However, the on-Site laboratory analysis of uranium in the confirmatory samples, combined with use of the RALs to guide the excavation, will provide confidence that uranium has been reduced to concentrations that meet the cleanup objectives. Since arsenic and thorium are present due to naturally occurring background conditions, fewer samples are required to demonstrate compliance with the cleanup levels.

6.7.2 Remedial Action Levels

RALs have been identified for each of the excavation areas and are specific to the excavation bottoms and sidewalls. Attachment C-1 provides documentation to support the derivation of the RALs. In summary:

- RALs for PCBs are 1 mg/kg for excavation bottom and sidewalls at each of the excavation areas. This RAL ensures that no residual concentrations of PCBs will exceed the ROD cleanup level within the excavation areas.
- Excavation sidewall RALs for uranium were identified by considering the uranium concentrations in soil that abuts the exposure area. More specifically, sidewall RALs were identified by reviewing the analytical data for the soil samples collected outside of the excavation boundary. Generally, the samples nearest to the excavation boundaries were reviewed, but when several samples were located near each other outside of the excavation boundaries, all samples were reviewed. The width of the areas represented by these samples ranged from approximately 50 feet to approximately 200 feet. This approach is necessary to avoid unnecessarily expanding remedial excavations into areas where risks were within risk management goals established by USEPA and remediation was therefore not required by the ROD. The sidewall RALs are used to guide horizontal excavation.
- Excavation bottom RALs for uranium were identified by considering the highest concentrations of uranium remaining in soils deeper than (beneath) the excavation cut lines. The bottom RALs are used to guide vertical excavation.

Sidewall and bottom RALs for uranium for each excavation area are summarized in Table C-1; their development is documented in Attachment C-1.

The RALs were tested to verify that if confirmatory soil samples contain uranium concentrations equal to the RALs, compliance with the cleanup objectives can be demonstrated (Attachment C-1).

6.7.3 Exposure Areas

Exposure areas that are used to demonstrate compliance with cleanup levels are shown in the figures provided for each excavation area, with an explanatory rationale provided below:

- AOI 8: The exposure area is the same as the original exposure area evaluated in the HHRA (Exposure Area A5). As shown in Figure C-6, the excavation will be performed in a large portion of the exposure area. Nearly all of 77 soil samples that are anticipated to remain in the exposure area after remediation are associated with uranium concentrations below 4 mg/kg (average 2.2 mg/kg; refer to COPC summary tables in Attachment C-1). Four of the soil samples are associated with uranium concentration between 7.5 and 10.7 mg/kg. Those four samples are dispersed throughout the exposure area and not clustered together in a particular portion of the exposure area. This indicates that if the exposure area was divided into smaller areas (e.g., half-acre areas), the EPCs for each area would not substantially differ from each other. Therefore, segregation of the original HHRA exposure area (Exposure Area A5) into smaller sub-areas is not necessary to evaluate compliance with cleanup levels for AOI 8.
- AOI 9: The exposure area is the same as the original exposure area evaluated in the HHRA (Exposure Area A4). As shown in Figure C-7, the excavation will be performed in a small portion of the exposure area. All but one of the 17 soil samples that are anticipated to remain in the

exposure area after remediation are associated with uranium concentrations below the cleanup level, with one sample only marginally higher than the cleanup level (2.8 mg/kg; average 1.8 mg/kg). This indicates that if the exposure area was divided into smaller areas (e.g., half-acre areas), the EPCs for each area would not substantially differ from each other. Therefore, segregation of the original HHRA exposure area (Exposure Area A4) into smaller sub-areas is not necessary to evaluate compliance with cleanup levels for AOI 9.

6.7.4 Final Residual EPCs

The final residual EPCs are calculated using the equation provided in Section 3.5 with the residual EPCs for soil remaining in the exposure area, the residual volume of soil remaining at the exposure area, and the EPC and volume of clean backfill material used to fill the excavation area.

6.7.4.1 Residual EPCs

The analytical data for the RI, PDI, and confirmatory/verification soil samples representative of soil that remains in the exposure area will be used to calculate EPCs. EPCs will be based on the lesser of the 95% UCL and maximum detected concentrations. The 95% UCLs will be calculated using USEPA ProUCL (version 5.2.0) software and will be presented for all COCs. More specifically, EPCs will be calculated using the following sources of data:

- PCBs and PAHs: RI and PDI samples that remain within the exposure area, and validated confirmatory bottom samples analyzed by the off-Site laboratory.
- Uranium, arsenic, and thorium: RI and PDI samples that remain within the exposure area, and validated verification bottom samples analyzed by the off-Site laboratory.

Residual EPCs calculated using the RALs as substitutions for the actual confirmatory bottom sample data are provided for uranium at each investigation area in Table C-2 to illustrate how the calculation is applied to evaluating compliance with cleanup goals, and to demonstrate that confirmatory sampling results that meet the RALs will result in final residual EPCs that meet the cleanup levels. Attachment C-1 provides documentation of the EPC calculations. As shown in Table C-2, residual EPCs are provided for soil beneath the excavation and soil throughout the exposure area.

During the implementation of the remedial activities, the EPC calculations will be updated to use the actual confirmatory sampling data for PCBs and verification sampling data for uranium, in place of the RALs. In addition, calculations will be completed for the other COCs using confirmatory sampling data for PAHs and verification sampling data for arsenic and thorium. Since many of the confirmatory and verification sampling results are expected to be lower than the RALs, residual EPCs are anticipated to be lower than the values shown in Table C-2.

6.7.4.2 Residual Volume

The volume of soil that is anticipated to remain in each of the exposure areas is calculated using the design software based on the existing cut lines. The soil volumes are calculated by using the depth of the deepest sample that will remain beneath the excavation or within the exposure area (outside of the design cut lines). For sample locations where soil at the deepest sampling interval is proposed to be excavated, the depth interval associated with the deepest sample is used to represent the volume of soil that will remain beneath the excavation.

For example:

- if soil 0 to 1 foot bgs at a given location is proposed to be excavated, and 1 to 2 feet bgs and 2 tp 3 feet bgs samples remain, then the 1- to 2- and 2- to 3-foot sampling intervals are used to represent the volume of soil that will remain beneath the excavation at that location;
- if soil 0 to 1 foot bgs, 1 to 2 feet bgs, and 2 to 3 feet bgs at a given location is proposed to be excavated, and no samples deeper than 3 feet bgs have been collected, then the 2- to 3-foot sampling interval is used as a proxy to represent the volume of soil that will remain beneath the excavation at that location;
- if soil 0 to 1 foot bgs, 2 to 4 feet bgs, and 6 to 8 feet bgs at a given location will remain within an exposure area, then soil to 8 feet bgs is used to represent the volume of soil that remains at that location.

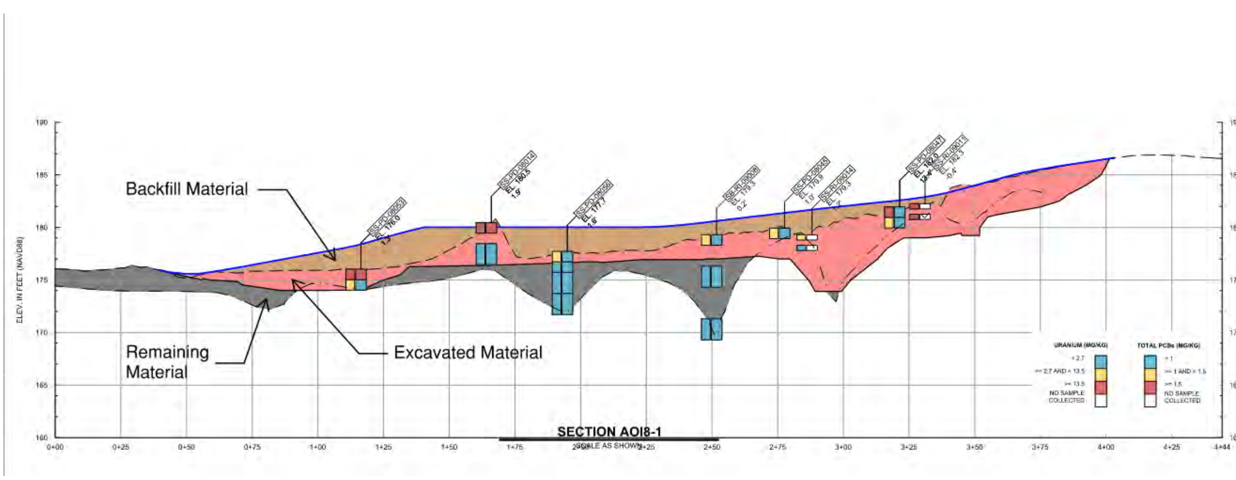
The design software interpolates between sample locations to calculate the volume of soil that remains outside of the design cut lines within the exposure area.

The residual volumes of remaining soil based on the design cut lines are provided in Table C-2. The residual volumes will be updated to reflect final excavation boundaries when the remedial activities are conducted.

6.7.4.3 Backfill Volume and EPC

The estimated volumes of clean backfill soil are provided in the Phase 1 design report and are provided in Table C-2. EPCs for each COC in backfill soil will be derived as the lesser of the maximum detected concentration and 95% UCL of samples used to verify the suitability of the soil as backfill material. The clean backfill EPCs provided in Table C-2 are based on the background concentration of uranium and one-half the detection limit for PCBs, to illustrate how the calculation is applied to evaluating compliance with cleanup goals. During the implementation of the remedial activities, the actual EPCs for clean backfill material based on backfill material testing will be used for the compliance evaluation.

The following figure illustrates how the residual volume and backfill volume is calculated, using a cross section from AOI 8 as an example.



HALEY ALDRICH

In this figure, soil represented by the gray coloring is soil that will remain beneath the excavation and within the exposure area (volume of soil remaining). Soil that is pink in coloring is soil that will be removed during the remedial excavation. That soil will be replaced by clean backfill material. Soil that is tan in coloring represents additional backfill material that is required to restore grades to achieve proper drainage within the excavation area. The volume of soil represented by the pink and tan coloring represents the volume of clean backfill. If an additional volume of clean backfill soil is required to achieve grading beyond the original grade (e.g., grading to support a specific attribute or use of the land), then the additional volume fill may be excluded from the volume-weighted EPC calculations.

6.7.5 Comparison of Final Residual EPCs to Cleanup Objectives

The final residual EPCs will be compared to the ROD cleanup levels. As shown in Table C-2, final residual EPCs for uranium and PCBs, assuming that all bottom confirmatory soil samples have PCB and uranium concentrations equal to the bottom RALs, are below the cleanup goals. This demonstrates that the using the RALs to guide excavation activities will provide a high level of confidence that the cleanup goals will be met.

During the implementation of the remedial activities, EPCs for PCBs and uranium will be updated with the confirmatory and verification sampling data, and final residual EPC calculations will be completed for the remainder of the COCs.

The evaluation will be documented in the Completion Report.

6.7.6 Residual Risk Analysis

Residual risks for the COCs and the COPCs in soil that will remain outside of the excavation boundary and within the exposure area will be calculated using the final residual EPCs to derive ILCR and HI values. Residual risks among all COCs and COPCs will then be summed to derive cumulative residual risks for each exposure area. The residual risks will be used to: A) identify the anticipated ILCR and HI values that will remain at the Site for each excavation scenario; and B) evaluate the risk reduction achieved through the remedial action.

Residual risks are presented as total risks inclusive of all COCs, total risks for the additional COPCs, total risks for the COCs and COPCs combined, and total incremental risks for the COCs. The incremental risks exclude risk contributions from arsenic and thorium because the risks for those two COCs are representative of naturally occurring background conditions.

Reduction in ILCR and HI values is provided for each exposure area by comparing the risks presented in the HHRA to the residual risks associated with the final residual EPCs.

Attachment C-1 provides documentation of the residual risk calculations. Residual risks are discussed below.

6.7.6.1 AOI 8

Residual risks are provided in Table C-3:

- Total residual risks for the excavation area (alone) and the entire exposure area are nearly identical to each other.

- Total residual cancer risk is estimated to be an ILCR of approximately 8E-05, but incremental residual ILCR is estimated to be 2E-06. These represent risk reductions of approximately 58% (total risk) and 98% (incremental risk).
- Total residual HI is 0.3 and the incremental HI is 0.2. These represent risk reductions of approximately 98%.
- Other COPCs contribute insignificant total risks, with an ILCR of approximately 5E-10 and HI values of approximately 0.5.
- Cumulative HI values for COCs and COPCs are below a HI of 1, with the HQs for COPCs contributing approximately twice as much to the HI as the COCs.

Arsenic and thorium were demonstrated to be a background condition in the HHRA, and USEPA established cleanup levels for those two COCs based on background concentrations. Although risks for arsenic are lower in the post-remediation dataset, the observation that residual EPCs and risks for thorium (the predominant risk contributor among arsenic and thorium) are consistent with those provided in the HHRA provides additional evidence that those constituents are a background condition. Consequently, remediation of soil is not necessarily expected to reduce the risk contribution from arsenic and thorium. As shown in Table C-3, however, residual EPCs for arsenic and thorium are below the cleanup levels for all excavation scenarios.

6.7.6.2 AOI 9

Residual risks are provided in Table C-4:

- Total residual risks for the excavation area (alone) and the entire exposure area are nearly identical to each other.
- Total residual cancer risk is estimated to be an ILCR of approximately 8E-05, but incremental residual ILCR is estimated to be 2E-06. These represent risk reductions of approximately 25% (total risk) and 92% (incremental risk).
- Total residual HI is 0.4 and the incremental HI is 0.2. These represent risk reductions of approximately 91%.
- Other COPCs contribute insignificant total risks, with an ILCR of approximately 5E-10 and HI values of approximately 0.4.
- Cumulative HI values for COCs and COPCs are below a HI of 1, with the HQs for COPCs contributing approximately as much to the HI as the COCs.

Arsenic and thorium were demonstrated to be a background condition in the HHRA, and USEPA established cleanup levels for those two COCs based on background concentrations. Although risks for arsenic are lower in the post-remediation dataset, the observation that residual EPCs and risks for thorium (the predominant risk contributor among arsenic and thorium) are consistent with those provided in the HHRA provides additional evidence that these constituents are a background condition. Consequently, remediation of soil is not necessarily expected to reduce risk contribution from arsenic and thorium. However, as shown in Table C-4, residual EPCs for arsenic and thorium are below the cleanup levels for all excavation scenarios.

6.8 COMPLIANCE WITH CLEANUP OBJECTIVES BY AREA

The general approach described in Section 6.7 will be used for the other areas of soil remediation. Some modifications to the approach, based on observations from the remediation of AOI 8 and AOI 9, will be included and are described in Section 6.8.1.

The approach described in Section 6.7 illustrates how the identification of exposure areas, RALs, confirmatory and verification sampling, exposure areas, and fill volumes are used to calculate residual EPCs and evaluate risk reduction. Although these aspects of the overall demonstration of compliance will be used for the other areas of soil remediation, only the information that required to support decision-making for evaluating confirmatory samples is described in this section. These include:

- Identification of the exposure areas that will be used to evaluate compliance with cleanup levels;
- Identification of bottom and sidewall RALs; and
- Calculation of residual EPCs that are based on the soil estimated to remain at the exposure areas and bottom RALs, to demonstrate that the excavation will achieve the cleanup levels.

6.8.1 Modifications to Evaluation of Confirmatory Samples

Based on observations and evaluation of confirmatory sampling data from the AOI 8 and AOI 9 excavations, some modifications to the process that is used to evaluate compliance with cleanup goals will be implemented.

- RALs will be derived for uranium only. The RALs for PCBs are 1 mg/kg for bottom and sidewalls and therefore do not require determination for each of the excavation areas.
- RALs for uranium will be calculated using the number of bottom samples associated with the verification sampling grid.
- Uranium that is reported at concentrations slightly above the RALs using the on-Site laboratory may be further evaluated by adjusting the concentrations to represent the anticipated analytical results from the off-Site laboratory (GEL), to help evaluate if further excavation is required. Attachment C-2 provides the correlation analysis and observations from review of 325 paired on-Site and GEL laboratory results for uranium. Overall, higher uranium concentrations were reported by the on-Site laboratory than by GEL. For the range of uranium concentrations that are of greatest interest for evaluating compliance with RALs (e.g., approximately 2.7 to 8 mg/kg), the ratio of on-Site uranium result to GEL uranium result is 1.28 for AOI 8 and 1.17 for AOI 9. Using the regression of on-Site and off-Site laboratory data from AOI 8, the GEL analytical result can be predicted from the on-Site laboratory data using the following equation: *GEL result = 0.8876 X on-Site result + 0.0006*. The uranium concentrations that are predicted from this equation are, on average, 1.24 times higher than the GEL reported concentrations.

6.8.2 Enabling Phase

No compliance evaluation is required for Enabling Phase work.

6.8.3 AOI 8 and AOI 9

The exposure areas, RALs and projected residual EPCs for AOI 8 and AOI 9 are presented in Section 6.7.

6.8.4 Courtyard

The Courtyard requires remediation due to risks calculated in the HHRA that were above an ILCR of 1E-04 and a HI of 1. The exposure area that will be used to evaluate compliance with cleanup levels is the excavation boundary as shown by the confirmatory sampling grid in Drawing C-501 included in Appendix A of the Phase 1 design report. The volume of soil remaining in the exposure area is calculated by multiplying the area of the exposure area (area of excavation) by 10 feet (10-foot depth) and then subtracting the volume of soil planned to be excavated. The volume of fill is calculated based on the anticipated grading design for the Courtyard.

The excavation boundary is defined by physical limits:

- Building slabs on the west and south side;
- The HB wall alignment on the southeast side;
- The top of slope descending to the Cooling Pond area in the northeast side; excavations required on the slope are a component of the Cooling Pond area remediation; and
- The excavation boundary on the north side, which is parallel to the north side of Building E; excavations required to the north of this area will be addressed as a component of the building slabs and outside area excavation.

Sidewall RALs for uranium are based on the highest concentrations at the edge of the top portion of the slope that descends to the Cooling Pond. The samples are listed in Attachment C-3 and as shown on Figure C-402 in Attachment A, they are located approximately 30 to 50 feet from the edge of the excavation. Bottom RALs for uranium are provided in Attachment C-3. Projected remaining soil volume, fill volume, and residual EPCs are provided in Attachment C-3.

6.8.5 Landfill and Sphagnum Bog

6.8.5.1 Landfill

The Landfill requires remediation due to buried debris within it; risks calculated in the HHRA were below an ILCR of 1E-04 and a HI of 1. The objective of the remediation is to remove debris and soil containing uranium and PCBs above the cleanup levels. The focus on the PDI was filling data gaps on the extent of soils with COCs above cleanup levels within the soils in the northern portion of the Landfill where elevated COC concentrations had been identified in the RI.

The exposure area that will be used to evaluate compliance with cleanup levels is the excavation boundary as shown by the confirmatory sampling grid in Drawing C-500 included in Appendix A of the Phase 1 design report. The volume of soil remaining in the exposure area is calculated by multiplying the area of the exposure area (area of excavation) by 10 feet (10-foot depth), and then subtracting the volume of soil planned to be excavated. The volume of fill is calculated based on the anticipated grading design for the Landfill area.

Uranium concentrations in soil samples collected from outside of the Landfill area range from 3.5 mg/kg (SB-RI-01018) to 9.6 mg/kg (SS-RI-14043). These uranium concentrations are similar to the concentrations reported within the proposed excavation that are nearest to the excavation boundary (2.9 mg/kg in SB-RI-03016 to 9.6 mg/kg in SB-RI-03018). Uranium concentrations are the highest in the north-central and northwestern portions of the Landfill area and decrease on the east side of the excavation area. The sidewall RAL is based on the highest uranium concentration in soils outside of the Landfill area, which is consistent with the highest concentration of uranium in soils within the excavation area, nearest the excavation boundary (9.6 mg/kg). The samples are listed in Attachment C-4 and as shown on Figure C-400 in Attachment A, they are located approximately 10 to 150 feet from the edge of the excavation.

The toe of the Landfill slope will be established as part of the sediment excavation of the wetland excavation. Depending on sequence of construction, temporary berms and erosion controls may be necessary to protect the Sphagnum Bog and the sensitive ecological resource.

Bottom and sidewalls for uranium are provided in Attachment C-4. Projected remaining soil volume, fill volume, and residual EPCs are provided in Attachment C-4.

6.8.5.2 Sphagnum Bog

The remediation area for the Sphagnum Bog was identified in the ROD based on the area of sediment at the toe of the southern and western edges that contains COCs above the Sphagnum Bog sediment cleanup levels (Section 3). Further remediation of bog sediments to a depth of greater than 2 feet within the Sphagnum Bog or to areas beyond the defined areas is deemed to pose a greater risk to the environment through potential destruction of the bog than from potential exposures to residual COCs. Therefore, although confirmatory sediment samples will be collected from the remediation footprint of the bog to document post-remedial conditions, the remediation will not be expanded if residual concentrations are above cleanup levels. Therefore, no RALs are required for the Sphagnum Bog. In addition, the Sphagnum Bog sediment will be restored approximately to existing grade using clean imported material. This will eliminate exposure pathways to sediment that remains at the base of the excavation.

6.8.6 Cooling Pond

6.8.6.1 Soil

The results of the HHRA demonstrated that Exposure Area B2 posed a risk above an ILCR of 1E-04 and above a HI of 1. This area was therefore identified as a remediation excavation area in the ROD. Exposure Area B-1 surrounds Exposure Area B2 and includes the portion of the Site adjacent to the west side of the Sphagnum Bog and substantial portion of the Landfill. Exposure Area B-1 was associated with risks that did not exceed an ILCR of 1E-04 or a HI of 1 (the incremental cancer risk that did not include naturally occurring arsenic and thorium was 2E-05).

Results of PDI sampling refined the remedial limits of Exposure Area B2 to the south and southeast of the pond and identified additional areas of PCBs above 1 mg/kg in soil at the north end of the pond, as well as two locations on the western slope of the pond. In addition, a portion of the original Cooling Pond footprint that was characterized as sediment in the RI/FS is now soil (due to contraction of the pond in the absence of stormwater runoff). Consequently, the area of remediation has been expanded to include those areas. Remediation of the Landfill is separate from remediation of the Cooling Pond area, and additional remediation will occur in soils adjacent to the Sphagnum Bog as a component of creating platforms to facilitate sediment remediation in the bog.

Therefore, the exposure area for soils surrounding the Cooling Pond includes the boundaries of Exposure Area B-2, expanded to the north and on small areas of the western slope to capture PCBs detected above 1 mg/kg and uranium detected above 27 mg/kg, as shown by the confirmatory sampling grid in Drawing C-502 included in Attachment 2, Appendix A of the Phase 1 design report. In addition, former pond bottom sediment that is now soil is included in the soil remediation area. The volume of soil remaining in the exposure area is calculated by multiplying the area of the exposure area by 10 feet (10-foot depth) and then subtracting the volume of soil planned to be excavated. The volume of fill is calculated based on the anticipated grading design for the Cooling Pond area. If groundwater is encountered at depth shallower than 10 feet below ground surface, then the excavation will not advance into the groundwater table (as defined and noted on Drawing C-408 in Attachment A2 of the Phase 1 design report). Therefore, the volume of soil remaining will be reduced by the depth that extends into the groundwater table. If less volume of soil is determined to remain at the Site based on depth to groundwater, then the RAL calculation (which assumed a depth of 10 feet) is conservative because less soil remaining would result in a lower volume-weighting of the soil remaining in place.

Sidewall RALs are based on the highest uranium concentration detected in soils bordering the excavation area, including soils on the western slope and soils adjacent to the eastern excavation cut that are within the grey-shaded areas shown on Figure C-405 in Attachment A. Bottom and sidewall RALs for uranium are provided in Attachment C-5. Projected remaining soil volume, fill volume, and residual EPCs are provided in Attachment C-5.

6.8.6.2 Sediment

Based on the results of the screening-level ecological risk assessment (SLERA), sediment in the Cooling Pond was deemed to pose an unacceptable risk. Further ecological evaluation of the Cooling Pond was not performed, and cleanup levels based on ecological risks were not calculated, because remediation of pond sediments was considered necessary. The results of the HHRA demonstrated that risks exceed an ILCR of 1E-04 and a HI of 1, due to PCBs in sediment and a cleanup level of 1 mg/kg PCBs was identified for pond sediment. Human health and ecological risks for potential exposure to sediment were evaluated for samples collected in the 0 to 1 foot bgs interval; exposure to sediments deeper than 1 foot was considered to be unlikely.

The Cooling Pond sediment will be excavated to 3 to 4 feet bgs, at which depth groundwater is anticipated to be encountered. Confirmatory sediment samples will be collected and evaluated using the PCB cleanup level derived based on human health risks and the ecological cleanup levels derived for the Sphagnum Bog. Sediment excavation will be expanded to meet those cleanup levels until depth to groundwater is reached. The depth of the removed sediment will then be backfilled with clean material, which will eliminate potential exposure pathways to deeper material that may remain.

6.9 CONSTRUCTION DEWATERING WATER QUALITY MONITORING

During remedial excavations of the Cooling Pond sediment, dewatering of the pond will be necessary. Water management would be such that the pond volume is dewatered and managed with water processing and minor treatment to remove suspended solids. It may be feasible to use the existing septic system in the north lot as a place to infiltrate treated pond water during the construction period.

Dewatering of the Cooling Pond will be necessary to facilitate sediment excavations. The pump intake for dewatering will be placed in the northern portion of the pond. Water will be pumped to a DETS located northwest of the Cooling Pond on the paved area. Treated effluent will be discharged to a septic tank and existing leach fields as shown in Attachment A2, Drawing C-302. Additional details pertaining to the DETS are included in the Technical Specifications (Attachment A1, Section 02 70 00 – Construction Dewatering and Water Management).

6.10 GROUNDWATER AND SURFACE WATER MONITORING

To monitor the short-term impacts the RA may have on groundwater and surface water quality, the QAO will collect groundwater and surface water samples during the RA.

6.11 WASTE HANDLING AND DISPOSAL

During soil excavation, the QAO will visually monitor the removal of surficial and buried waste (defined as material that is not soil, sediment, groundwater, or surface water). The QAO will visually confirm that no waste is visible on the ground surface, nor in the sidewalls or bottom of an excavation in waste areas above the groundwater table before any fill material is placed in the open excavation, other than is required as daily cover. If waste is observed, the RAC will be notified to expand the excavation laterally and/or vertically, as appropriate, until no waste is observed on the ground surface, or in the sidewalls or bottom of an excavation.

For excavation of waste that extends below the groundwater table, the QAO will periodically (at least daily) review the output (either on-screen in the cab of the excavator, in an electronic file or hard copy provided by the RAC, or by other means acceptable to the QAO) from the excavator-mounted guidance system to confirm the target excavation elevations indicated on the Contract Drawings have been achieved. Once the RAC indicates the data show the target excavation elevations have need achieved, the QAO will visually monitor the contents of the excavator bucket from the final cut/pass to verify that there is no visible waste in the bucket or in the haul truck receiving the waste from the final cut/pass. If waste is observed in the bucket or in the haul truck, the RAC will be notified to expand the excavation laterally and/or vertically, as appropriate, until no waste is visible in the bucket or in haul truck. After the target excavation elevations have been achieved, visual confirmation by the QAO as described herein will be the governing means of determining acceptance of waste removal from below the groundwater table. The RAC will provide an updated excavation area figure (electronic or hard copy) to the QAO on a daily basis (or other frequency acceptable to the QAO based on productivity). The RAC and QAO will retain a copy of the figure to document that the excavation of all waste has been achieved in a specific area or part of anarea.

The QAO will visually monitor the loose thickness of each lift and that each lift receives the minimum number of compactor passes required by the Technical Specifications. The QAO will also visually confirm that each lift of waste is placed in an approximate horizontal orientation and that when required, the surface to receive the waste includes a notch into the existing surface or previously placed waste.

The QAO will visually confirm that at the end of each workday exposed waste is covered with soil, tarps, or other temporary measures in accordance with the Technical Specifications.

6.12 CONCRETE PROCESSING

During processing of concrete, the QAO will periodically observe the RAC operations and will indicate if dust emanating from the operation (crushing, transporting, placing, spreading, etc.) is visible at the fence line or at the Site boundary. The QAO will alert the RAC and the PC if in the opinion of the QAO, visible dust is a concern. The QAO will visually monitor the processed material for compliance with particle size, and the removal of rebar and miscellaneous debris. The QAO will alert the RAC if material is not in compliance with the Technical Specifications.

6.13 RADIOLOGICAL SCREENING

Excavated materials will be screened for DU by the Radiation Safety Officer (RSO). Material collected by the erosion controls measures will also be screened periodically as needed. In addition, where applicable, all equipment and tools entering the restricted area will be screened by a Health Physicist (HP) according to the Radiological Surveys HPP (HP-NMI-05 in the FSP, RDWP Appendix I) to determine if background levels of radiation existed on the equipment prior to exposure to Site soils. To Haley & Aldrich's knowledge, background levels of radiation were not detected on equipment prior to exposure to Site soils during the PDI and are not expected during remedial activities. Additionally, disposable barriers will be applied as directed by the on-site HP or RSO to prevent contaminating equipment and tools while in the restricted area. Further details on the Radiation Protection Program are included in the HASP.

6.14 RESTORATION

The QAO will visually monitor the restoration of the Site, including seeding, planting, the installation of erosion control blankets, the placement of riprap and aggregates, and the installation of fence and gates noting observations relative to the following:

- Verification of the use of the accepted seed mix;
- Preparation of vegetative support soil to receive seed;
- Visually checking the type and density of wetlands plantings;
- Confirming riprap is correctly sized and placed to the specified thickness;
- Confirming aggregates are placed to the specified thickness as required in the Technical Specifications; and
- Confirming fence and gates are installed per the Contract Documents and that locks have been installed.

6.15 REVEGETATION

This section of the CQA/QCP addresses the CQA program to be implemented with regard to revegetation at the Site. Items addressed in this section include permanent seeding and installation of an erosion control blanket and turf reinforcement mat.

6.16 PRE-CONSTRUCTION QUALIFYING OF MATERIAL SOURCES

The following construction materials must be prequalified through the submittal process prior to their use on Site:

- Erosion Control Blanket/Turf Reinforcement Mat
- Permanent Seed

6.16.1 Erosion Control Blanket/Turf Reinforcement Mat

Prior to installation, the RAC will provide the EOR with the following quality control information from the erosion control blanket/turf reinforcement mat manufacturer:

- A list of guaranteed properties for the type of erosion control blanket/turf reinforcement mat to be delivered, which meet or exceed the criteria given in the Technical Specifications;
- A written certification signed by a responsible party employed by the erosion control blanket/turf reinforcement mat manufacturer that the materials assigned and delivered meet or exceed the guaranteed properties for that type of erosion control blanket/turf reinforcement mat; and
- Manufacturer's guidelines on installation procedures (e.g., staking pattern, overlaps, anchorage, etc.) for the type of erosion control blanket/turf reinforcement mat, site conditions, and intended use.

The EOR will examine the erosion control blanket/ turf reinforcement mat manufacturer's certifications to verify that the property values listed on the certifications meet or exceed those guaranteed. The EOR will report any deviations from the above requirements to the RAC, and the RAC shall rectify them at no expense to the SDs prior to installation of the erosion control blanket/turf reinforcement mat.

6.16.2 Permanent Seeding

Prior to installation, the RAC will be required to provide the EOR with the following information on permanent seeding:

- Quality control information and certifications for the fertilizer, lime (if needed), seed mix, and mulch;
- A written certification signed by a responsible party employed by the seed supplier that the permanent seed meets or exceeds the requirements of the Technical Specifications; and
- The name of the proposed seeding subcontractor (if applicable), and a description of the proposed method of applying the fertilizer, lime (if needed), seed, and mulch.

The EOR will examine the supplier's certifications to verify that the property values listed on the certifications meet or exceed those guaranteed and that proper and complete documentation has been provided by the RAC. The EOR will report any deviations from the above requirements to the RAC, and the RAC shall rectify them at no expense to the SDs prior.

6.16.3 Material Conformance Testing

Conformance sampling and testing of the erosion control blanket and permanent seeding components will not be conducted unless requested by the EOR. If deemed necessary by the EOR, the conformance test requirements will be determined at that time as appropriate to evaluate the material properties.

6.17 FIELD EVALUATION/MONITORING

6.17.1 Erosion Control Blanket/Turf Reinforcement Mat

During shipment and storage, the RAC will be required to keep the erosion control blanket/turf reinforcement mat off the ground and protect the erosion control blanket/turf reinforcement mat from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

The EOR will observe the rolls upon delivery at the Site. Any damaged rolls will be rejected by the EOR and are required to be repaired or replaced by the RAC.

The RAC will be required to handle all erosion control blanket/turf reinforcement mat in such a manner as to ensure the erosion control blanket/turf reinforcement mat is not damaged in any way. The EOR will verify compliance with the following:

- Immediately prior to erosion control blanket/turf reinforcement mat placement, the subgrade is smooth and visibly free of ruts, rocks, protrusions, or other obstructions that will damage the erosion control blanket/turf reinforcement mat;
- Seed, fertilizer, and lime (if required) are applied to areas receiving erosion control blanket/turf reinforcement mat prior to erosion control blanket/turf reinforcement mat placement;
- Erosion control blanket/turf reinforcement mat is securely anchored in an embedment trench (if required) and that the embedment trench is properly backfilled and compacted, according to manufacturer's recommendations and/or as requested by the EOR;
- In the presence of wind, erosion control blanket/turf reinforcement mat is weighted with sandbags (or equivalent ballast weight approved by the EOR), and that sandbags remain until the erosion control blanket is properly fastened using the required staking (i.e., stapling) pattern given by the manufacturer's recommendations and/or as requested by the EOR;
- Seams are properly overlapped and fastened, according to the manufacturer's recommendations and/or as requested by the EOR; and
- A visual examination of the erosion control blanket/turf reinforcement mat is carried out after installation to verify that no potentially harmful foreign objects, such as needles or tools, are present.

6.17.2 Permanent Seeding

The EOR will monitor and document the application of permanent seeding, including the following:

- Verifying that the proper type and proportions of seed mix, fertilizer, lime (if needed) and mulch are used by visually observing mixing/placement and randomly obtaining information printed on seed bags and fertilizer bags used in the mix;
- Verifying that the soil surface to be seeded is prepared in accordance with the Technical Specifications; and
- Observing seeding operations to verify complete coverage and timely application.

As described in the Technical Specifications, in areas where vegetative growth has not been established to the satisfaction of the EOR within the specified time period, the area will be reworked, if necessary, and re-seeded.

6.17.3 Wetland Restoration

This section of the CQA/QCP addresses the CQA program to be implemented with regard to wetland restoration.

6.17.4 Pre-Construction Qualifying of Material Sources

Prior to construction using earthen materials (high organic content vegetative support soil), the EOR will obtain a soil sample from each proposed source. The soil sample(s) will be supplied by the RAC. The physical and chemical properties of the materials will be evaluated by the QA laboratory, and results will be reviewed by the EOR and compared to the requirements of the Technical Specifications to verify that the materials meet the requirements.

The following materials must be prequalified prior to their use:

- High organic content vegetative support soil
- Plants
- Permanent Seed

6.17.5 Field Evaluation/Monitoring of Construction Techniques

The EOR will monitor and document the backfilling. Monitoring the construction work for placement of the high organic content vegetative support will include the following:

- Monitoring the thickness of lifts as placed;
- Documenting the construction equipment used to place the material;
- Monitoring material placement techniques to verify that the underlying materials are not disturbed; and
- Observing plantings.

The EOR will monitor the seeding and planting activities, which includes:

- Monitoring even distribution of seeds; and
- Monitoring plant spacings.

6.17.6 Material Conformance Testing

During construction, a conformance testing program will be implemented by the EOR to verify that the physical and chemical properties of the high organic content vegetative support meet the specified material properties. The EOR will obtain soil samples from the RAC for conformance testing from borrow sources, on-Site stockpiles, or from trucks as they unload material at the Site. The laboratory test methods and frequencies required for CQA conformance testing are given in Technical Specification Section 31 00 00 – Earthwork.

If a sample fails a conformance test, the EOR will notify the RAC and use of the material represented by that sample will not be allowed. Additional tests or replacement of the material will be performed by the RAC under the direction of the EOR, or the RAC will use approved material from a different source.

6.17.7 Routine Field Observations

Thickness verification of placed high organic content vegetative support will be performed by the EOR during construction to evaluate the RAC's work with respect to the requirements of the Technical Specifications. The test methods and frequencies for CQA field testing/thickness verification are provided in Technical Specification Section 31 00 00 – Earthwork and Technical Specification Section 32 30 00 – Restoration.

6.17.8 Special Testing

A special testing frequency will be used at the discretion of the EOR when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- The lift thickness is greater than specified
- The material is at improper and/or highly variable moisture content
- The fill materials differ substantially from those specified

During construction, the frequency of testing may also be increased in the following situations:

- Adverse weather conditions
- Breakdown of equipment
- At the start and finish of grading
- If the material fails to meet specification requirements

6.17.9 Temporary Erosion and Sediment Controls

The RAC has primary responsibility for the installation, inspection, and maintenance of perimeter and internal erosion and sediment controls at least weekly and after each storm (precipitation and flood) event. The QAO will visually monitor the temporary perimeter erosion and sediment controls to be installed by the RAC for compliance with the Contract Drawings and Technical Specifications. QAO inspections will occur on a weekly basis and after precipitation and after flooding events that result in out-of-bank flow within the limit of the Site. The QAO will prepare written reports that will identify any deficiencies that require corrective action by the RAC.

The QAO will review the condition of the following elements:

- Stabilized construction entrances
- Temporary interceptor berms, ditches, and channels routing runoff to stormwater management basins
- Silt fences, coir logs, and bale dikes
- Restoration of disturbed areas with seeding (temporary and/or permanent), mulch, or erosion control matting as appropriate
- Inspection of uncontrolled discharge of sediment-laden water onto surrounding roadways, or into surrounding wetlands and water courses; and
- Implementation of corrective measures. The QAO will submit the report to the EOR.

6.17.10 Monitoring Well Abandonment

This section of the CQA/QCP addresses the CQA program to be implemented for installation and abandonment of monitoring wells. Monitoring well abandonment procedures are covered in Technical Specification Section 33 29 00 – Well Abandonment and Protection. Documentation of well abandonment will include a log for each well abandoned.

6.17.11 Field Evaluation/Monitoring of Construction Techniques

During construction of monitoring wells, the EOR will verify compliance with the following:

- Wells are advanced using the approved equipment and procedures to the elevations indicated in the Contract Documents;
- Boreholes remain stable and are straight;
- Piezometer and well screens are set at the elevations indicated in the Contract Documents;
- Bottom plugs are installed;
- Casing joints are tight;
- Filter material is placed as specified;
- Bentonite seals are placed as specified;
- Cement-bentonite grout seals are placed as specified;
- Steel protective casings are placed at the specified elevations and set in concrete pad;
- Where applicable, anti-seep collar(s) are properly installed; and
- Piezometer and well locations and elevations are surveyed in accordance with the Technical Specifications.

The EOR will also maintain logs of the piezometer/well installation to document the soil conditions and groundwater table encountered during the installation and to record the quantities and types of materials used.

During abandonment of monitoring wells, the EOR will verify compliance with the following:

- Screens, casings, and steel protective casings are removed;
- Bentonite seals are placed as specified; and
- Neat cement grout seals are placed as specified.

The EOR will also maintain a log of the piezometer/well abandonment activities listed above.

7. Plan Modification Procedure

Should this CQA/QCP require modification, the proposed change will be submitted in writing by the EOR to the PC. The PC will advise USEPA of the change and request USEPA approval, as appropriate. A modification will be issued in the form of an addendum and will be forwarded to recipients of copies of the CQA/QCP to document changes.

TABLES

Table C-1
Remedial Action Levels for Uranium: AOI 8 and AOI 9
Nuclear Metals
Concord, Massachusetts
File No. 131884

Excavation Area	Confirmatory Samples and Remedial Action Levels					
	Bottom (number samples)	RAL (mg/kg) [a]	Rationale	Sidewall (number samples)	RAL (mg/kg) [a]	Rationale
AOI 8 [b]	62	4.0	Highest that can remain in all bottom confirmatory samples and achieve residual EPC that does not exceed cleanup goal	28	6.4	Highest concentration in samples bordering exposure area
AOI 9 [c]	16	2.7	Cleanup goal; highest anticipated to remain based on design cut lines is 1.9 mg/kg	12	3.6	Highest concentration in samples bordering exposure area

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
RAL - Remedial Action Level
[a] RALs are identified in Appendix C, Attachment C-1, Part 2.
[b] Numbers of bottom and sidewall samples are defined by the confirmatory soil sampling grids (Figure C-4).
[c] Numbers of bottom and sidewall samples are defined by the confirmatory soil sampling grids (Figure C-5).

Table C-2
Example Residual Exposure Point Concentration Calculations using Confirmatory Sample Data at RAL Concentrations : AOI 8 and AOI 9
Nuclear Metals
Concord, Massachusetts
File No. 131884

Exposure Area	COC	Residual EPCs Estimated using RALs for Confirmatory Samples				Residual Volume of Remaining Soil [c]		Clean Backfill [c]		Final Volume-weighted Residual EPCs		Cleanup Goal (mg/kg)
		Excavation based on RALs (mg/kg) [a]	Number of Samples	Exposure Area based on RALs (mg/kg) [b]	Number of Samples	Volume of Soil Remaining - Excavation (cy)	Volume of Soil Remaining - Exposure Area (cy)	Backfill EPC (mg/kg) [d]	Volume of Clean Backfill (cy)	Excavation (mg/kg) [e]	Exposure Area (mg/kg) [e]	
AOI 8	Uranium	3.0	126	3.2	139	1620	3920	1.6	3800	2.0	2.4	2.7
	PCBs	0.58	125	0.54	137	1620	3920	0.05	3800	0.21	0.30	1
AOI 9	Uranium	2.5	26	2.4	32	208	461	1.6	250	2.0	2.1	2.7
	PCBs	0.80	26	0.65	33	208	461	0.05	250	0.39	0.44	1

ABBREVIATIONS AND NOTES:
EPC - exposure point concentration
mg/kg - millgram per kilogram
cy - cubic yards
PCBs - polychlorinated biphenyls

The calculations presented in this table area based on design calculations and an assumption that PCBs and uranium are present in all bottom confirmatory soil sample at concenrations equal to the RALs. All calculations will be udpdated with the actual soil volumes, confirmatory sample analytical data, and backfil EPCs when the remediation is implemented.
[a] - EPC derived in Attachment C-1, Part 3 as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint, plus bottom confirmatory samples assuming that PCB and uranium concentrations are equal to the bottom RALs.
[b] - EPC derived in Attachment C-1, Part 3 as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint and within the exposure area, plus bottom confirmatory samples assuming that PCB and uranium concentrations are equal to the bottom RALs.
[c] - Volumes are provided in Appendix C, Section 2.2 and in the Figures provided in Attachment C-1, Part 4.
[d] - Assumed to be equal to the soil background concenration for uranium and the detection limit for PCBs.
[e] - Derived as: [(Residual EPC) x (Residual volume)] + [(Backfill EPC) x (Backfill volume)] / (Residual volume + backfill volume)

Table C-3
Residual Risks and Reductions in Risk - AOI 8 (Formerly HHRA Exposure Area A5 - AOI 8 Sweepings Area)
Nuclear Metals
Concord, Massachusetts
File No. 131884

Soil Cleanup Levels for the Protection of Human Health			Risk Reduction Analysis using RALs for Confirmatory Samples [d]												
	Selected Cleanup Level (mg/kg)		HHRA Results - AOI 8 [a]			Excavation Area					Exposure Area				
			EPC	ICLR	HQ	EPC [b]	ILCR	% Reduction	HQ	% Reduction	EPC [c]	ILCR	% Reduction	HQ	% Reduction
COC															
Benzo(a)anthracene	0.34	ILCR	not COPC			not COPC					not COPC				
Benzo(a)pyrene	0.22	Background	0.12	4.0E-06	NA	not COPC					0.028	1.1E-07	97%	7.1E-04	
Benzo(b)fluoranthene	0.34	ILCR	not COPC			not COPC					not COPC				
Indeno(1,2,3-cd)pyrene	0.34	ILCR	not COPC			not COPC					not COPC				
Polychlorinated biphenyls (PCBs)	1	Policy	18.6	4.0E-05	8	0.21	3.9E-07	99%	8.0E-02	99%	0.30	5.5E-07	99%	1.1E-01	99%
Arsenic	13.7	Background	8.7	1.0E-05	0.2	6.8	4.5E-06	55%	9.0E-02	55%	6.7	4.5E-06	55%	8.8E-02	56%
Thorium	7.4	Background	5.1	7.0E-05		6.1	7.3E-05	-4%			5.9	7.1E-05	-1%		
Uranium	2.7	ILCR	82	6.0E-05	1	2.0	7.5E-07	99%	2.0E-02	98%	2.4	8.9E-07	99%	2.4E-02	98%
COPC															
Aluminum						7893			4.6E-02		8922			5.2E-02	
Cobalt						3.5	4.7E-10		6.8E-02		3.4	4.5E-10		6.6E-02	
Iron						10847			9.1E-02		11245			9.4E-02	
Manganese						126			3.1E-02		123			3.0E-02	
Thallium						0.10			5.9E-02		0.10			6.1E-02	
Titanium						579					543				
Zirconium						3.0			2.2E-01		2.7			2.0E-01	
TOTAL: COCs				**2E-04**	**9.2**		**8E-05**	57%	**0.2**	98%		**8E-05**	58%	**0.2**	98%
TOTAL: Additional COPCs							**5E-10**		**0.5**			**5E-10**		**0.5**	
TOTAL: COCs + Additional COPCs							**8E-05**		**0.7**			**8E-05**		**0.7**	
TOTAL: COCs Incremental [e]				**1E-04**	**9.0**		**1E-06**	99%	**0.1**	99%		**2E-06**	99%	**0.1**	98%

ABBREVIATIONS AND NOTES:
mg/kg - milligram per kilogram
COC - chemical of concern
COPC - chemical of potential concern
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
ILCR - incremental lifetime cancer risk

[a] - Values are from the Human Health Risk Assessment for the NMI Site for exposure area A5 (de maximis, September 2013)
[b] - The EPCs for PCBs and uranium are the final residual EPCs provided in Table C-2. The EPCs for other COCs and the COPCs are derived in Attchment C-1, Part 3 as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint. The EPCs will be updated using confirmatory and verification sampling data when the remediation is implemented.
[c] - The EPCs for PCBs and uranium are the final residual EPCs provided in Table C-2. The EPCs for other COCs and the COPCs are derived in Attachment C-1, Part 3 as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint and within the exposure area. The EPCs will be updated using confirmatory and verification sampling data when the remediation is implemented.
[d] - Risks are calculated in Attachment C-1, Part 5.
[e] - Calculated as Total-COC risk minus risks for arsenic and thorium

Below cleanup level
>85% risk reduction

Table C-4
Residual Risks and Reductions in Risk - AOI 9 (Formerly HHRA Exposure Area A4 - AOI 14 AOI 14 North)
Nuclear Metals
Concord, Massachusetts
File No. 131884

Soil Cleanup Levels for the Protection of Human Health			Risk Reduction Analysis using RALs for Confirmatory Samples [d]												
	Selected Cleanup Level (mg/kg)		HHRA Results - AOI 8 [a]			Excavation Area					Exposure Area				
			EPC	ICLR	HQ	EPC [b]	ILCR	% Reduction	HQ	% Reduction	EPC [c]	ILCR	% Reduction	HQ	% Reduction
COC															
Benzo(a)anthracene	0.34	ILCR	not COC			not COPC					not COPC				
Benzo(a)pyrene	0.22	Background	0.15	8.0E-06	NA	not COPC					not COPC				
Benzo(b)fluoranthene	0.34	ILCR	not COC			not COPC					not COPC				
Indeno(1,2,3-cd)pyrene	0.34	ILCR	not COC			not COPC					not COPC				
Polychlorinated biphenyls (PCBs)	1	Policy	4.35	9.0E-06	1.8	0.39	7.2E-07	92%	1.5E-01	92%	0.44	8.1E-07	91%	1.7E-01	91%
Arsenic	13.7	Background	13	1.0E-05	0.3	5.3	3.5E-06	65%	7.0E-02	77%	5.6	3.8E-06	62%	7.4E-02	75%
Thorium	7.4	Background	4.8	7.0E-05		6.0	7.1E-05	-2%			6.2	7.4E-05	-5%		
Uranium	2.7	ILCR	17.4	9.0E-06	0.3	2.0	7.4E-07	92%	2.0E-02	93%	2.1	7.8E-07	91%	2.1E-02	93%
COPC															
Aluminum						8681			5.1E-02		9003			5.3E-02	
Cobalt						3.5	4.7E-10		6.8E-02		3.7	5.0E-10		7.2E-02	
Iron						9130			7.7E-02		8951			7.5E-02	
Titanium						486					496				
Zirconium						2.0			1.5E-01		2.1			1.5E-01	
TOTAL: COCs				**1E-04**	**2.4**		**8E-05**	28%	**0.2**	90%		**8E-05**	25%	**0.3**	89%
TOTAL: Additional COPCs							**5E-10**		**0.3**			**5E-10**		**0.4**	
TOTAL: COCs + Additional COPCs							**8E-05**		**0.6**			**8E-05**		**0.6**	
TOTAL: COCs Incremental [e]				**3E-05**	**2.1**		**1E-06**	94%	**0.2**	92%		**2E-06**	94%	**0.2**	91%

ABBREVIATIONS AND NOTES:
mg/kg - milligram per kilogram
COC - chemical of concern
COPC - chemical of potential concern
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
ILCR - incremental lifetime cancer risk

[a] - Values are from the Human Health Risk Assessment for the NMI Site for exposure area A5 (de maximis, September 2013)
[b] - The EPCs for PCBs and uranium are the final residual EPCs provided in Table C-2. The EPCs for other COCs and the COPCs are derived in Attchment C-1, Part 3 as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint. The EPCs will be updated using confirmatory and verification sampling data when the remediation is implemented.
[c] - The EPCs for PCBs and uranium are the final residual EPCs provided in Table C-2. The EPCs for other COCs and the COPCs are derived in Attachment C-1, Part 3 as the lesser of the 95% upper confidence limit and maximum concentration >80% risk reduction and verification sampling data when the remediation is implemented.
[d] - Risks are calculated in Attachment C-1, Part 5.
[e] - Calculated as Total-COC risk minus risks for arsenic and thorium

(green)	Below cleanup level
(yellow)	>85% risk reduction

Table C-5
Remedial Action Levels for Uranium: Coutyard (AOI-1 and AOI 15)
Nuclear Metals
Concord, Massachusetts
File No. 131884

Excavation Area	Confirmatory Samples and Remedial Action Levels					
	Bottom (number confirmatory samples)	RAL (mg/kg)	Rationale	Sidewall (number confirmatory samples)	RAL (mg/kg)	Rationale
Uranium	50	3.5	Highest that can remain in all bottom confirmatory samples and achieve residual EPC that does not exceed cleanup goal	12	3.9	The excavation is defined by physical boundaries. The RAL is used to evaluate sidewall samples at the northern end of the excavation and along the eastern edge of the excavation at the top of slope, and is based on the maximum uranium concentratios detected in the upper portion of the slope between the courtyard area and cooling pond.

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
RAL - Remedial Action Level
RAL calculations are provided in Attachment C-3

Samples used to identify sidewall RALs

Sample	Uranium (mg/kg)
SB-RI-11010	2.6
SB-RI-11013	1.4
SB-RI-11014	3.3
SB-RI-11015	3.9

Table C-6
Projected Residual Exposure Point Concentration Calculations using Confirmatory Sample Data at Bottom RAL Concentrations: Courtyard
Nuclear Metals
Concord, Massachusetts
File No. 131884

Exposure Area	COC	Residual EPCs Estimated using RALs for Confirmatory Samples		Residual Volume of Remaining Soil	Clean Backfill		Final Volume-weighted Residual EPCs	Cleanup Goal (mg/kg)
		Excavation based on RALs (mg/kg) [a]	Number of Samples	Volume of Soil Remaining - Excavation (cy)	Backfill EPC (mg/kg) [b]	Volume of Clean Backfill (cy)	Excavation (mg/kg) [c]	
Courtyard	Uranium	3.34	72	15800	1.6	9640	2.7	2.7

ABBREVIATIONS AND NOTES:
EPC - exposure point concentration
mg/kg - millgram per kilogram
cy - cubic yards
PCBs - polychlorinated biphenyls

The calculations presented in this table area based on design calculations and an assumption that uranium is present in all bottom confirmatory soil sample at concenrations equal to the RALs. All calculations will be udpdated with the actual soil volumes, confirmatory sample analytical data, and backfill EPCs when the remediation is implemented.
[a] - EPC is the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint anc within the exposure area, plus bottom confirmatory samples assuming that uranium concentrations are equal to the bottom RALs (ProUCL input and output in Attachment C-3)
[b] - Assumed to be equal to the soil background concenration for uranium.
[c] - Derived as: [(Residual EPC) x (Residual volume)] + [(Backfill EPC) x (Backfill volume)] / (Residual volume + backfill volume)

Table C-7
Remedial Action Levels for Uranium: Landfill
Nuclear Metals
Concord, Massachusetts
File No. 131884

Excavation Area	Confirmatory Samples and Remedial Action Levels					
	Bottom (number confirmatory samples)	RAL (mg/kg)	Rationale	Sidewall (number confirmatory samples)	RAL (mg/kg)	Rationale
Uranium	29	4.5	Highest that can remain in all bottom confirmatory samples and achieve residual EPC that does not exceed cleanup goal	13	9.6	Highest concentration in samples surrounding exposure area and within excavation, nearest to the excavation boundary.

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
RAL - Remedial Action Level
RAL calculations are provided in Attachment C-4

Samples used to identify sidewall RALs

Sample	Uranium (mg/kg)
SB-RI-03018	9.6
SB-RI-03016	2.9
SB-RI-03017	2.2
SS_PD-03010	4.2
TP-RI-03016	5.1
TP-RI-03018	5.1
TP-RI-03017	3.9
TP-RI-03010	1.3
TP-RI-03014	4.6
TP-RI-03019	2.6
TP-RI-03020	1.5
SS-RI-14043	9.6

Table C-8
Projected Residual Exposure Point Concentration Calculations using Confirmatory Sample Data at RAL Concentrations: Landfill
Nuclear Metals
Concord, Massachusetts
File No. 131884

Exposure Area	COC	Residual EPCs Estimated using RALs for Confirmatory Samples		Residual Volume of Remaining Soil	Clean Backfill		Final Volume-weighted Residual EPCs	Cleanup Goal (mg/kg)
		Excavation based on RALs (mg/kg) [a]	Number of Samples	Volume of Soil Remaining - Excavation (cy)	Backfill EPC (mg/kg) [b]	Volume of Clean Backfill (cy)	Excavation (mg/kg) [c]	
Landfill	Uranium	2.97	29	18,469	1.6	3,894	2.7	2.7

ABBREVIATIONS AND NOTES:
EPC - exposure point concentration
mg/kg - millgram per kilogram
cy - cubic yards
PCBs - polychlorinated biphenyls

The calculations presented in this table area based on design calculations and an assumption that uranium is present in all bottom confirmatory soil sample at concenrations equal to the RALs. All calculations will be udpdated with the actual soil volumes, confirmatory sample analytical data, and backfil EPCs when the remediation is implemented.
[a] - EPC is the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint anc within the exposure area, plus bottom confirmatory samples assuming that uranium concentrations are equal to the bottom RALs (ProUCL input and output in Attachment C-4)
[b] - Assumed to be equal to the soil background concenration for uranium.
[c] - Derived as: [(Residual EPC) x (Residual volume)] + [(Backfill EPC) x (Backfill volume)] / (Residual volume + backfill volume)

Table C-9
Remedial Action Levels for Uranium: Cooling Pond
Nuclear Metals
Concord, Massachusetts
File No. 131884

Excavation Area	Confirmatory Samples and Remedial Action Levels					
	Bottom (number confirmatory samples)	RAL (mg/kg)	Rationale	Sidewall (number confirmatory samples)	RAL (mg/kg)	Rationale
Uranium	30	3.5	Highest that can remain in all bottom confirmatory samples and achieve residual EPC that does not exceed cleanup goal	19	11.9	Highest concentration in samples surrounding excavation area.

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
RAL - Remedial Action Level
RAL calculations are provided in Attachment C-5

Samples used to identify sidewall RALs

Sample	Uranium (mg/kg)
SS-PD-02041	3.99
SB-PD-04050	**3.16**
SB-PD-04051	**1.6**
SB-PD-04052	**2.1**
SB-RI-04003	**1.6**
SS-PD-04010	**2.92 J**
SS-PD-04013	**8.42**
SS-PD-04022	**5.28**
SS-PD-04023	**6.22 J**
SS-PD-04053	**9.55 J**
SS-RI-04004	**3.9**
SS-RI-04007	**1.8**
SS-RI-04007	**11.9**
SS-RI-04009	**2.9**
SS-RI-04016	**3.1**
SS-RI-04016	**2.3**
SS-RI-04017	**2.5**
SS-RI-04020	**5**

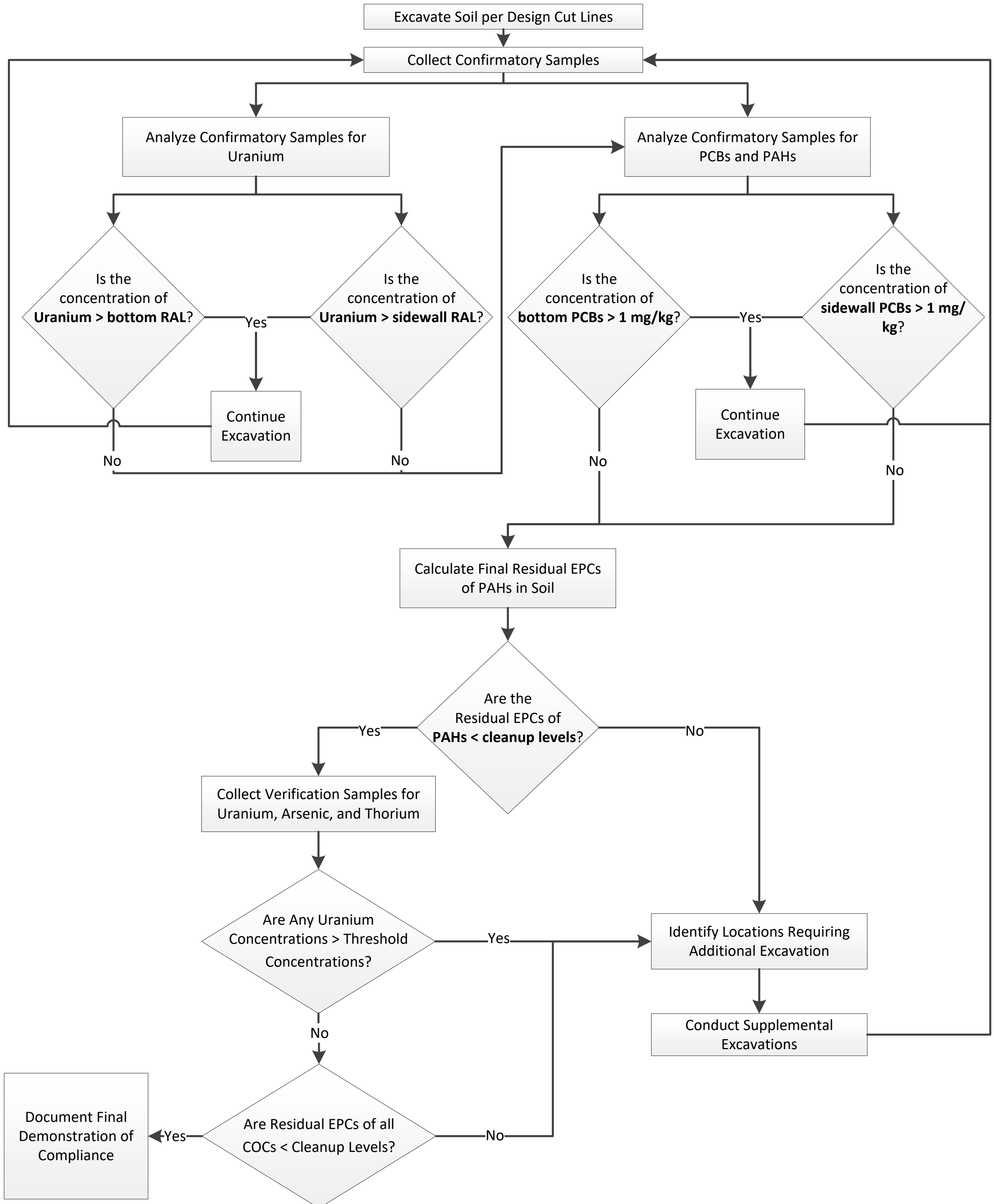
Table C-10
Projected Residual Exposure Point Concentration Calculations using Confirmatory Sample Data at RAL Concentrations: Cooling Pond
Nuclear Metals
Concord, Massachusetts
File No. 131884

Exposure Area	COC	Residual EPCs Estimated using RALs for Confirmatory Samples		Residual Volume of Remaining Soil	Clean Backfill		Final Volume-weighted Residual EPCs	Cleanup Goal (mg/kg)
		Excavation based on RALs (mg/kg) [a]	Number of Samples	Volume of Soil Remaining - Excavation (cy)	Backfill EPC (mg/kg) [b]	Volume of Clean Backfill (cy)	Excavation (mg/kg) [c]	
Cooling Pond	Uranium	3.27	30	17,689	1.6	11,257	2.6	2.7

ABBREVIATIONS AND NOTES:
EPC - exposure point concentration
mg/kg - millgram per kilogram
cy - cubic yards
PCBs - polychlorinated biphenyls

The calculations presented in this table area based on design calculations and an assumption that uranium is present in a
bottom confirmatory soil sample at concenrations equal to the RALs. All calculations will be udpdated with the actual soil volumes, confirmator
sample analytical data, and backfil EPCs when the remediation is implemented
[a] - EPC is the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint a
within the exposure area, plus bottom confirmatory samples assuming that uranium concentrations are equal to the bottom RALs (ProUCL input and output in Attachment C-
[b] - Assumed to be equal to the soil background concenration for uranium
[c] - Derived as: [(Residual EPC) x (Residual volume)] + [(Backfill EPC) x (Backfill volume)] / (Residual volume + backfill volume

FIGURES



HALEY ALDRICH

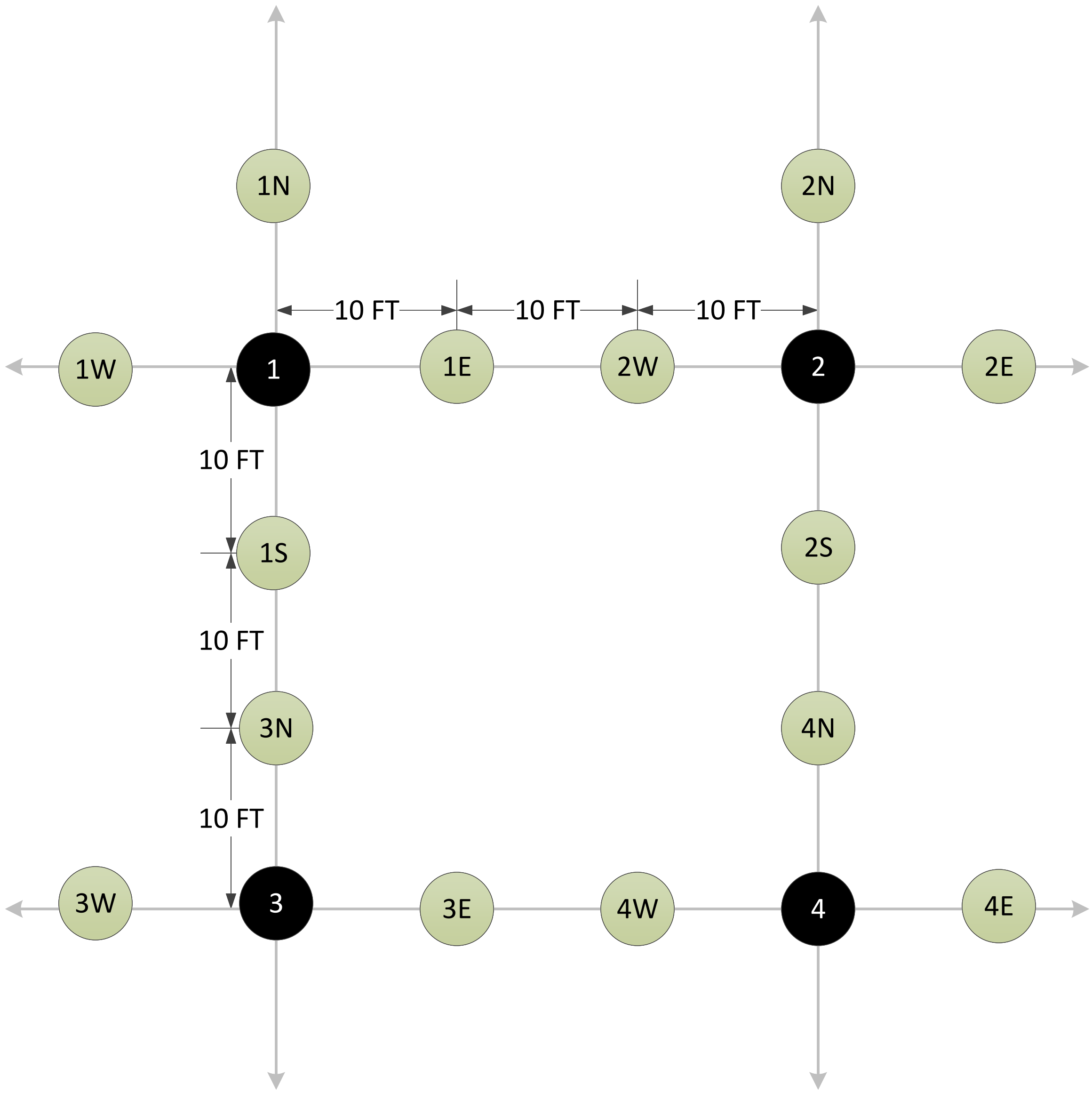
NUCLEAR METALS, INC. SUPERFUND SITE
2229 MAIN STREET
CONCORD, MASSACHUSETTS

CONFIRMATORY SAMPLING DECISION MAKING PROCESS

SCALE: NONE
SEPTEMBER 2023

FIGURE C-1

\\haleyaldrich.com\share\bos_common\131884-NMI\CQAP\Flow Charts\2022-0726-NMI-Generalized Remediation Flow Chart-D5.vsd



LEGEND:

1 Grid Node, one fifth of confirmation composite sample

1E 90 degree 10-FT step outs from grid node to complete remaining four components of composite sample

HALEY ALDRICH

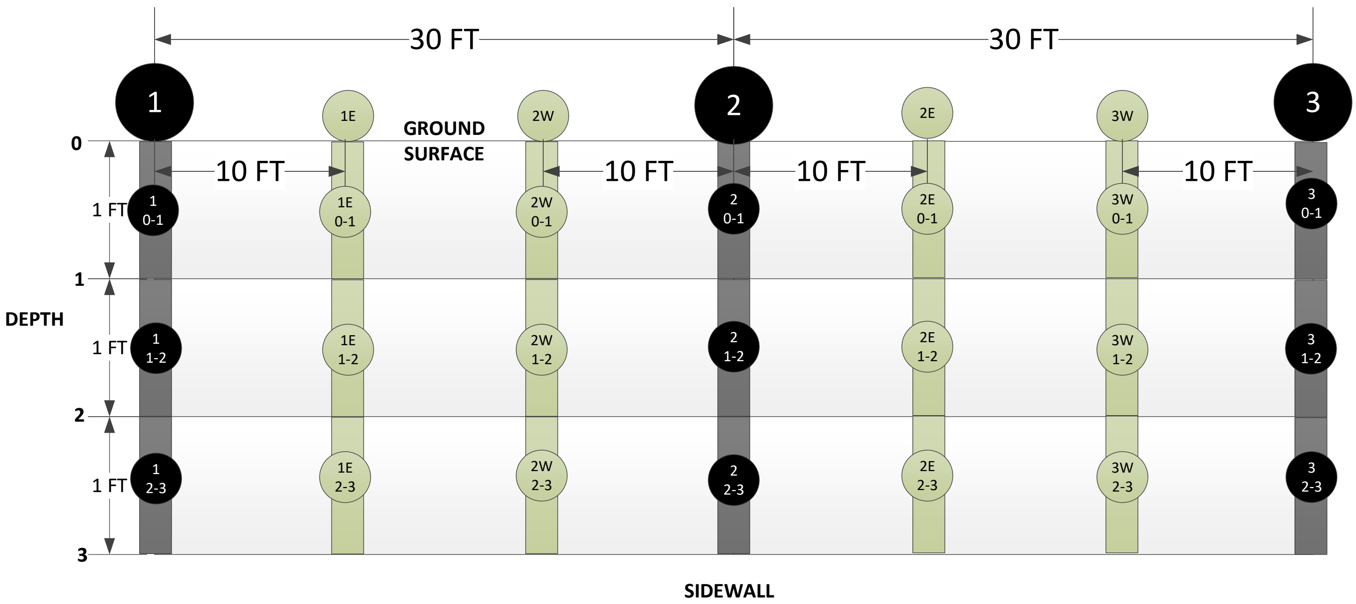
NUCLEAR METALS, INC. SUPERFUND SITE
2229 MAIN STREET
CONCORD, MASSACHUSETTS

Confirmatory Sampling Grid

SCALE: NONE
SEPTEMBER 2023

FIGURE C-2

\\haleyaldrich.com\share\bos_common\131884-NMI\CQAP\2022-07 Confirmation Grid.vsd



LEGEND:

1 — Grid Node, one third sidewall composite sample

1E — 90 degree 10-FT step outs from grid node to complete remaining composite sample

HALEY ALDRICH

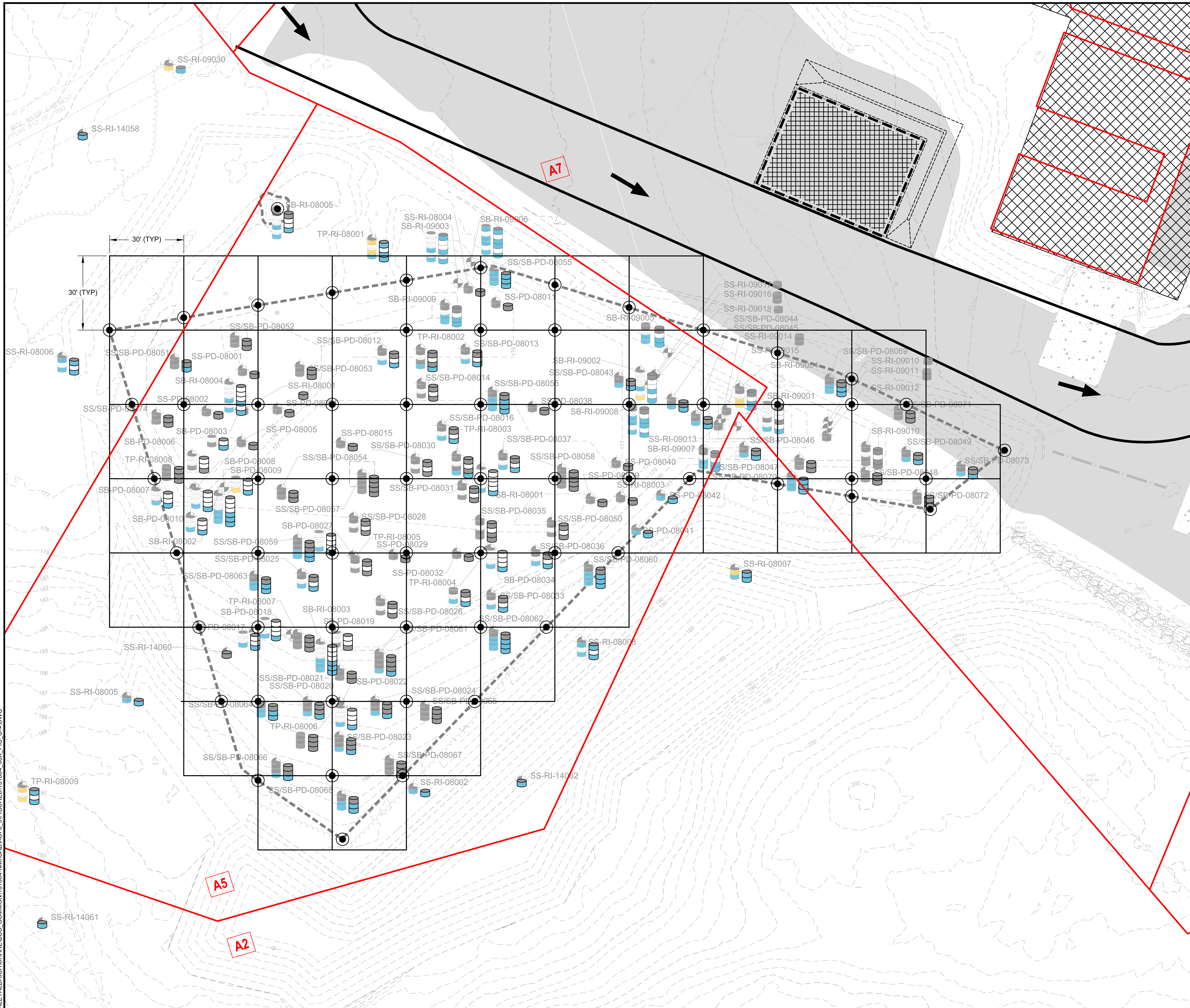
NUCLEAR METALS, INC. SUPERFUND SITE
2229 MAIN STREET
CONCORD, MASSACHUSETTS

SIDEWALL CONFIRMATORY SAMPLE

SCALE: NONE
SEPTEMBER 2023

FIGURE C-3

\\haleyaldrich.com\share\bos_common\131884-NMI\CQAP\2022-07 Confirmation Grid.vsd



LEGEND

- LIMITS OF EXCAVATION
- FORMER BUILDING SLAB
- CHAIN LINK FENCE
- GUARD RAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRICAL LINE
- UNKNOWN UTILITY
- VEGETATION BOUNDARY
- MONITORING OR PRODUCTION WELL
- STORM DRAIN
- ELECTRICAL BOX
- TREE/SHRUB
- ASPHALT
- CONCRETE
- GRAVEL
- LAYDOWN / STOCKPILE AREA
- MATERIAL PROCESSING AREA
- STRAW BALES
- HISTORICAL SAMPLE LOCATION
- PROPOSED CONFIRMATORY SAMPLING LOCATION
- EXPOSURE AREA AND BOUNDARY
- 5 EXPOSURE AREA LABEL

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS >10 FEET. THE INTERVAL SHOWN IS THE INTERVAL AT WHICH THE MAXIMUM VALUE IS REPORTED.

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED
SAMPLE REMOVED	SAMPLE REMOVED

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-102.
2. CONFIRMATORY SAMPLES MAY BE COLLECTED IN ISOLATED AREAS OUTSIDE OF THE LARGER EXCAVATION AREAS AS NECESSARY.

N

0 20 40 60 80

SCALE IN FEET

HALEY ALDRICH

Project No.:	131884
Scale:	SHOWN
Date:	SEPTEMBER 2022
Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

Rev.	Description	By	Date
B	100% DESIGN	H&A	09/23/22
A	95% DESIGN	H&A	08/16/22

REMEDIAL DESIGN
100% DESIGN

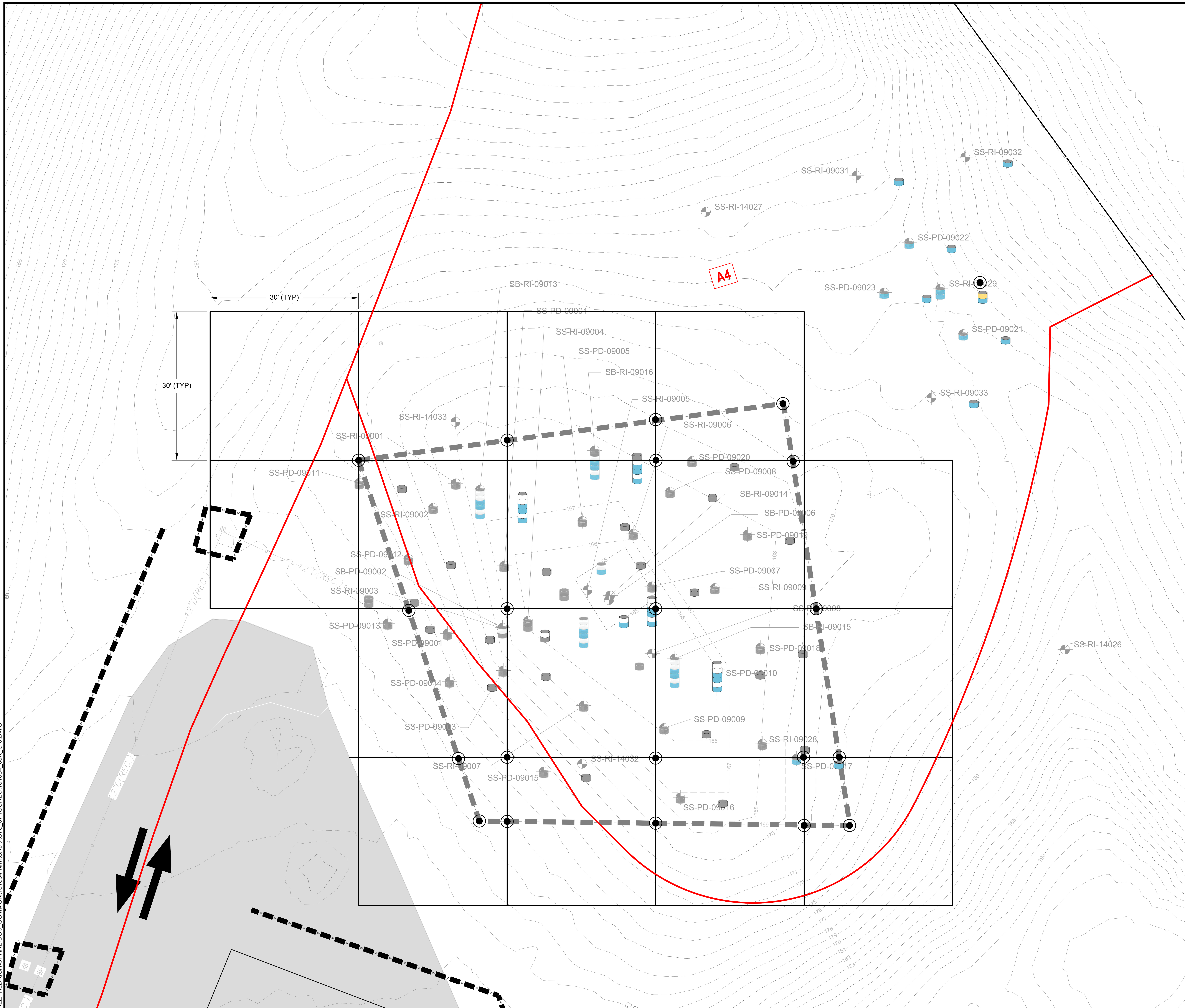
2229 MAIN STREET
CONCORD,
MASSACHUSETTS

CONFIRMATORY SAMPLING LOCATIONS AOI 8

C-4

Sheet: 17 of 23

GAINES, JACK \\HALEYALDRICH\SHARE\BOS_COMMON\131884-NMI\CAD\AOI 8_9\FIGURES\131884_00X_FIG_C-4.DWG Printed: 9/22/2022 3:16 PM Layout: C-4



LEGEND

- LIMITS OF EXCAVATION
- CHAIN LINK FENCE
- GUARD RAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRICAL LINE
- OVERHEAD ELECTRICAL LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- MONITORING OR PRODUCTION WELL
- STORM DRAIN
- ELECTRICAL BOX
- TREE/SHRUB
- ASPHALT
- CONCRETE
- LAYDOWN / STOCKPILE AREA
- STRAW BALES
- HISTORICAL SAMPLE LOCATION
- PROPOSED CONFIRMATORY SAMPLING LOCATION
- EXPOSURE AREAS
- A5 EXPOSURE LABELS

SAMPLE LEGEND

GROUND SURFACE
0 TO 1.00
1.01 TO 2.00
2.01 TO 4.00
4.01 TO 6.00
6.01 TO 8.00
8.01 TO 10.00
>10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS >10 FEET. THE INTERVAL SHOWN IS THE INTERVAL AT WHICH THE MAXIMUM VALUE IS REPORTED.

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED
SAMPLE REMOVED	SAMPLE REMOVED

NOTES

1. FOR SURVEY AND GENERAL NOTES SEE G-102.
2. CONFIRMATORY SAMPLES MAY BE COLLECTED IN ISOLATED AREAS OUTSIDE OF THE LARGER EXCAVATION AREAS AS NECESSARY.

N

0 10 20 30 40
SCALE IN FEET

HALEY ALDRICH

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Project No.:	131884
Scale:	SHOWN
Date:	SEPTEMBER 2022
Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

Rev.	Description	By	Date
B	100% DESIGN	H&A	09/23/22
A	95% DESIGN	H&A	08/16/22

REMEDIAL DESIGN
100% DESIGN

2229 MAIN STREET
CONCORD, MASSACHUSETTS

CONFIRMATORY SAMPLING LOCATIONS AOI 9

C-5

Saved by: JGAINES
Printed: 9/26/2022 11:46 AM
Sheet: FIG C-6
\\HALEYALDRICH\SHARE\BOS_COMMON\131884-NMI\CAD\AOI 8_0131884_00X_C-400_C-402.DWG

SAMPLE LEGEND

- GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 — SAMPLE INTERVAL IS PROVIDED AT DEPTHS >10 FEET. THE INTERVAL SHOWN IS THE INTERVAL AT WHICH THE MAXIMUM VALUE IS REPORTED.

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

N

0 20 40 60 80
SCALE IN FEET

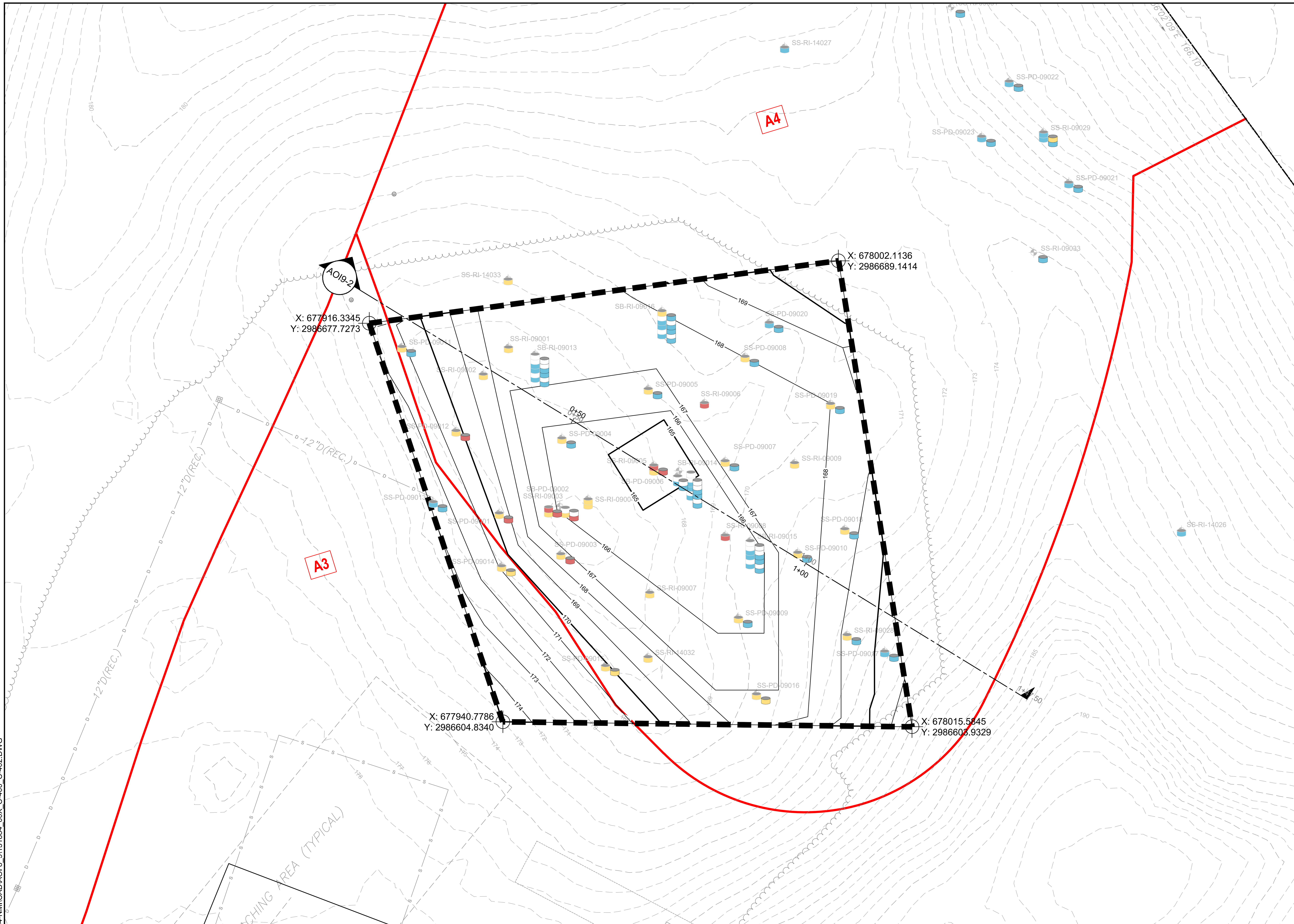
HALEY ALDRICH

NUCLEAR METALS, INC
CONCORD, MASSACHUSETTS

AOI8 - ALL SAMPLES
(WITH EXCAVATION)

SCALE: AS SHOWN
SEPTEMBER 2023

FIGURE C-6



LEGEND

- SITE BOUNDARY
- LIMITS OF EXCAVATION
- 1 FT PROPOSED GROUND CONTOUR
- 5 FT PROPOSED GROUND CONTOUR
- STRAW WATTLES
- STRAW BALES
- TRUCK ROUTE
- FORMER BUILDING SLAB
- CHAIN LINK FENCE
- GUARD RAIL
- 1 FT EXISTING GROUND CONTOUR
- 5 FT EXISTING GROUND CONTOUR
- STORM DRAIN LINE
- SANITARY SEWER LINE
- WATER LINE
- ELECTRICAL LINE
- OVERHEAD ELECTRICAL LINE
- UNKNOWN UTILITY
- WETLAND BOUNDARY
- VEGETATION BOUNDARY
- MONITORING OR PRODUCTION WELL
- STORM DRAIN
- ELECTRICAL BOX
- TREE/SHRUB
- ASPHALT
- CONCRETE
- GRAVEL
- HISTORICAL SAMPLE LOCATION
- EXPOSURE AREAS
- A5 EXPOSURE LABELS

SAMPLE LEGEND

GROUND SURFACE
- 0 TO 1.00
- 1.01 TO 2.00
- 2.01 TO 4.00
- 4.01 TO 6.00
- 6.01 TO 8.00
- 8.01 TO 10.00
- >10.00

10-11 SAMPLE INTERVAL IS PROVIDED AT DEPTHS >10 FEET. THE INTERVAL SHOWN IS THE INTERVAL AT WHICH THE MAXIMUM VALUE IS REPORTED.

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

N

0 20 40 60 80
SCALE IN FEET

HALEY ALDRICH

NUCLEAR METALS, INC
CONCORD, MASSACHUSETTS

AOI9 - ALL SAMPLES
(WITH EXCAVATION)

SCALE: AS SHOWN
SEPTEMBER 2023

FIGURE C-7

Saved by: JGAINES Printed: 9/26/2022 1:51 PM Sheet: FIG C-7
\\HALEYALDRICH\SHARE\BOS_COMMON\131884-NMI\CAD\AOI 8_9\131884_00X_C-400_C-402.DWG

ATTACHMENT C-1
Supporting Risk Information for Compliance Evaluation: **AOI 8 and AOI 9**

Attachment C-1 Supporting Risk Information for Compliance Evaluation

This Attachment provides additional documentation to support the evaluation of compliance with cleanup levels, as described in in Sections 3, 5, and 6 of the CQA Report. Supporting documentation is provided in four parts to this Attachment.

Part 1: Data evaluation and selection of chemicals of potential concern (COPC)
Part 2: Remedial action levels (RALs) for uranium
Part 3: Exposure point concentrations (EPCs)
Part 4: Residual volume calculations
Part 5: Residual risks

PART 1
DATA EVALUATION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Part 1: Data evaluation and selection of chemicals of potential concern (COPC)

Soil samples that are anticipated to remain at the Site after remediation is completed (i.e., samples that are outside of the excavation cut lines) were identified. Analytical data for those samples was tabulated to facilitate screening of the data against ROD cleanup levels and USEPA Regional Screening Levels (RSLs), and to enable calculation of exposure point concentration (EPCs). Part 1 of this Attachment provides the methodology and results for the data summarization and data screening, and Part 3 provides methodology and results of the EPC calculations.

Data Summarization

For each area of the site where excavation activities are planned, soil samples associated with the Human Health Risk Assessment (HHRA) exposure area where the excavation is planned were identified as follows:

- Remedial Investigation (RI) soil samples that are located outside of the excavation cut lines
- Pre-Design Investigation (PDI) soil samples that are located outside of the excavation cut lines

The data sets used to develop EPCs for the HHRA were used as a starting point, PDI samples were added, and then samples within the excavation cut lines (i.e., samples anticipated to be removed during remedial implementation) were identified and removed from the data sets.

Analytical data were grouped as follows:

1) Samples located beneath the excavation boundary; these represent samples located beneath the excavation footprint ('beneath' data sets). These samples are used to help evaluate compliance with cleanup levels.
2) Samples located within the exposure area outside of the excavation cut lines; these represent samples in data group (1), plus additional samples that are located within the exposure area, but outside of the excavation cut lines ('beneath + exposure area data sets)/ These samples are used to help evaluate compliance with cleanup levels.
3) Samples located adjacent to the exposure area; these represent samples located adjacent to the horizontal boundaries of the exposure area, generally the nearest samples to each of the exposure area boundaries. These samples are used to help identify side wall Remedial action levels (RALs).
4) Soil samples collected 0 to 10 feet (ft) below ground surface (bgs) were included in the data sets and were summarized together (i.e., separate summaries of surface soil (0 to 1 ft bgs) and subsurface soil were not developed). This approach was used because all excavation areas will include removal of soil, and the response action objectives in the ROD apply to soil 0 to 10 ft bgs.

The analytical data for each data group was summarized into descriptors which identify:

- Frequency of detection (number of positively detected results/total number of results)
- Range of non-detected results (range of sample quantitation limits)
- Range of detected concentrations
- Arithmetic mean concentration

The following procedures were applied when summarizing the analytical data for the HHRA:

- All data was validated in accordance with the Quality Assurance Project Plan (QAPP).
- For samples in which both an original and a field duplicate result are available, only the original sample was used.
- Rejected data ("R" qualified results), if present, were not used in the risk assessment.
- Results qualified as estimated ("J" qualified) were used in the risk assessment.
- For samples in which analyte concentrations are detected outside the calibration range, and the samples are diluted and reanalyzed, only the re-analysis results were used.
- When calculating the arithmetic mean concentrations for purposes of presenting the mean in the data summary tables, one-half the value reported as the non-detect value (usually the SQL) was used for results reported as not detected.

Data Screening

The maximum detected concentrations of constituents in each of the data sets was compared to USEPA RSLs (HI = 0.1; May 2022) and the Record of Decision (ROD cleanup levels. The comparisons to ROD cleanup levels were completed to understand which COCs will remain in soil at the Site at concentrations above cleanup levels and the maximum concentration of those COCs relative to cleanup levels. This information was used as a cross-check that the design cut lines adequately captured soil associated with elevated concentrations of the COCs. The comparisons to RSLs were completed to identify those constituents in soil that will remain at the Site at concentrations above RSLs (i.e., analytes retained as COPCs) so that cumulative risks for those constituents can be accounted for in the residual risk analysis.

Analytes were retained as COPCs if the maximum detected concentration was higher than the ROD cleanup level or the RSL, and if no screening level was available. Analytes regarded as essential nutrients (calcium, magnesium, potassium, sodium) were excluded as COPCs.

Uranium and thorium were analyzed using methods that report the results both in units of mass (ICP-MS; milligrams per kilogram [mg/kg]) and units of activity (gamma-spectroscopy; pCi/g). The cleanup goals based on mass incorporate the isotopic profiles and associated radiological cancer potencies for depleted uranium (DU) and natural thorium. Therefore, the compliance with cleanup levels for uranium and thorium is evaluated using analytical data reported in mass with the mass-based cleanup goals.

The cleanup goal for polychlorinated biphenyls (PCBs) is based on the total PCB concentration, which is the total concentration of Aroclors detected in each sample. Therefore, PCBs were retained as COPCs if the total PCB concentration exceeded the ROD cleanup goal of 1 mg/kg or the RSL of 0.23 mg/kg (based on Aroclor-1242 and Aroclor-1248, which are slightly lower than the RSLs for Aroclor-1254 and Arcolor-1260).

Data Sets and Screening Results

Data summaries and screening are documented in the tables provided in the attachments to Part 1 of this Attachment. The tables provided in the attachments are grouped by remediation area.

SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 8 - BENEATH
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1	COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)	Exceeds ROD Action Level? (Yes/No)
Volatile Organic Compounds (mg/kg)									
Acetone	1 / 3	0.00416 : 0.00479	0.008 - 0.008	0.00416	7000 n	no	BSL	NA	
Semi-Volatile Organic Compounds (mg/kg)									
Aniline	1 / 27	0.102 : 0.591	0.663 - 0.663	0.0860	44 n	no	BSL	NA	
Benzo(a)anthracene	2 / 56	0.0101 : 0.0591	0.0148 - 0.0203	0.00974	1.1 c	no	BSL	0.34 ILCR	no
Benzo(a)pyrene	2 / 56	0.0101 : 0.0591	0.0267 - 0.102	0.0112	0.11 c*	no	BSL	0.22 BKG	no
Benzo(b)fluoranthene	5 / 56	0.0101 : 0.0591	0.0114 - 0.0559	0.0111	1.1 c	no	BSL	0.34 ILCR	no
Benzo(g,h,i)perylene	1 / 56	0.0101 : 0.0591	0.021 - 0.021	0.00934	180 n	no	BSL	NA	
Benzo(k)fluoranthene	1 / 56	0.0101 : 0.0591	0.011 - 0.011	0.00941	11 c	no	BSL	NA	
Benzoic acid	1 / 45	0.169 : 0.985	0.416 - 0.416	0.131	25000 n	no	BSL	NA	
bis(2-Ethylhexyl)phthalate	15 / 44	0.0103 : 0.18	0.0108 - 0.06	0.0148	39 c**	no	BSL	NA	
Butyl benzylphthalate	2 / 45	0.0101 : 0.377	0.0147 - 0.0501	0.0190	290 c**	no	BSL	NA	
Chrysene	3 / 56	0.0101 : 0.0591	0.0148 - 0.0242	0.00989	110 c	no	BSL	NA	
Diethyl phthalate	1 / 45	0.0101 : 0.377	0.0162 - 0.0162	0.0184	5100 n	no	BSL	NA	
Di-n-butylphthalate	14 / 45	0.0101 : 0.377	0.0112 - 0.025	0.0214	630 n	no	BSL	NA	
Fluoranthene	5 / 56	0.0101 : 0.0591	0.0125 - 0.0587	0.0112	240 n	no	BSL	NA	
Pentachlorophenol	1 / 45	0.101 : 0.591	0.252 - 0.252	0.0761	1 c*	no	BSL	NA	
Phenanthrene	2 / 56	0.0101 : 0.0591	0.0137 - 0.0242	0.00979	180 n	no	BSL	NA	
Pyrene	5 / 56	0.0101 : 0.0591	0.0118 - 0.0587	0.0114	180 n	no	BSL	NA	
EPH (mg/kg)									
C19-C36 Aliphatic Hydrocarbons	1 / 3	8.46 : 8.72	4.13 - 4.13	4.24	23000 n	no	BSL	NA	
PCBs (mg/kg)									
Aroclor-1254 (PCB-1254)	33 / 64	0.00112 : 0.0037	0.0011 - 0.333	0.0221	0.12 n	YES	ASL	NA	[a]
Aroclor-1254/1260 (PCB-1254/1260)	24 / 42	0.001531 : 0.00382	0.0011 - 0.2481	0.0254		YES	NSL	NA	[a]
Aroclor-1260 (PCB-1260)	19 / 64	0.00112 : 0.0041	0.00148 - 0.0864	0.00456	0.24 c	no	BSL	NA	[a]
Polychlorinated biphenyls (PCBs)	33 / 63	0.00112 : 0.0037	0.0011 - 0.2481	0.0263	0.23 c	YES	ASL	1 Policy	no
Inorganic Compounds (mg/kg)									
Aluminum	23 / 23		4920 - 12500	7143	7700 n	YES	ASL	NA	
Arsenic	64 / 64		2.37 - 24.2	6.19	0.68 c**R	YES	ASL	13.7 BKG	YES
Barium	23 / 23		15.6 - 69.9	29.9	1500 n	no	BSL	NA	
Beryllium	23 / 23		0.15 - 0.47	0.26	16 n	no	BSL	NA	
Cadmium	23 / 23		0.075 - 0.47	0.21	0.71 n	no	BSL	NA	
Calcium	23 / 23		285 - 1460	773		no	E	NA	
Chromium	23 / 23		9.2 - 23.8	14.0	12000 n	no	BSL	NA	
Cobalt	23 / 23		1.6 - 5.9	3.0	2.3 n	YES	ASL	NA	
Copper	11 / 23	5.3 : 12.1	5.9 - 18.8	7.43	310 n	no	BSL	NA	
Iron	23 / 23		6160 - 15100	9750	5500 n	YES	ASL	NA	
Lead	23 / 23		2.7 - 13.2	4.91	400 G	no	BSL	NA	
Magnesium	23 / 23		1570 - 4220	2507		no	E	NA	
Manganese	23 / 23		65.2 - 235	110	180 n	YES	ASL	NA	
Mercury	12 / 23	0.00195 : 0.0022	0.0023 - 0.18	0.011	1.1 n	no	BSL	NA	
Molybdenum	20 / 23	0.19 : 0.28	0.19 - 15.3	1.50	39 n	no	BSL	NA	
Nickel	23 / 23		5.1 - 20.7	8.81	150 n	no	BSL	NA	
Potassium	23 / 23		556 - 2860	1539		no	E	NA	
Selenium	8 / 23	0.181 : 0.55	0.2 - 2.1	0.41	39 n	no	BSL	NA	
Silver	4 / 23	0.019 : 0.053	0.023 - 0.032	0.017	39 n	no	BSL	NA	
Sodium	23 / 23		39.1 - 171	79.7		no	E	NA	

SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 8 - BENEATH
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1		COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)		Exceeds ROD Action Level? (Yes/No)
Thallium	4 / 23	0.076 : 0.19	0.071 - 0.26	0.072	0.078	n	YES	ASL	NA		
Thorium	64 / 64		2.67 - 10.6	5.78			YES	NSL	7.4	BKG	YES
Titanium	23 / 23		232 - 1170	499			YES	NSL	NA		
Tungsten	6 / 23	0.089 : 0.29	0.16 - 0.53	0.13	6.3	n	no	BSL	NA		
Uranium	64 / 64		0.77 - 3.6	1.78			YES	NSL	2.7	ILCR	YES
Uranium-235	64 / 64		0.00522 - 0.025	0.0109			YES	NSL	2.7	ILCR	no
Uranium-238	64 / 64		0.765 - 3.5	1.77	1.6	n	YES	ASL	2.7	ILCR	YES
Vanadium	23 / 23		9.4 - 25.7	14.6	39	n	no	BSL	NA		
Zinc	23 / 23		11.2 - 42.5	19.2	2300	n	no	BSL	NA		
Zirconium	23 / 23		1.6 - 5.2	2.6	0.63	n	YES	ASL	NA		
Radiological (pCi/g)											
Thorium-228	1 / 1		1.09 - 1.09	1.09			YES	NSL	NA		[b]
Thorium-230	1 / 1		1.29 - 1.29	1.29			YES	NSL	NA		[b]
Thorium-232	43 / 43		0.243 - 4.8	1.32			YES	NSL	NA		[b]
Uranium-233 & 234	42 / 42		0.363 - 1.12	0.763			YES	NSL	NA		[b]
Uranium-234	1 / 1		0.555 - 0.555	0.555			YES	NSL	NA		[b]
Uranium-238	1 / 1		1.12 - 1.12	1.12	1.6	n	no	BSL	NA		[b]

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
pCi/g: picoCuries per gram
NA: Not Applicable
RSL: Regional Screening Level
ASL - Concentration used for screening is greater than the screening toxicity value; the analyte was selected as a COPC.
BSL - Concentration used for screening is less than the screening toxicity value; the analyte was not selected as a COPC.
E - Compound is an essential nutrient.
NSL - No screening level available; the analyte was selected as a COPC.

Soil Regional Screening Level (HI = 0.1), May 2021.
c: cancer
c**: cancer where n SL < 10X c SL
c**R: cancer where n SL < 10X c SL RBA applied (See User Guide for Arsenic notice)
G: see user guide on lead
n: noncancer
ns: noncancer, concentration may exceed Csat (See User Guide)

SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 8 - BENEATH AND EXPOSURE AREA
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1		COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)		Exceeds ROD Action Level? (Yes/No)
Volatile Organic Compounds (mg/kg)											
Acetone	4 / 11	0.00416 : 0.138	0.0048 - 0.229	0.0302	7000	n	no	BSL	NA		
Semi-Volatile Organic Compounds (mg/kg)											
Acenaphthene	1 / 66	0.0101 : 0.376	0.0132 - 0.0132	0.0131	360	n	no	BSL	NA		
Aniline	1 / 27	0.102 : 0.591	0.663 - 0.663	0.0860	44	n	no	BSL	NA		
Anthracene	1 / 66	0.0101 : 0.376	0.031 - 0.031	0.0133	1800	n	no	BSL	NA		
Benzo(a)anthracene	3 / 66	0.0101 : 0.376	0.0148 - 0.172	0.0158	1.1	c	no	BSL	0.34	ILCR	no
Benzo(a)pyrene	6 / 66	0.0101 : 0.376	0.0267 - 0.183	0.0219	0.11	c*	YES	ASL	0.22	BKG	no
Benzo(b)fluoranthene	8 / 66	0.0101 : 0.376	0.0114 - 0.301	0.0222	1.1	c	no	BSL	0.34	ILCR	no
Benzo(g,h,i)perylene	3 / 66	0.0101 : 0.376	0.021 - 0.0627	0.0141	180	n	no	BSL	NA		
Benzo(k)fluoranthene	2 / 66	0.0101 : 0.376	0.011 - 0.0924	0.0144	11	c	no	BSL	NA		
Benzoic acid	4 / 54	0.169 : 7.53	0.416 - 0.758	0.243	25000	n	no	BSL	NA		
bis(2-Ethylhexyl)phthalate	20 / 53	0.0103 : 3.76	0.0108 - 0.262	0.0619	39	c**	no	BSL	NA		
Butyl benzylphthalate	3 / 54	0.0101 : 3.76	0.0147 - 0.0648	0.0733	290	c**	no	BSL	NA		
Carbazole	1 / 54	0.0101 : 3.76	0.0213 - 0.0213	0.0717			YES	NSL	NA		
Chrysene	6 / 66	0.0101 : 0.376	0.0148 - 0.188	0.0178	110	c	no	BSL	NA		
Diethyl phthalate	1 / 54	0.0101 : 3.76	0.0162 - 0.0162	0.0753	5100	n	no	BSL	NA		
Di-n-butylphthalate	16 / 54	0.0101 : 3.76	0.0112 - 0.0281	0.0753	630	n	no	BSL	NA		
Fluoranthene	9 / 66	0.0101 : 0.376	0.0125 - 0.366	0.0230	240	n	no	BSL	NA		
Fluorene	2 / 66	0.0101 : 0.376	0.0052 - 0.0129	0.0128	240	n	no	BSL	NA		
Indeno(1,2,3-cd)pyrene	1 / 66	0.0101 : 0.376	0.0812 - 0.0812	0.0141	1.1	c	no	BSL	0.34	ILCR	no
Pentachlorophenol	1 / 54	0.101 : 3.76	0.252 - 0.252	0.124	1	c*	no	BSL	NA		
Phenanthrene	5 / 66	0.0101 : 0.376	0.0137 - 0.193	0.0176	180	n	no	BSL	NA		
Pyrene	10 / 66	0.0101 : 0.376	0.0118 - 0.393	0.0244	180	n	no	BSL	NA		
EPH (mg/kg)											
C10-C22 Aromatic Hydrocarbons	4 / 11	17.5 : 20.4	6.97 - 142	27.9	240	n	no	BSL	NA		
C19-C36 Aliphatic Hydrocarbons	5 / 11	8.26 : 9.29	4.13 - 45	9.04	23000	n	no	BSL	NA		
PCBs (mg/kg)											
Aroclor-1254 (PCB-1254)	42 / 76	0.00112 : 0.00393	0.0011 - 0.386	0.0287	0.12	n	YES	ASL	NA		[a]
Aroclor-1254/1260 (PCB-1254/1260)	33 / 54	0.001531 : 0.0078	0.0011 - 0.432	0.0369			YES	NSL	NA		[a]
Aroclor-1260 (PCB-1260)	27 / 76	0.00112 : 0.0041	0.00148 - 0.0864	0.00591	0.24	c	no	BSL	NA		[a]
Polychlorinated biphenyls (PCBs)	42 / 75	0.00112 : 0.00393	0.0011 - 0.432	0.0343	0.23	c	YES	ASL	1	Policy	no
Inorganic Compounds (mg/kg)											
Aluminum	35 / 35		4920 - 13800	8175	7700	n	YES	ASL	NA		
Antimony	1 / 35	0.0201 : 0.24	0.41 - 0.41	0.035	3.1	n	no	BSL	NA		
Arsenic	76 / 77	6.1 : 6.1	2.37 - 24.2	6.13	0.68	c**R	YES	ASL	13.7	BKG	YES
Barium	35 / 35		14.1 - 69.9	28.1	1500	n	no	BSL	NA		
Beryllium	35 / 35		0.15 - 0.47	0.29	16	n	no	BSL	NA		
Cadmium	35 / 35		0.065 - 0.47	0.18	0.71	n	no	BSL	NA		
Calcium	35 / 35		217 - 2350	747			no	E	NA		
Chromium	35 / 35		9.2 - 23.8	14.6	12000	n	no	BSL	NA		
Cobalt	35 / 35		1.5 - 5.9	3.0	2.3	n	YES	ASL	NA		
Copper	20 / 35	5.3 : 17.2	5.9 - 22.8	8.7	310	n	no	BSL	NA		
Iron	35 / 35		6160 - 15600	10390	5500	n	YES	ASL	NA		
Lead	35 / 35		2.7 - 41.1	9.1	400	G	no	BSL	NA		
Magnesium	35 / 35		1170 - 4220	2527			no	E	NA		
Manganese	35 / 35		37.8 - 235	109	180	n	YES	ASL	NA		

SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 8 - BENEATH AND EXPOSURE AREA
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1	COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)	Exceeds ROD Action Level? (Yes/No)
Mercury	23 / 35	0.00195 : 0.025	0.0023 - 0.23	0.033	1.1 n	no	BSL	NA	
Molybdenum	32 / 35	0.19 : 0.28	0.19 - 15.3	1.2	39 n	no	BSL	NA	
Nickel	35 / 35		5.1 - 20.7	9.1	150 n	no	BSL	NA	
Potassium	35 / 35		369 - 2860	1393		no	E	NA	
Selenium	16 / 35	0.181 : 1.2	0.2 - 2.1	0.51	39 n	no	BSL	NA	
Silver	13 / 35	0.019 : 0.053	0.02 - 0.058	0.023	39 n	no	BSL	NA	
Sodium	34 / 35	50.9 : 50.9	32.9 - 171	68.1		no	E	NA	
Thallium	10 / 35	0.076 : 0.19	0.071 - 0.26	0.078	0.078 n	YES	ASL	NA	
Thorium	77 / 77		2.67 - 10.6	5.65		YES	NSL	7.4 BKG	YES
Titanium	35 / 35		232 - 1170	488		YES	NSL	NA	
Tungsten	11 / 35	0.089 : 0.57	0.16 - 0.53	0.17	6.3 n	no	BSL	NA	
Uranium	77 / 77		0.77 - 10.7	2.2		YES	NSL	2.7 ILCR	YES
Uranium-235	78 / 78		0.00522 - 0.029	0.0113		YES	NSL	2.7 ILCR	no
Uranium-238	77 / 77		0.765 - 10.7	2.14	1.6 n	YES	ASL	2.7 ILCR	YES
Vanadium	35 / 35		9.4 - 29.6	16.2	39 n	no	BSL	NA	
Zinc	34 / 35	57.9 : 57.9	11.2 - 44	21.6	2300 n	no	BSL	NA	
Zirconium	34 / 35	1.93 : 1.93	1.2 - 5.2	2.4	0.63 n	YES	ASL	NA	
Radiological (pCi/g)									
Thorium-228	3 / 3		0.91 - 1.55	1.18		YES	NSL	NA	[b]
Thorium-230	3 / 3		0.715 - 1.29	0.968		YES	NSL	NA	[b]
Thorium-232	46 / 46		0.243 - 4.8	1.31		YES	NSL	NA	[b]
Uranium-233 & 234	43 / 43		0.363 - 1.12	0.758		YES	NSL	NA	[b]
Uranium-234	3 / 3		0.555 - 1.04	0.747		YES	NSL	NA	[b]
Uranium-238	3 / 3		0.596 - 3.43	1.72	1.6 n	YES	ASL	NA	[b]

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c**: cancer where n SL < 10X c SL
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G: see user guide on lead
n: noncancer
ns: noncancer, concentration may exceed Csat (See User Guide)

SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 8 - OUTSIDE
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1		COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)		Exceeds ROD Action Level? (Yes/No)
Semi-Volatile Organic Compounds (mg/kg)											
Benzo(a)pyrene	1 / 1		0.102 - 0.102	0.102	0.11	c*	no	BSL	0.22	BKG	no
Benzo(b)fluoranthene	1 / 1		0.0504 - 0.0504	0.0504	1.1	c	no	BSL	0.34	ILCR	no
Chrysene	1 / 1		0.025 - 0.025	0.0250	110	c	no	BSL	NA		
Fluoranthene	1 / 1		0.0509 - 0.0509	0.0509	240	n	no	BSL	NA		
Phenanthrene	1 / 1		0.023 - 0.023	0.0230	180	n	no	BSL	NA		
Pyrene	1 / 1		0.0483 - 0.0483	0.0483	180	n	no	BSL	NA		
PCBs (mg/kg)											
Aroclor-1254 (PCB-1254)	2 / 5	0.0039 : 0.004	0.019 - 0.0228	0.00954	0.12	n	no	BSL	NA		[a]
Aroclor-1254/1260 (PCB-1254/1260)	2 / 5	0.00174 : 0.0018	0.0271 - 0.0384	0.0136			YES	NSL	NA		[a]
Aroclor-1260 (PCB-1260)	2 / 5	0.0039 : 0.004	0.0081 - 0.0156	0.00592	0.24	c	no	BSL	NA		[a]
Polychlorinated biphenyls (PCBs)	2 / 5	0.0039 : 0.004	0.0271 - 0.0384	0.0143	0.23	c	no	BSL	1	Policy	no
Inorganic Compounds (mg/kg)											
Aluminum	10 / 10		4270 - 18800	10717	7700	n	YES	ASL	NA		
Arsenic	9 / 10	5.4 : 5.4	2.7 - 16.9	7.2	0.68	c**R	YES	ASL	13.7	BKG	YES
Barium	8 / 10	12.9 : 13.4	15.4 - 29.4	19.2	1500	n	no	BSL	NA		
Beryllium	10 / 10		0.16 - 0.52	0.35	16	n	no	BSL	NA		
Cadmium	6 / 10	0.074 : 0.082	0.12 - 0.19	0.10	0.71	n	no	BSL	NA		
Calcium	8 / 10	171 : 191	200 - 800	419			no	E	NA		
Chromium	10 / 10		8.3 - 17.3	13.0	12000	n	no	BSL	NA		
Cobalt	10 / 10		1.2 - 4.2	2.5	2.3	n	YES	ASL	NA		
Copper	5 / 10	5.6 : 10	8.3 - 10.4	6.7	310	n	no	BSL	NA		
Iron	10 / 10		5410 - 14400	11204	5500	n	YES	ASL	NA		
Lead	10 / 10		7.7 - 64.9	22.5	400	G	no	BSL	NA		
Magnesium	10 / 10		1210 - 2950	1865			no	E	NA		
Manganese	10 / 10		38.7 - 182	88.1	180	n	YES	ASL	NA		
Mercury	5 / 10	0.0104 : 0.041	0.0511 - 0.104	0.0425	1.1	n	no	BSL	NA		
Molybdenum	8 / 10	0.28 : 0.34	0.421 - 1.35	0.668	39	n	no	BSL	NA		
Nickel	10 / 10		5.2 - 13.1	8.6	150	n	no	BSL	NA		
Potassium	10 / 10		371 - 1560	754			no	E	NA		
Selenium	2 / 10	0.141 : 0.83	0.27 - 0.38	0.21	39	n	no	BSL	NA		
Silver	10 / 10		0.028 - 0.13	0.049	39	n	no	BSL	NA		
Sodium	5 / 10	33 : 60.8	43.6 - 55.4	36.1			no	E	NA		
Thorium	10 / 10		2.8 - 24.9	7.0			YES	NSL	7.4	BKG	YES
Titanium	10 / 10		145 - 697	454			YES	NSL	NA		
Tungsten	3 / 10	0.17 : 0.632	0.38 - 0.851	0.320	6.3	n	no	BSL	NA		
Uranium	10 / 10		1.3 - 6.4	2.4			YES	NSL	2.7	ILCR	YES
Uranium-235	10 / 10		0.0055 - 0.017	0.010			YES	NSL	2.7	ILCR	no
Uranium-238	10 / 10		1.3 - 6.3	2.4	1.6	n	YES	ASL	2.7	ILCR	YES
Vanadium	10 / 10		9.1 - 31.8	20.1	39	n	no	BSL	NA		
Zinc	5 / 10	12.2 : 23.9	18.4 - 21.4	14.5	2300	n	no	BSL	NA		
Zirconium	5 / 10	1.1 : 2.49	1.1 - 3.3	1.4	0.63	n	YES	ASL	NA		

SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 8 - OUTSIDE
CONCORD, MASSACHUSETTS
FILE NO. 131884

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SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 9 - BENEATH
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1		COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)		Exceeds ROD Action Level? (Yes/No)
Semi-Volatile Organic Compounds (mg/kg)											
Benzoic acid	1 / 2	0.97 : 0.97	0.425 - 0.425	0.455	25000	n	no	BSL	NA		
PCBs (mg/kg)											
Aroclor-1254 (PCB-1254)	10 / 10		0.0025 - 0.196	0.0432	0.12	n	YES	ASL	NA		[a]
Aroclor-1254/1260 (PCB-1254/1260)	9 / 9		0.003244 - 0.2733	0.0615			YES	NSL	NA		[a]
Aroclor-1260 (PCB-1260)	10 / 10		0.000744 - 0.0773	0.0134	0.24	c	no	BSL	NA		[a]
Polychlorinated biphenyls (PCBs)	10 / 10		0.00325 - 0.2733	0.0566	0.23	c	YES	ASL	1	Policy	no
Inorganic Compounds (mg/kg)											
Aluminum	8 / 8		6410 - 10200	7825	7700	n	YES	ASL	NA		
Arsenic	10 / 10		3.6 - 6.6	4.8	0.68	c**R	YES	ASL	13.7	BKG	no
Barium	8 / 8		13 - 49.9	22.4	1500	n	no	BSL	NA		
Beryllium	8 / 8		0.25 - 0.42	0.32	16	n	no	BSL	NA		
Cadmium	8 / 8		0.1 - 0.14	0.12	0.71	n	no	BSL	NA		
Calcium	8 / 8		238 - 1020	599			no	E	NA		
Chromium	8 / 8		10.7 - 21.9	14.9	12000	n	no	BSL	NA		
Cobalt	8 / 8		2.7 - 3.9	3.1	2.3	n	YES	ASL	NA		
Iron	8 / 8		7590 - 9790	8585	5500	n	YES	ASL	NA		
Lead	8 / 8		3.7 - 9.2	5.1	400	G	no	BSL	NA		
Magnesium	8 / 8		1620 - 3250	2358			no	E	NA		
Manganese	8 / 8		76.3 - 132	100	180	n	no	BSL	NA		
Mercury	8 / 8		0.0025 - 0.019	0.0083	1.1	n	no	BSL	NA		
Molybdenum	6 / 8	0.23 : 0.27	0.32 - 1.7	0.54	39	n	no	BSL	NA		
Nickel	8 / 8		6.3 - 10.9	7.9	150	n	no	BSL	NA		
Potassium	8 / 8		499 - 1860	1044			no	E	NA		
Sodium	8 / 8		40.3 - 148	89.2			no	E	NA		
Thorium	10 / 10		4.3 - 6.7	5.5			YES	NSL	7.4	BKG	no
Titanium	8 / 8		404 - 521	456			YES	NSL	NA		
Uranium	10 / 10		1.1 - 1.9	1.6			YES	NSL	2.7	ILCR	no
Uranium-235	10 / 10		0.0073 - 0.012	0.0099			YES	NSL	2.7	ILCR	no
Uranium-238	10 / 10		1.1 - 1.9	1.6	1.6	n	YES	ASL	2.7	ILCR	no
Vanadium	8 / 8		11.3 - 16	13.3	39	n	no	BSL	NA		
Zinc	8 / 8		13.2 - 19.5	16.6	2300	n	no	BSL	NA		
Zirconium	8 / 8		1.5 - 2.4	1.9	0.63	n	YES	ASL	NA		

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NUCLEAR METALS - AOI 9 - BENEATH
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1	COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)	Exceeds ROD Action Level? (Yes/No)
Radiological (pCi/g)									
Thorium-232	2 / 2		1.24 - 1.24	1.24		YES	NSL	NA	[b]
Uranium-233 & 234	2 / 2		0.767 - 0.928	0.848		YES	NSL	NA	[b]

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NUCLEAR METALS - AOI 9 - BENEATH AND EXPOSURE AREA
CONCORD, MASSACHUSETTS
FILE NO. 131884

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Semi-Volatile Organic Compounds (mg/kg)											
Acenaphthylene	1 / 14	0.0109 : 0.115	0.0784 - 0.0784	0.0232	180	n	no	BSL	NA		
Benzo(a)anthracene	2 / 14	0.011 : 0.115	0.0219 - 0.0306	0.0220	1.1	c	no	BSL	0.34	ILCR	no
Benzo(a)pyrene	2 / 14	0.011 : 0.115	0.0474 - 0.0938	0.0273	0.11	c*	no	BSL	0.22	BKG	no
Benzo(b)fluoranthene	2 / 14	0.011 : 0.115	0.0327 - 0.0449	0.0238	1.1	c	no	BSL	0.34	ILCR	no
Benzo(k)fluoranthene	1 / 14	0.0109 : 0.115	0.0156 - 0.0156	0.0198	11	c	no	BSL	NA		
Benzoic acid	3 / 5	0.97 : 1.91	0.425 - 0.457	0.551	25000	n	no	BSL	NA		
Chrysene	2 / 14	0.011 : 0.115	0.0212 - 0.0234	0.0215	110	c	no	BSL	NA		
Fluoranthene	2 / 14	0.011 : 0.115	0.0365 - 0.0368	0.0235	240	n	no	BSL	NA		
Fluorene	1 / 14	0.0109 : 0.115	0.0276 - 0.0276	0.0196	240	n	no	BSL	NA		
Phenanthrene	2 / 14	0.011 : 0.115	0.0128 - 0.0163	0.0204	180	n	no	BSL	NA		
Pyrene	2 / 14	0.011 : 0.115	0.0405 - 0.0438	0.0243	180	n	no	BSL	NA		
PCBs (mg/kg)											
Aroclor-1254 (PCB-1254)	13 / 17	0.004 : 0.0366	0.0025 - 0.196	0.0312	0.12	n	YES	ASL	NA		[a]
Aroclor-1254/1260 (PCB-1254/1260)	10 / 13	0.001815 : 0.0244	0.003244 - 0.2733	0.0510			YES	NSL	NA		[a]
Aroclor-1260 (PCB-1260)	13 / 17	0.004 : 0.0366	0.000744 - 0.0773	0.0139	0.24	c	no	BSL	NA		[a]
Polychlorinated biphenyls (PCBs)	13 / 17	0.004 : 0.0366	0.00325 - 0.2733	0.0426	0.23	c	YES	ASL	1	Policy	no
Inorganic Compounds (mg/kg)											
Aluminum	11 / 11		6410 - 11200	8147	7700	n	YES	ASL	NA		
Arsenic	15 / 16	4.2 : 4.2	3.6 - 6.6	5.1	0.68	c**R	YES	ASL	13.7	BKG	no
Barium	9 / 11	11.9 : 15	13 - 49.9	19.3	1500	n	no	BSL	NA		
Beryllium	11 / 11		0.25 - 0.48	0.34	16	n	no	BSL	NA		
Cadmium	9 / 11	0.051 : 0.074	0.1 - 0.17	0.11	0.71	n	no	BSL	NA		
Calcium	11 / 11		238 - 1020	525			no	E	NA		
Chromium	11 / 11		8.8 - 21.9	13.9	12000	n	no	BSL	NA		
Cobalt	11 / 11		1.1 - 5.6	3.0	2.3	n	YES	ASL	NA		
Copper	1 / 11	4.1 : 9.3	11.8 - 11.8	3.92	310	n	no	BSL	NA		
Iron	11 / 11		6730 - 9790	8440	5500	n	YES	ASL	NA		
Lead	11 / 11		3.7 - 40.1	11.1	400	G	no	BSL	NA		
Magnesium	11 / 11		1100 - 3250	2168			no	E	NA		
Manganese	11 / 11		40.6 - 132	91.0	180	n	no	BSL	NA		
Mercury	10 / 11	0.02 : 0.02	0.0025 - 0.0579	0.0161	1.1	n	no	BSL	NA		
Molybdenum	8 / 11	0.23 : 0.39	0.32 - 1.7	0.530	39	n	no	BSL	NA		
Nickel	11 / 11		5.2 - 11.2	7.87	150	n	no	BSL	NA		
Potassium	11 / 11		380 - 1860	940			no	E	NA		
Silver	3 / 11	0.014 : 0.03	0.025 - 0.066	0.021	39	n	no	BSL	NA		
Sodium	9 / 11	45.8 : 66.8	40.3 - 148	75.1			no	E	NA		
Thorium	16 / 16		3.03 - 8.9	5.60			YES	NSL	7.4	BKG	YES
Titanium	11 / 11		365 - 613	457			YES	NSL	NA		
Uranium	16 / 16		1.1 - 2.8	1.8			YES	NSL	2.7	ILCR	YES
Uranium-235	16 / 16		0.0061 - 0.014	0.010			YES	NSL	2.7	ILCR	no
Uranium-238	16 / 16		1.1 - 2.8	1.8	1.6	n	YES	ASL	2.7	ILCR	YES
Vanadium	11 / 11		11.3 - 20.5	14.9	39	n	no	BSL	NA		
Zinc	9 / 11	12.5 : 19.4	13.2 - 19.5	15.1	2300	n	no	BSL	NA		
Zirconium	9 / 11	1.14 : 1.2	1.5 - 2.4	1.7	0.63	n	YES	ASL	NA		

SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 9 - BENEATH AND EXPOSURE AREA
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1	COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)	Exceeds ROD Action Level? (Yes/No)
Radiological (pCi/g)									
Thorium-232	5 / 5		0.894 - 1.47	1.18		YES	NSL	NA	[b]
Uranium-233 & 234	5 / 5		0.677 - 0.928	0.773		YES	NSL	NA	[b]

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
pCi/g: picoCuries per gram
NA: Not Applicable
RSL: Regional Screening Level
ASL - Concentration used for screening is greater than the screening toxicity value; the analyte was selected as a COPC.
BSL - Concentration used for screening is less than the screening toxicity value; the analyte was not selected as a COPC.
E - Compound is an essential nutrient.
NSL - No screening level available; the analyte was selected as a COPC.

Soil Regional Screening Level (HI = 0.1), May 2021.
c: cancer
c**: cancer where n SL < 10X c SL
c**R: cancer where n SL < 10X c SL RBA applied (See User Guide for Arsenic notice)
G: see user guide on lead
n: noncancer
ns: noncancer, concentration may exceed Csat (See User Guide)

SUMMARY STATISTICS OF SOIL ANALYTICAL RESULTS AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS - AOI 9 - OUTSIDE
CONCORD, MASSACHUSETTS
FILE NO. 131884

chemical_name	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	Average of All Samples	USEPA Residential Soil RSL May 2022 HI = 0.1	COPC? (Yes/No)	Rationale for Contaminant Deletion or Selection	ROD Action Level Human Health (mg/Kg)	Exceeds ROD Action Level? (Yes/No)
Inorganic Compounds (mg/kg)									
Aluminum	4 / 4		9350 - 14500	10673	7700 n	YES	ASL	NA	
Arsenic	3 / 4	6 : 6	6.4 - 10	6.9	0.68 c**R	YES	ASL	13.7 BKG	no
Barium	2 / 4	13.9 : 15.6	20.9 - 21.3	14.2	1500 n	no	BSL	NA	
Beryllium	4 / 4		0.26 - 0.74	0.43	16 n	no	BSL	NA	
Cadmium	1 / 4	0.068 : 0.11	0.089 - 0.089	0.055	0.71 n	no	BSL	NA	
Calcium	4 / 4		401 - 4350	1431		no	E	NA	
Chromium	4 / 4		11.7 - 20.3	15.4	12000 n	no	BSL	NA	
Cobalt	4 / 4		1.5 - 3.7	2.5	2.3 n	YES	ASL	NA	
Iron	4 / 4		8880 - 12400	10520	5500 n	YES	ASL	NA	
Lead	4 / 4		35 - 53.7	41.1	400 G	no	BSL	NA	
Magnesium	4 / 4		1340 - 2720	2013		no	E	NA	
Manganese	4 / 4		57.3 - 114	83.6	180 n	no	BSL	NA	
Mercury	4 / 4		0.0595 - 0.0817	0.0658	1.1 n	no	BSL	NA	
Molybdenum	4 / 4		0.616 - 1.26	0.852	39 n	no	BSL	NA	
Nickel	4 / 4		7.3 - 16.6	11.0	150 n	no	BSL	NA	
Potassium	4 / 4		517 - 1420	757		no	E	NA	
Silver	4 / 4		0.063 - 0.12	0.086	39 n	no	BSL	NA	
Thorium	4 / 4		3.39 - 4.85	4.32		YES	NSL	7.4 BKG	no
Titanium	4 / 4		464 - 620	522		YES	NSL	NA	
Tungsten	2 / 4	0.591 : 0.61	0.62 - 0.989	0.552	6.3 n	no	BSL	NA	
Uranium	4 / 4		2.3 - 3.6	2.8		YES	NSL	2.7 ILCR	YES
Uranium-235	4 / 4		0.0081 - 0.011	0.0097		YES	NSL	2.7 ILCR	no
Uranium-238	4 / 4		2.3 - 3.6	2.8	1.6 n	YES	ASL	2.7 ILCR	YES
Vanadium	4 / 4		19.5 - 32.4	24.9	39 n	no	BSL	NA	
Radiological (pCi/g)									
Thorium-228	1 / 1		0.856 - 0.856	0.856		YES	NSL	NA	[a]
Thorium-230	1 / 1		0.682 - 0.682	0.682		YES	NSL	NA	[a]
Thorium-232	1 / 1		0.962 - 0.962	0.962		YES	NSL	NA	[a]
Uranium-234	1 / 1		0.893 - 0.893	0.893		YES	NSL	NA	[a]
Uranium-238	1 / 1		1.06 - 1.06	1.06	1.6 n	no	BSL	NA	[a]

ABBREVIATIONS AND NOTES:
mg/kg: milligram per kilogram
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E - Compound is an essential nutrient.
NSL - No screening level available; the analyte was selected as a COPC.

Soil Regional Screening Level (HI = 0.1), May 2021.
c: cancer
c**: cancer where n SL < 10X c SL
c**R: cancer where n SL < 10X c SL RBA applied (See User Guide for Arsenic notice)
G: see user guide on lead
n: noncancer
ns: noncancer, concentration may exceed Csat (See User Guide)

PART 2
REMEDIAL ACTION LEVELS FOR URANIUM

Part 2: Remedial action levels (RALs) for uranium

RALs represent the highest concentrations of COCs that can remain in soil within the excavation area, but still allow for the area to be compliant with cleanup objectives. As described in the CQA report, RALs for PCBs are established at the cleanup level of 1 mg/kg and RALs for polycyclic aromatic hydrocarbons (PAHs), arsenic, and thorium are not required because PAHs contributed low risks and the presence of arsenic and thorium is attributable to naturally occurring background conditions.

Bottom RALs for uranium were identified in consideration of the soil concentrations that are anticipated to remain in soil beneath the excavation footprint. An ideal RAL is a value which is higher than the residual concentrations in soil remaining beneath the excavation to avoid excavating more soil than is necessary to achieve the cleanup objective, but still low enough to ensure that if all confirmatory samples had uranium at the RAL, the final residual EPC would not exceed the cleanup level. Information to support the selection of RALs for each of the remediation areas is provided below.

AOI 8:

- Bottom: The highest concentration remaining in the data set for soil beneath the excavation is 3.6 mg/kg (refer to tables in Part 1 of this Attachment). Using the methodology described in Section 6.5 of the CQA document and Part 3 of this Attachment, if it is assumed that all confirmatory bottom samples have a uranium concentration of 4 mg/kg, then the final residual EPC for uranium would meet the cleanup level. Consequently, a uranium concentration of 4 mg/kg was identified as the bottom RAL.
- Side wall: The highest concentration in soil samples that abut exposure area A5 is 6.4 mg/kg (SS-RI-09030, 0 to 1 ft bgs) (refer to tables in Part 1 of this Attachment). Therefore, a concentration of 6.4 mg/kg was identified as the side wall RAL.

AOI 9:

- Bottom: The highest concentration remaining in the data set for soil beneath the excavation is 1.9 mg/kg (refer to tables in Part 1 of this Attachment). Using the methodology described in Section 6.5 of the CQA document and Part 3 of this Attachment, if it is assumed that all confirmatory bottom samples have a uranium concentration equal to the cleanup level of 2.7 mg/kg, then the final residual EPC for uranium would meet the cleanup level. Consequently, a uranium concentration of 2.7 mg/kg was identified as the bottom RAL.
- Side wall: The highest concentration in soil samples that abut exposure area A5 is 3.6 mg/kg (SS-RI-140225, 0 to 1 ft bgs) (refer to tables in Part 1 of this Attachment). Therefore, a concentration of 3.6 mg/kg was identified as the side wall RAL.

PART 3
EXPOSURE POINT CONCENTRATIONS

Part 3: Exposure point concentrations (EPCs)

EPCs are used to evaluate compliance with cleanup levels and to calculate residual risks. EPCs are identified as the lesser of the 95% upper concentration limit (95 UCL) and the maximum detected concentration within each data set. 95% UCLs are calculated using USEPA ProUCL (version 5.2.0) software. EPCs were developed for the following data sets:

A) Soil samples representative of anticipated post-remedial conditions beneath the excavation

B) Soil samples representative of anticipated post-remedial conditions beneath the excavation and throughout the exposure area

For each of these data sets, two groups of EPCs were developed:

1) EPCs based on RI and PDI data representative of soil conditions that exist outside of the design cut lines. These EPCs were developed for all COCs and COPCs.

2) EPCs based on RI and PDI data representative of soil conditions that exist outside of the design cut lines (i.e., the same data set as (1)), plus confirmatory data for bottom samples assuming that concentrations of bottom confirmatory samples are equal to the bottom RALs. These EPCs were developed for PCBs and uranium and were used to:

    a. Help set the bottom RAL values

    b. Verify that confirmatory samples that meet the RALs will provide high confidence that the final residual EPCs for PCBs and uranium will meet the cleanup levels

   These EPCs were developed by creating a ProUCL input file that included the RI and PDI data representative of soil conditions that exist outside of the design cut lines, then adding the number of confirmatory bottom samples that are proposed to be collected within the excavation footprints (refer to Sections 5 and 6 of the CQA report), and assigning concentrations of PCBs and uranium equal to the bottom RALs to each of the bottom confirmatory samples.

During the remedial implementation, the EPCs in group (2) will be re-calculated using on RI and PDI data representative of soil conditions that exist outside of the design cut lines and the actual confirmatory and verification sampling data for all of the COCs. The resulting EPCs will be used to derive final residual EPCs using the methodology described in the CQA report. The final residual EPCs will be used to evaluate compliance with the cleanup levels and to support the residual risk analysis. The EPCs developed in group (1) for the COPCs will be used to support the residual risk analysis.

The attachments to Part 3 of this Attachment provide documentation of the EPCs for each of the remediation areas and are grouped by remediation area. Within each attachment, the following information is provided:

- EPC summary table providing EPCs for each of the data sets
- ProUCL input file for each data set
- ProUCL outpuf file for each data set

Exposure Point Concentrations

EXPOSURE POINT CONCENTRATIONS
AOI 8 (FORMERLY HHRA EXPOSURE AREA A5 - AOI 8 SWEEPINGS AREA)
NUCLEAR METALS
CONCORD, MASSACHUSETTS
FILE NO. 131884

Exposure Point	Chemical of Potential Concern (1)	Arithmetic Mean	95% UCL (2) (calculation)	Maximum Detected Concentration	Exposure Point Concentration			
					EPC	Units	Statistic	Rationale
AOI 8	**PCBs (mg/kg)**							
Beneath	Polychlorinated biphenyls (PCBs)	0.026	0.0233 KM H	0.2481	0.023	mg/Kg	UCL - KM H	(4)
	Inorganic Compounds (mg/kg)							
	Aluminum	7,143	7,893 95% Student's-t	12,500	7,893	mg/Kg	UCL - 95% Student's-t	(4)
	Arsenic	6.2	6.822 95% Student's-t	24.2	6.8	mg/Kg	UCL - 95% Student's-t	(4)
	Cobalt	3.03	3.465 95% Student's-t	5.9	3.5	mg/Kg	UCL - 95% Student's-t	(4)
	Iron	9,750	10,847 95% Student's-t	15,100	10,847	mg/Kg	UCL - 95% Student's-t	(4)
	Manganese	110	126.2 95% Student's-t	235	126	mg/Kg	UCL - 95% Student's-t	(4)
	Thallium	0.07	0.101 95% KM (t)	0.26	0.101	mg/Kg	UCL - 95% KM (t)	(4)
	Thorium	5.8	6.115 95% Student's-t	10.6	6.1	mg/Kg	UCL - 95% Student's-t	(4)
	Titanium	499	578.6 95% Student's-t	1,170	579	mg/Kg	UCL - 95% Student's-t	(4)
	Uranium	1.8	1.793 95% Student's-t	3.6	1.8	mg/Kg	UCL - 95% Student's-t	(4)
	Zirconium	2.6	3.015 95% Student's-t	5.2	3.0	mg/Kg	UCL - 95% Student's-t	(4)
AOI 8	**PCBs (mg/kg)**							
Beneath + RALs	Polychlorinated biphenyls (PCBs)	0.506	0.579 95% KM (t)	1	0.58	mg/Kg	UCL - 95% KM (t)	(4)
	Inorganic Compounds (mg/kg)							
	Uranium	2.818	3.001 95% Student's-t	4	3.0	mg/Kg	UCL - 95% Student's-t	(4)
AOI 8	**Semi-Volatile Organic Compounds (mg/kg)**							
Beneath +	Benzo(a)pyrene	0.022	0.0275 95% KM (t)	0.183	0.028	mg/Kg	UCL - 95% KM (t)	(4)
Exposure Area	Carbazole	0.072	NC	0.0213	0.021	mg/Kg	Maximum	(3)
	PCBs (mg/kg)							
	Polychlorinated biphenyls (PCBs)	0.034	0.0414 KM H	0.432	0.041	mg/Kg	UCL - KM H	(4)
	Inorganic Compounds (mg/kg)							
	Aluminum	8,175	8,922 95% Student's-t	13,800	8,922	mg/Kg	UCL - 95% Student's-t	(4)
	Arsenic	6.13	6.685 95% KM (t)	24.2	6.7	mg/Kg	UCL - 95% KM (t)	(4)
	Cobalt	3.03	3.359 95% Student's-t	5.9	3.4	mg/Kg	UCL - 95% Student's-t	(4)
	Iron	10,390	11,245 95% Student's-t	15,600	11,245	mg/Kg	UCL - 95% Student's-t	(4)
	Manganese	109	122.7 95% Student's-t	235	123	mg/Kg	UCL - 95% Student's-t	(4)
	Thallium	0.078	0.103 95% KM Adjusted Gamma	0.26	0.103	mg/Kg	UCL - 95% KM Adjusted Gamma	(4)
	Thorium	5.65	5.942 95% Student's-t	10.6	5.9	mg/Kg	UCL - 95% Student's-t	(4)
	Titanium	488	542.6 95% Student's-t	1,170	543	mg/Kg	UCL - 95% Student's-t	(4)
	Uranium	2.15	2.404 95% Student's-t	10.7	2.4	mg/Kg	UCL - 95% Student's-t	(4)
	Zirconium	2.38	2.728 95% KM Adjusted Gamma	5.2	2.7	mg/Kg	UCL - 95% KM Adjusted Gamma	(4)
AOI 8	**PCBs (mg/kg)**							
Beneath +	Polychlorinated biphenyls (PCBs)	0.469	0.538 95% KM (t)	1	0.54	mg/Kg	UCL - 95% KM (t)	(4)
Exposure Area + RALs	**Inorganic Compounds (mg/kg)**							
	Uranium	2.93	3.158 95% Student's-t	10.7	3.2	mg/Kg	UCL - 95% Student's-t	(4)

NOTES:

(1) Chemicals of potential concern (COPCs) are identified in Appendix Part 1.
(2) 95% UCL is calculated using ProUCL software (V. 5.2.0); calculations presented in Appendix Part 3.
(3) The maximum detected concentration is used as the EPC because it is lower than the calculated 95% UCL, or no 95% UCL is calculated.
(4) The 95% UCL is used as the EPC because the calculated 95% UCL is less than the maximum detected concentration.

EPC = Exposure Point Concentration
mg/Kg = milligrams per kilogram
NC - Not Calculated
UCL = Upper Confidence Limit on the arithmetic mean

EXPOSURE POINT CONCENTRATIONS
AOI 9 (FORMERLY HHRA EXPOSURE AREA A4 - AOI 14 NORTH)
NUCLEAR METALS
CONCORD, MASSACHUSETTS
FILE NO. 131884

Exposure Point	Chemical of Potential Concern (1)	Arithmetic Mean	95% UCL (2) (calculation)	Maximum Detected Concentration	Exposure Point Concentration			
					EPC	Units	Statistic	Rationale
AOI 9	**PCBs (mg/kg)**							
Beneath	Polychlorinated biphenyls (PCBs)	0.057	0.157 95% Adjusted Gamma	0.2733	0.16	mg/Kg	UCL - 95% Adjusted Gamma	(4)
	Inorganic Compounds (mg/kg)							
	Aluminum	7,825	8,681 95% Student's-t	10,200	8,681	mg/Kg	UCL - 95% Student's-t	(4)
	Arsenic	4.8	5.313 95% Student's-t	6.6	5.3	mg/Kg	UCL - 95% Student's-t	(4)
	Cobalt	3.1	3.469 95% Student's-t	3.9	3.5	mg/Kg	UCL - 95% Student's-t	(4)
	Iron	8,585	9,130 95% Student's-t	9,790	9,130	mg/Kg		(4)
	Thorium	5.5	5.993 95% Student's-t	6.7	6.0	mg/Kg	UCL - 95% Student's-t	(4)
	Titanium	456	486 95% Student's-t	521	486	mg/Kg	UCL - 95% Student's-t	(4)
	Uranium	1.6	1.747 95% Student's-t	1.9	1.7	mg/Kg	UCL - 95% Student's-t	(4)
	Zirconium	1.9	2.133 95% Student's-t	2.4	2.1	mg/Kg	UCL - 95% Student's-t	(4)
AOI 9	**PCBs (mg/kg)**							
Beneath + RALs	Polychlorinated biphenyls (PCBs)	0.637	0.795 95% Student's-t	1	0.80	mg/Kg	UCL - 95% Student's-t	(4)
	Inorganic Compounds (mg/kg)							
	Uranium	2.278	2.467 95% Student's-t	2.7	2.5	mg/Kg	UCL - 95% Student's-t	(4)
AOI 9	**PCBs (mg/kg)**							
Beneath + Exposure Area	Polychlorinated biphenyls (PCBs)	0.043	0.102 95% KM Adjusted Gamma	0.2733	0.10	mg/Kg	UCL - 95% KM Adjusted Gamma	(4)
	Inorganic Compounds (mg/kg)							
	Aluminum	8,147	9,003 95% Student's-t	11,200	9,003	mg/Kg	UCL - 95% Student's-t	(4)
	Arsenic	5.1	5.633 95% KM (t)	6.6	5.6	mg/Kg	UCL - 95% KM (t)	(4)
	Cobalt	3.0	3.69 95% Student's-t	5.6	3.7	mg/Kg	UCL - 95% Student's-t	(4)
	Iron	8,440	8,951 95% Student's-t	9,790	8,951	mg/Kg	UCL - 95% Student's-t	(4)
	Thorium	5.6	6.202 95% Student's-t	8.9	6.2	mg/Kg	UCL - 95% Student's-t	(4)
	Titanium	457	495.5 95% Student's-t	613	496	mg/Kg	UCL - 95% Student's-t	(4)
	Uranium	1.8	1.946 95% Student's-t	2.8	1.9	mg/Kg	UCL - 95% Student's-t	(4)
	Zirconium	1.7	2.08 95% KM (t)	2.4	2.1	mg/Kg	UCL - 95% KM (t)	(4)
AOI 9	**PCBs (mg/kg)**							
Beneath + Exposure Area + RALs	Polychlorinated biphenyls (PCBs)	0.507	0.651 95% KM (t)	1	0.65	mg/Kg	UCL - 95% KM (t)	(4)
	Inorganic Compounds (mg/kg)							
	Uranium	2.24	2.401 95% Student's-t	2.8	2.4	mg/Kg	UCL - 95% Student's-t	(4)

NOTES:

(1) Chemicals of potential concern (COPCs) are identified in Appendix Part 1.
(2) 95% UCL is calculated using ProUCL software (V. 5.2.0); calculations presented in Appendix Part 3.
(3) The maximum detected concentration is used as the EPC because it is lower than the calculated 95% UCL, or no 95% UCL is calculated.
(4) The 95% UCL is used as the EPC because the calculated 95% UCL is less than the maximum detected concentration.

EPC = Exposure Point Concentration
mg/Kg = milligrams per kilogram
NC - Not Calculated
UCL = Upper Confidence Limit on the arithmetic mean

ProUCL Input

ProUCL Input
AOI-08: Beneath

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Aluminum	D_Aluminum	Arsenic	D_Arsenic	Cobalt	D_Cobalt
SB-PD-08008	SB-PD-08008-004-111620	11/16/2020	4	6	N	EA08 - Beneath	0.00116	0			5.18	1		
SB-PD-08009	SB-PD-08009-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00124	0			4.14	1		
SB-PD-08010	SB-PD-08010-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00127	0			5.49	1		
SB-PD-08012	SB-PD-08012-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00562	1			5.94	1		
SB-PD-08013	SB-PD-08013-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00244	1			6.15	1		
SB-PD-08016	SB-PD-08016-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00621	1			7.25	1		
SB-PD-08017	SB-PD-08017-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00117	0			2.81	1		
SB-PD-08018	SB-PD-08018-004-111620	11/16/2020	4	6	N	EA08 - Beneath	0.00112	0			3.75	1		
SB-PD-08020	SB-PD-08020-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00221	1			4.88	1		
SB-PD-08022	SB-PD-08022-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.0018	1			4.53	1		
SB-PD-08023	SB-PD-08023-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00455	1			6.2	1		
SB-PD-08024	SB-PD-08024-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00116	0			5.36	1		
SB-PD-08025	SB-PD-08025-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00376	1			6.02	1		
SB-PD-08027	SB-PD-08027-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.00911	1			6.03	1		
SB-PD-08033	SB-PD-08033-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00123	0			6.62	1		
SB-PD-08034	SB-PD-08034-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.179	1			5.1	1		
SB-PD-08037	SB-PD-08037-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.0589	1			5.82	1		
SB-PD-08043	SB-PD-08043-001-101520	10/15/2020	1	2	N	EA08 - Beneath	0.00433	1			2.94	1		
SB-PD-08056	SB-PD-08056-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0012	0			4.56	1		
SB-PD-08056	SB-PD-08056-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00117	0			4.55	1		
SB-PD-08056	SB-PD-08056-004-032921	03/29/2021	4	6	N	EA08 - Beneath	0.0012	0			6.85	1		
SB-PD-08058	SB-PD-08058-002-033021	03/30/2021	2	4	N	EA08 - Beneath	0.00126	0			5.17	1		
SB-PD-08058	SB-PD-08058-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.00119	0			2.37	1		
SB-PD-08059	SB-PD-08059-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0187	1			6.48	1		
SB-PD-08059	SB-PD-08059-004-032921	03/29/2021	4	6	N	EA08 - Beneath	0.00115	0			5.94	1		
SB-PD-08061	SB-PD-08061-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.0032	1			6.52	1		
SB-PD-08062	SB-PD-08062-001-033021	03/30/2021	1	2	N	EA08 - Beneath	0.00129	0			10.5	1		
SB-PD-08062	SB-PD-08062-002-033021	03/30/2021	2	4	N	EA08 - Beneath	0.00117	0			5.89	1		
SB-PD-08062	SB-PD-08062-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.00128	0			4.63	1		
SB-PD-08064	SB-PD-08064-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0283	1			4.18	1		
SB-PD-08064	SB-PD-08064-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00121	0			4.33	1		
SB-PD-08066	SB-PD-08066-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0454	1			5.86	1		
SB-PD-08068	SB-PD-08068-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0143	1			7.99	1		
SB-PD-08068	SB-PD-08068-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00662	1			5.58	1		
SB-PD-08070	SB-PD-08070-001-033121	03/31/2021	1	2	N	EA08 - Beneath	0.00121	0			5.55	1		
SB-PD-08070	SB-PD-08070-002-033121	03/31/2021	2	4	N	EA08 - Beneath	0.00117	0			6.25	1		
SB-PD-08073	SB-PD-08073-001-033121	03/31/2021	1	2	N	EA08 - Beneath	0.00347	1			8.56	1		
SB-RI-08001	SBRI08001005-10/11/2005	10/11/2005	6	8	N	EA08 - Beneath	0.0113	1	5540	1	3.6	1	1.9	1
SB-RI-08002	SBRI08002005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	0.0037	0	7830	1	5.1	1	2.7	1
SB-RI-08002	SBRI08002008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0285	1	7720	1	6.9	1	3.6	1
SB-RI-08003	SBRI08003005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	0.0014	1	6340	1	4.6	1	3	1
SB-RI-08003	SBRI08003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0036	0	5600	1	6.1	1	3.7	1
SB-RI-08004	SBRI08004004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.0034	0	5610	1	4.2	1	1.9	1

ProUCL Input
AOI-08: Beneath

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Aluminum	D_Aluminum	Arsenic	D_Arsenic	Cobalt	D_Cobalt
SB-RI-08004	SBRI08004008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0037	0	7440	1	9	1	2.3	1
SB-RI-08005	SBRI08005004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.002	1	5200	1	5.9	1	2.2	1
SB-RI-08005	SBRI08005008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath			5130	1	6.9	1	1.9	1
SB-RI-09001	SBRI09001008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0037	0	6970	1	4.3	1	2.4	1
SB-RI-09002	SBRI09002004-10/12/2005	10/12/2005	4	6	N	EA08 - Beneath	0.0035	0	6570	1	5.2	1	4.2	1
SB-RI-09002	SBRI09002008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0011	1	12000	1	4.9	1	5.9	1
SB-RI-09003	SBRI09003004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.0077	1	5500	1	5.7	1	2.1	1
SB-RI-09003	SBRI09003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0037	0	4920	1	5.9	1	1.6	1
SB-RI-09004	SBRI09004003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.032	1	7500	1	24.2	1	2.7	1
SB-RI-09005	SBRI09005003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0034	0	5260	1	6.3	1	1.9	1
SB-RI-09007	SBRI09007003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0034	0	8090	1	4.9	1	4.3	1
SB-RI-09008	SBRI09008003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0018	1	10200	1	7.5	1	4.8	1
SB-RI-09008	SBRI09008008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0037	0	7830	1	4.2	1	2.7	1
SB-RI-09009	SBRI09009003-10/11/2005	10/11/2005	3	5	N	EA08 - Beneath	0.00343	0	5220	1	5.3	1	2.2	1
SS-PD-08041	SS-PD-08041-000-101520	10/15/2020	0	1	N	EA08 - Beneath	0.227	1			6.05	1		
SS-PD-08042	SS-PD-08042-000-101520	10/15/2020	0	1	N	EA08 - Beneath	0.0242	1			6.79	1		
SS-PD-08055	SS-PD-08055-000-033021	03/30/2021	0	1	N	EA08 - Beneath	0.00419	1			4.88	1		
SS-PD-08070	SS-PD-08070-000-033121	03/31/2021	0	1	N	EA08 - Beneath	0.0401	1			5.03	1		
TP-RI-08002	TPRI08002004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	0.2481	1	8390	1	15.7	1	4.5	1
TP-RI-08003	TPRI08003004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	0.141	1	6930	1	13.2	1	4.9	1
TP-RI-08004	TPRI08004003-11/30/2004	11/30/2004	3	4	N	EA08 - Beneath	0.0674	1	12500	1	6.8	1	2.4	1

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Iron	D_Iron	Manganese	D_Manganese	Thallium	D_Thallium	Thorium	D_Thorium	Titanium
SB-PD-08008	SB-PD-08008-004-111620	11/16/2020	4	6	N	EA08 - Beneath							6.33	1	
SB-PD-08009	SB-PD-08009-002-111620	11/16/2020	2	4	N	EA08 - Beneath							2.67	1	
SB-PD-08010	SB-PD-08010-002-111620	11/16/2020	2	4	N	EA08 - Beneath							5.92	1	
SB-PD-08012	SB-PD-08012-002-111820	11/18/2020	2	4	N	EA08 - Beneath							4.57	1	
SB-PD-08013	SB-PD-08013-002-111820	11/18/2020	2	4	N	EA08 - Beneath							3.87	1	
SB-PD-08016	SB-PD-08016-002-111820	11/18/2020	2	4	N	EA08 - Beneath							3.64	1	
SB-PD-08017	SB-PD-08017-002-111620	11/16/2020	2	4	N	EA08 - Beneath							4.25	1	
SB-PD-08018	SB-PD-08018-004-111620	11/16/2020	4	6	N	EA08 - Beneath							4.57	1	
SB-PD-08020	SB-PD-08020-002-111720	11/17/2020	2	4	N	EA08 - Beneath							4.87	1	
SB-PD-08022	SB-PD-08022-004-111720	11/17/2020	4	6	N	EA08 - Beneath							6.82	1	
SB-PD-08023	SB-PD-08023-002-111720	11/17/2020	2	4	N	EA08 - Beneath							6.38	1	
SB-PD-08024	SB-PD-08024-002-111720	11/17/2020	2	4	N	EA08 - Beneath							6.4	1	
SB-PD-08025	SB-PD-08025-002-111720	11/17/2020	2	4	N	EA08 - Beneath							6.09	1	
SB-PD-08027	SB-PD-08027-004-111720	11/17/2020	4	6	N	EA08 - Beneath							5.75	1	
SB-PD-08033	SB-PD-08033-002-111720	11/17/2020	2	4	N	EA08 - Beneath							6.61	1	
SB-PD-08034	SB-PD-08034-004-111720	11/17/2020	4	6	N	EA08 - Beneath							7.15	1	
SB-PD-08037	SB-PD-08037-002-111820	11/18/2020	2	4	N	EA08 - Beneath							5.38	1	
SB-PD-08043	SB-PD-08043-001-101520	10/15/2020	1	2	N	EA08 - Beneath							5.64	1	
SB-PD-08056	SB-PD-08056-001-032921	03/29/2021	1	2	N	EA08 - Beneath							5.22	1	
SB-PD-08056	SB-PD-08056-002-032921	03/29/2021	2	4	N	EA08 - Beneath							4.78	1	
SB-PD-08056	SB-PD-08056-004-032921	03/29/2021	4	6	N	EA08 - Beneath							4.66	1	
SB-PD-08058	SB-PD-08058-002-033021	03/30/2021	2	4	N	EA08 - Beneath							4.72	1	
SB-PD-08058	SB-PD-08058-004-033021	03/30/2021	4	6	N	EA08 - Beneath							3.98	1	
SB-PD-08059	SB-PD-08059-002-032921	03/29/2021	2	4	N	EA08 - Beneath							6.38	1	
SB-PD-08059	SB-PD-08059-004-032921	03/29/2021	4	6	N	EA08 - Beneath							4.76	1	
SB-PD-08061	SB-PD-08061-004-033021	03/30/2021	4	6	N	EA08 - Beneath							4.97	1	
SB-PD-08062	SB-PD-08062-001-033021	03/30/2021	1	2	N	EA08 - Beneath							7.41	1	
SB-PD-08062	SB-PD-08062-002-033021	03/30/2021	2	4	N	EA08 - Beneath							7.07	1	
SB-PD-08062	SB-PD-08062-004-033021	03/30/2021	4	6	N	EA08 - Beneath							7.3	1	
SB-PD-08064	SB-PD-08064-001-032921	03/29/2021	1	2	N	EA08 - Beneath							5.98	1	
SB-PD-08064	SB-PD-08064-002-032921	03/29/2021	2	4	N	EA08 - Beneath							6.22	1	
SB-PD-08066	SB-PD-08066-002-032921	03/29/2021	2	4	N	EA08 - Beneath							6.83	1	
SB-PD-08068	SB-PD-08068-001-032921	03/29/2021	1	2	N	EA08 - Beneath							6.68	1	
SB-PD-08068	SB-PD-08068-002-032921	03/29/2021	2	4	N	EA08 - Beneath							7.39	1	
SB-PD-08070	SB-PD-08070-001-033121	03/31/2021	1	2	N	EA08 - Beneath							6.56	1	
SB-PD-08070	SB-PD-08070-002-033121	03/31/2021	2	4	N	EA08 - Beneath							4.34	1	
SB-PD-08073	SB-PD-08073-001-033121	03/31/2021	1	2	N	EA08 - Beneath							6.93	1	
SB-RI-08001	SBRI08001005-10/11/2005	10/11/2005	6	8	N	EA08 - Beneath	6700	1	74.6	1	0.097	0	4.1	1	333
SB-RI-08002	SBRI08002005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	7540	1	88.7	1	0.11	0	8.2	1	547
SB-RI-08002	SBRI08002008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	10300	1	135	1	0.14	0	7.4	1	607
SB-RI-08003	SBRI08003005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	7680	1	92.4	1	0.14	0	5.4	1	394
SB-RI-08003	SBRI08003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	8840	1	120	1	0.11	0	5.2	1	463
SB-RI-08004	SBRI08004004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	6520	1	66.4	1	0.08	0	4.2	1	349

ProUCL Input
AOI-08: Beneath

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Iron	D_Iron	Manganese	D_Manganese	Thallium	D_Thallium	Thorium	D_Thorium	Titanium
SB-RI-08004	SBRI08004008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	8540	1	89.8	1	0.12	0	8	1	520
SB-RI-08005	SBRI08005004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	6840	1	67.2	1	0.079	0	4.2	1	323
SB-RI-08005	SBRI08005008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	7050	1	69.9	1	0.084	0	5.6	1	365
SB-RI-09001	SBRI09001008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	9940	1	98.1	1	0.18	0	7.3	1	652
SB-RI-09002	SBRI09002004-10/12/2005	10/12/2005	4	6	N	EA08 - Beneath	11900	1	127	1	0.19	0	7.2	1	732
SB-RI-09002	SBRI09002008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	13400	1	178	1	0.26	1	10.6	1	1170
SB-RI-09003	SBRI09003004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	7440	1	75.6	1	0.097	0	5.5	1	387
SB-RI-09003	SBRI09003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	6160	1	75.5	1	0.093	0	4.2	1	318
SB-RI-09004	SBRI09004003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	14000	1	93.2	1	0.099	0	5.7	1	466
SB-RI-09005	SBRI09005003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	6990	1	65.2	1	0.076	0	5.5	1	327
SB-RI-09007	SBRI09007003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	14800	1	160	1	0.19	0	6.5	1	849
SB-RI-09008	SBRI09008003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	13600	1	154	1	0.18	0	7.1	1	753
SB-RI-09008	SBRI09008008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	8310	1	113	1	0.13	0	8.6	1	633
SB-RI-09009	SBRI09009003-10/11/2005	10/11/2005	3	5	N	EA08 - Beneath	7200	1	78.7	1	0.095	0	3.6	1	390
SS-PD-08041	SS-PD-08041-000-101520	10/15/2020	0	1	N	EA08 - Beneath							5.95	1	
SS-PD-08042	SS-PD-08042-000-101520	10/15/2020	0	1	N	EA08 - Beneath							6.46	1	
SS-PD-08055	SS-PD-08055-000-033021	03/30/2021	0	1	N	EA08 - Beneath							3.67	1	
SS-PD-08070	SS-PD-08070-000-033121	03/31/2021	0	1	N	EA08 - Beneath							5.37	1	
TP-RI-08002	TPRI08002004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	15100	1	189	1	0.089	1	5.6	1	244
TP-RI-08003	TPRI08003004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	13800	1	235	1	0.071	1	6.7	1	232
TP-RI-08004	TPRI08004003-11/30/2004	11/30/2004	3	4	N	EA08 - Beneath	11600	1	78.6	1	0.095	1	5.5	1	422

ProUCL Input
AOI-08: Beneath

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	D_Titanium	Uranium	D_Uranium	Uranium-238	D_Uranium-238	Zirconium	D_Zirconium
SB-PD-08008	SB-PD-08008-004-111620	11/16/2020	4	6	N	EA08 - Beneath		1.47	1	1.45	1		
SB-PD-08009	SB-PD-08009-002-111620	11/16/2020	2	4	N	EA08 - Beneath		2.74	1	2.73	1		
SB-PD-08010	SB-PD-08010-002-111620	11/16/2020	2	4	N	EA08 - Beneath		1.27	1	1.26	1		
SB-PD-08012	SB-PD-08012-002-111820	11/18/2020	2	4	N	EA08 - Beneath		1.17	1	1.16	1		
SB-PD-08013	SB-PD-08013-002-111820	11/18/2020	2	4	N	EA08 - Beneath		1.1	1	1.09	1		
SB-PD-08016	SB-PD-08016-002-111820	11/18/2020	2	4	N	EA08 - Beneath		0.948	1	0.942	1		
SB-PD-08017	SB-PD-08017-002-111620	11/16/2020	2	4	N	EA08 - Beneath		0.77	1	0.765	1		
SB-PD-08018	SB-PD-08018-004-111620	11/16/2020	4	6	N	EA08 - Beneath		1.13	1	1.12	1		
SB-PD-08020	SB-PD-08020-002-111720	11/17/2020	2	4	N	EA08 - Beneath		1.52	1	1.51	1		
SB-PD-08022	SB-PD-08022-004-111720	11/17/2020	4	6	N	EA08 - Beneath		1.96	1	1.94	1		
SB-PD-08023	SB-PD-08023-002-111720	11/17/2020	2	4	N	EA08 - Beneath		1.2	1	1.19	1		
SB-PD-08024	SB-PD-08024-002-111720	11/17/2020	2	4	N	EA08 - Beneath		1.36	1	1.35	1		
SB-PD-08025	SB-PD-08025-002-111720	11/17/2020	2	4	N	EA08 - Beneath		1.69	1	1.68	1		
SB-PD-08027	SB-PD-08027-004-111720	11/17/2020	4	6	N	EA08 - Beneath		1.38	1	1.37	1		
SB-PD-08033	SB-PD-08033-002-111720	11/17/2020	2	4	N	EA08 - Beneath		1.33	1	1.32	1		
SB-PD-08034	SB-PD-08034-004-111720	11/17/2020	4	6	N	EA08 - Beneath		1.85	1	1.84	1		
SB-PD-08037	SB-PD-08037-002-111820	11/18/2020	2	4	N	EA08 - Beneath		1.34	1	1.33	1		
SB-PD-08043	SB-PD-08043-001-101520	10/15/2020	1	2	N	EA08 - Beneath		2.58	1	2.57	1		
SB-PD-08056	SB-PD-08056-001-032921	03/29/2021	1	2	N	EA08 - Beneath		1.17	1	1.16	1		
SB-PD-08056	SB-PD-08056-002-032921	03/29/2021	2	4	N	EA08 - Beneath		1.13	1	1.12	1		
SB-PD-08056	SB-PD-08056-004-032921	03/29/2021	4	6	N	EA08 - Beneath		1.17	1	1.17	1		
SB-PD-08058	SB-PD-08058-002-033021	03/30/2021	2	4	N	EA08 - Beneath		1.04	1	1.04	1		
SB-PD-08058	SB-PD-08058-004-033021	03/30/2021	4	6	N	EA08 - Beneath		0.836	1	0.83	1		
SB-PD-08059	SB-PD-08059-002-032921	03/29/2021	2	4	N	EA08 - Beneath		2.12	1	2.1	1		
SB-PD-08059	SB-PD-08059-004-032921	03/29/2021	4	6	N	EA08 - Beneath		1.53	1	1.52	1		
SB-PD-08061	SB-PD-08061-004-033021	03/30/2021	4	6	N	EA08 - Beneath		1.43	1	1.42	1		
SB-PD-08062	SB-PD-08062-001-033021	03/30/2021	1	2	N	EA08 - Beneath		1.68	1	1.67	1		
SB-PD-08062	SB-PD-08062-002-033021	03/30/2021	2	4	N	EA08 - Beneath		1.78	1	1.77	1		
SB-PD-08062	SB-PD-08062-004-033021	03/30/2021	4	6	N	EA08 - Beneath		2.01	1	2	1		
SB-PD-08064	SB-PD-08064-001-032921	03/29/2021	1	2	N	EA08 - Beneath		2.18	1	2.16	1		
SB-PD-08064	SB-PD-08064-002-032921	03/29/2021	2	4	N	EA08 - Beneath		1.38	1	1.37	1		
SB-PD-08066	SB-PD-08066-002-032921	03/29/2021	2	4	N	EA08 - Beneath		1.38	1	1.37	1		
SB-PD-08068	SB-PD-08068-001-032921	03/29/2021	1	2	N	EA08 - Beneath		1.59	1	1.58	1		
SB-PD-08068	SB-PD-08068-002-032921	03/29/2021	2	4	N	EA08 - Beneath		1.85	1	1.84	1		
SB-PD-08070	SB-PD-08070-001-033121	03/31/2021	1	2	N	EA08 - Beneath		1.66	1	1.65	1		
SB-PD-08070	SB-PD-08070-002-033121	03/31/2021	2	4	N	EA08 - Beneath		1.57	1	1.56	1		
SB-PD-08073	SB-PD-08073-001-033121	03/31/2021	1	2	N	EA08 - Beneath		1.35	1	1.35	1		
SB-RI-08001	SBRI08001005-10/11/2005	10/11/2005	6	8	N	EA08 - Beneath	1	1.1	1	1.1	1	2.3	1
SB-RI-08002	SBRI08002005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	1	2.2	1	2.2	1	2.6	1
SB-RI-08002	SBRI08002008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	1	2.5	1	2.5	1	2.6	1
SB-RI-08003	SBRI08003005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	1	1.2	1	1.2	1	2.1	1
SB-RI-08003	SBRI08003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	1	1.5	1	1.5	1	2.4	1
SB-RI-08004	SBRI08004004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	1	1	1	1	1	1.9	1

ProUCL Input
AOI-08: Beneath

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	D_Titanium	Uranium	D_Uranium	Uranium-238	D_Uranium-238	Zirconium	D_Zirconium
SB-RI-08004	SBRI08004008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	1	2.2	1	2.2	1	3.3	1
SB-RI-08005	SBRI08005004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	1	1.4	1	1.4	1	1.8	1
SB-RI-08005	SBRI08005008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	1	1.4	1	1.4	1	2.3	1
SB-RI-09001	SBRI09001008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	1	1.6	1	1.6	1	2.6	1
SB-RI-09002	SBRI09002004-10/12/2005	10/12/2005	4	6	N	EA08 - Beneath	1	2.6	1	2.6	1	1.7	1
SB-RI-09002	SBRI09002008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	1	3	1	3	1	5.1	1
SB-RI-09003	SBRI09003004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	1	2.5	1	2.5	1	2	1
SB-RI-09003	SBRI09003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	1	0.98	1	0.97	1	1.6	1
SB-RI-09004	SBRI09004003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	1	3.6	1	3.5	1	2.9	1
SB-RI-09005	SBRI09005003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	1	1.3	1	1.3	1	2	1
SB-RI-09007	SBRI09007003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	1	1.7	1	1.7	1	1.7	1
SB-RI-09008	SBRI09008003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	1	2.1	1	2.1	1	2.1	1
SB-RI-09008	SBRI09008008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	1	2.2	1	2.1	1	3.7	1
SB-RI-09009	SBRI09009003-10/11/2005	10/11/2005	3	5	N	EA08 - Beneath	1	1	1	1	1	1.7	1
SS-PD-08041	SS-PD-08041-000-101520	10/15/2020	0	1	N	EA08 - Beneath		1.77	1	1.76	1		
SS-PD-08042	SS-PD-08042-000-101520	10/15/2020	0	1	N	EA08 - Beneath		2.1	1	2.09	1		
SS-PD-08055	SS-PD-08055-000-033021	03/30/2021	0	1	N	EA08 - Beneath		2	1	1.99	1		
SS-PD-08070	SS-PD-08070-000-033121	03/31/2021	0	1	N	EA08 - Beneath		2.66	1	2.65	1		
TP-RI-08002	TPRI08002004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	1	2.4	1	2.4	1	4.8	1
TP-RI-08003	TPRI08003004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	1	1.8	1	1.8	1	5.2	1
TP-RI-08004	TPRI08004003-11/30/2004	11/30/2004	3	4	N	EA08 - Beneath	1	1.6	1	1.6	1	2	1

ProUCL Input
AOI-08: Beneath + Exposure Area

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Benzo(a)pyrene	D_Benzo(a)pyrene	Carbazole	D_Carbazole	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Aluminum	D_Aluminum	Arsenic	D_Arsenic
SB-PD-08007	SB-PD-08007-002-111620	11/16/2020	2	4	N	EA08 - Exposure Area	0.0107	0	0.0107	0	0.00118	0			6.29	1
SB-PD-08008	SB-PD-08008-004-111620	11/16/2020	4	6	N	EA08 - Beneath	0.0105	0	0.0105	0	0.00116	0			5.18	1
SB-PD-08009	SB-PD-08009-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.0112	0	0.0112	0	0.00124	0			4.14	1
SB-PD-08010	SB-PD-08010-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.0115	0	0.0115	0	0.00127	0			5.49	1
SB-PD-08012	SB-PD-08012-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.0267	1	0.0107	0	0.00562	1			5.94	1
SB-PD-08013	SB-PD-08013-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.0105	0	0.0105	0	0.00244	1			6.15	1
SB-PD-08016	SB-PD-08016-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.0107	0	0.0107	0	0.00621	1			7.25	1
SB-PD-08017	SB-PD-08017-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.0106	0	0.0106	0	0.00117	0			2.81	1
SB-PD-08018	SB-PD-08018-004-111620	11/16/2020	4	6	N	EA08 - Beneath	0.0102	0	0.0102	0	0.00112	0			3.75	1
SB-PD-08020	SB-PD-08020-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.0106	0	0.0106	0	0.00221	1			4.88	1
SB-PD-08022	SB-PD-08022-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.0102	0	0.0102	0	0.0018	1			4.53	1
SB-PD-08023	SB-PD-08023-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.011	0	0.011	0	0.00455	1			6.2	1
SB-PD-08024	SB-PD-08024-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.0104	0	0.0104	0	0.00116	0			5.36	1
SB-PD-08025	SB-PD-08025-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.0114	0	0.0114	0	0.00376	1			6.02	1
SB-PD-08027	SB-PD-08027-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.0103	0	0.0103	0	0.00911	1			6.03	1
SB-PD-08033	SB-PD-08033-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.0111	0	0.0111	0	0.00123	0			6.62	1
SB-PD-08034	SB-PD-08034-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.0101	0	0.0101	0	0.179	1			5.1	1
SB-PD-08037	SB-PD-08037-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.0108	0	0.0108	0	0.0589	1			5.82	1
SB-PD-08043	SB-PD-08043-001-101520	10/15/2020	1	2	N	EA08 - Beneath	0.0113	0	0.0113	0	0.00433	1			2.94	1
SB-PD-08056	SB-PD-08056-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0106	0	0.0106	0	0.0012	0			4.56	1
SB-PD-08056	SB-PD-08056-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0105	0	0.0105	0	0.00117	0			4.55	1
SB-PD-08056	SB-PD-08056-004-032921	03/29/2021	4	6	N	EA08 - Beneath	0.0109	0	0.0109	0	0.0012	0			6.85	1
SB-PD-08058	SB-PD-08058-002-033021	03/30/2021	2	4	N	EA08 - Beneath	0.0114	0	0.0114	0	0.00126	0			5.17	1
SB-PD-08058	SB-PD-08058-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.0107	0	0.0107	0	0.00119	0			2.37	1
SB-PD-08059	SB-PD-08059-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0114	0	0.0114	0	0.0187	1			6.48	1
SB-PD-08059	SB-PD-08059-004-032921	03/29/2021	4	6	N	EA08 - Beneath	0.0103	0	0.0103	0	0.00115	0			5.94	1
SB-PD-08061	SB-PD-08061-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.0109	0	0.0109	0	0.0032	1			6.52	1
SB-PD-08062	SB-PD-08062-001-033021	03/30/2021	1	2	N	EA08 - Beneath	0.0116	0	0.0116	0	0.00129	0			10.5	1
SB-PD-08062	SB-PD-08062-002-033021	03/30/2021	2	4	N	EA08 - Beneath	0.0107	0	0.0107	0	0.00117	0			5.89	1
SB-PD-08062	SB-PD-08062-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.0114	0	0.0114	0	0.00128	0			4.63	1
SB-PD-08064	SB-PD-08064-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0102	0	0.0102	0	0.0283	1			4.18	1
SB-PD-08064	SB-PD-08064-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0107	0	0.0107	0	0.00121	0			4.33	1
SB-PD-08066	SB-PD-08066-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0106	0	0.0106	0	0.0454	1			5.86	1
SB-PD-08068	SB-PD-08068-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0117	0	0.0117	0	0.0143	1			7.99	1
SB-PD-08068	SB-PD-08068-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0115	0	0.0115	0	0.00662	1			5.58	1
SB-PD-08070	SB-PD-08070-001-033121	03/31/2021	1	2	N	EA08 - Beneath	0.011	0	0.011	0	0.00121	0			5.55	1
SB-PD-08070	SB-PD-08070-002-033121	03/31/2021	2	4	N	EA08 - Beneath	0.0105	0	0.0105	0	0.00117	0			6.25	1
SB-PD-08073	SB-PD-08073-001-033121	03/31/2021	1	2	N	EA08 - Beneath	0.0105	0	0.0105	0	0.00347	1			8.56	1
SB-RI-08001	SBRI08001005-10/11/2005	10/11/2005	6	8	N	EA08 - Beneath					0.0113	1	5540	1	3.6	1
SB-RI-08002	SBRI08002005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath					0.0037	0	7830	1	5.1	1
SB-RI-08002	SBRI08002008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath					0.0285	1	7720	1	6.9	1
SB-RI-08003	SBRI08003005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath					0.0014	1	6340	1	4.6	1
SB-RI-08003	SBRI08003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath					0.0036	0	5600	1	6.1	1

ProUCL Input
AOI-08: Beneath + Exposure Area

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Benzo(a)pyrene	D_Benzo(a)pyrene	Carbazole	D_Carbazole	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Aluminum	D_Aluminum	Arsenic	D_Arsenic
SB-RI-08004	SBRI08004004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath					0.0034	0	5610	1	4.2	1
SB-RI-08004	SBRI08004008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath					0.0037	0	7440	1	9	1
SB-RI-08005	SBRI08005004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath					0.002	1	5200	1	5.9	1
SB-RI-08005	SBRI08005008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath							5130	1	6.9	1
SB-RI-09001	SBRI09001008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0368	0			0.0037	0	6970	1	4.3	1
SB-RI-09002	SBRI09002004-10/12/2005	10/12/2005	4	6	N	EA08 - Beneath	0.0347	0			0.0035	0	6570	1	5.2	1
SB-RI-09002	SBRI09002008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0413	0			0.0011	1	12000	1	4.9	1
SB-RI-09003	SBRI09003004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.0373	0			0.0077	1	5500	1	5.7	1
SB-RI-09003	SBRI09003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0372	0			0.0037	0	4920	1	5.9	1
SB-RI-09004	SBRI09004003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0361	0			0.032	1	7500	1	24.2	1
SB-RI-09005	SBRI09005003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0342	0			0.0034	0	5260	1	6.3	1
SB-RI-09006	SBRI09006000-10/11/2005	10/11/2005	0	1	N	EA08 - Exposure Area	0.0401	0			0.004	1	10400	1	4.4	1
SB-RI-09007	SBRI09007003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0341	0			0.0034	0	8090	1	4.9	1
SB-RI-09008	SBRI09008003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0345	0			0.0018	1	10200	1	7.5	1
SB-RI-09008	SBRI09008008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.037	0			0.0037	0	7830	1	4.2	1
SB-RI-09009	SBRI09009003-10/11/2005	10/11/2005	3	5	N	EA08 - Beneath	0.0343	0			0.00343	0	5220	1	5.3	1
SS-PD-08041	SS-PD-08041-000-101520	10/15/2020	0	1	N	EA08 - Beneath	0.0108	0	0.0108	0	0.227	1			6.05	1
SS-PD-08042	SS-PD-08042-000-101520	10/15/2020	0	1	N	EA08 - Beneath	0.0111	0	0.0111	0	0.0242	1			6.79	1
SS-PD-08055	SS-PD-08055-000-033021	03/30/2021	0	1	N	EA08 - Beneath	0.0591	0	0.0591	0	0.00419	1			4.88	1
SS-PD-08070	SS-PD-08070-000-033121	03/31/2021	0	1	N	EA08 - Beneath	0.043	0	0.043	0	0.0401	1			5.03	1
SS-RI-08002	SSRI08002000-5/5/2005	05/05/2005	0	0.5	N	EA08 - Exposure Area	0.376	0	3.76	0	0.012	1	6260	1	5.2	1
SS-RI-08005	SSRI08005000-5/5/2005	05/05/2005	0	0.5	N	EA08 - Exposure Area	0.139	1	0.434	0	0.0131	1	10800	1	5.9	1
SS-RI-08008	SSRI08008000-10/18/2005	10/18/2005	0	1	N	EA08 - Exposure Area					0.0411	1	9610	1	5.8	1
SS-RI-08008	SSRI08008002-10/18/2005	10/18/2005	2	2.5	N	EA08 - Exposure Area					0.0036	0	10100	1	6.2	1
SS-RI-14062	SSRI14062000-10/7/2004	10/07/2004	0	1	N	EA08 - Exposure Area							13200	1	6.1	0
TP-RI-08001	TPRI08001000-12/1/2004	12/01/2004	0	1	N	EA08 - Exposure Area	0.0348	0	0.348	0	0.432	1	8340	1	6.4	1
TP-RI-08001	TPRI08001002-12/1/2004	12/01/2004	2	3	N	EA08 - Exposure Area	0.0352	0	0.352	0	0.0775	1	8120	1	5.5	1
TP-RI-08001	TPRI08001004-12/1/2004	12/01/2004	4	5	N	EA08 - Exposure Area	0.0367	0	0.367	0	0.043	1	13200	1	5.6	1
TP-RI-08002	TPRI08002004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	0.0364	0	0.364	0	0.2481	1	8390	1	15.7	1
TP-RI-08003	TPRI08003004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	0.036	0	0.36	0	0.141	1	6930	1	13.2	1
TP-RI-08004	TPRI08004003-11/30/2004	11/30/2004	3	4	N	EA08 - Beneath	0.102	1	0.377	0	0.0674	1	12500	1	6.8	1
TP-RI-08009	TPRI08009000-11/30/2004	11/30/2004	0	1	N	EA08 - Exposure Area	0.136	1	0.403	0	0.023	1	10700	1	7.1	1
TP-RI-08009	TPRI08009002-11/30/2004	11/30/2004	2	3	N	EA08 - Exposure Area	0.183	1	0.0213	1	0.2727	1	7320	1	8.7	1
TP-RI-08009	TPRI08009003-11/30/2004	11/30/2004	3	4	N	EA08 - Exposure Area	0.092	1	0.393	0	0.00393	0	13800	1	5.7	1

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Cobalt	D_Cobalt	Iron	D_Iron	Manganese	D_Manganese	Thallium	D_Thallium	Thorium	D_Thorium
SB-PD-08007	SB-PD-08007-002-111620	11/16/2020	2	4	N	EA08 - Exposure Area									4.34	1
SB-PD-08008	SB-PD-08008-004-111620	11/16/2020	4	6	N	EA08 - Beneath									6.33	1
SB-PD-08009	SB-PD-08009-002-111620	11/16/2020	2	4	N	EA08 - Beneath									2.67	1
SB-PD-08010	SB-PD-08010-002-111620	11/16/2020	2	4	N	EA08 - Beneath									5.92	1
SB-PD-08012	SB-PD-08012-002-111820	11/18/2020	2	4	N	EA08 - Beneath									4.57	1
SB-PD-08013	SB-PD-08013-002-111820	11/18/2020	2	4	N	EA08 - Beneath									3.87	1
SB-PD-08016	SB-PD-08016-002-111820	11/18/2020	2	4	N	EA08 - Beneath									3.64	1
SB-PD-08017	SB-PD-08017-002-111620	11/16/2020	2	4	N	EA08 - Beneath									4.25	1
SB-PD-08018	SB-PD-08018-004-111620	11/16/2020	4	6	N	EA08 - Beneath									4.57	1
SB-PD-08020	SB-PD-08020-002-111720	11/17/2020	2	4	N	EA08 - Beneath									4.87	1
SB-PD-08022	SB-PD-08022-004-111720	11/17/2020	4	6	N	EA08 - Beneath									6.82	1
SB-PD-08023	SB-PD-08023-002-111720	11/17/2020	2	4	N	EA08 - Beneath									6.38	1
SB-PD-08024	SB-PD-08024-002-111720	11/17/2020	2	4	N	EA08 - Beneath									6.4	1
SB-PD-08025	SB-PD-08025-002-111720	11/17/2020	2	4	N	EA08 - Beneath									6.09	1
SB-PD-08027	SB-PD-08027-004-111720	11/17/2020	4	6	N	EA08 - Beneath									5.75	1
SB-PD-08033	SB-PD-08033-002-111720	11/17/2020	2	4	N	EA08 - Beneath									6.61	1
SB-PD-08034	SB-PD-08034-004-111720	11/17/2020	4	6	N	EA08 - Beneath									7.15	1
SB-PD-08037	SB-PD-08037-002-111820	11/18/2020	2	4	N	EA08 - Beneath									5.38	1
SB-PD-08043	SB-PD-08043-001-101520	10/15/2020	1	2	N	EA08 - Beneath									5.64	1
SB-PD-08056	SB-PD-08056-001-032921	03/29/2021	1	2	N	EA08 - Beneath									5.22	1
SB-PD-08056	SB-PD-08056-002-032921	03/29/2021	2	4	N	EA08 - Beneath									4.78	1
SB-PD-08056	SB-PD-08056-004-032921	03/29/2021	4	6	N	EA08 - Beneath									4.66	1
SB-PD-08058	SB-PD-08058-002-033021	03/30/2021	2	4	N	EA08 - Beneath									4.72	1
SB-PD-08058	SB-PD-08058-004-033021	03/30/2021	4	6	N	EA08 - Beneath									3.98	1
SB-PD-08059	SB-PD-08059-002-032921	03/29/2021	2	4	N	EA08 - Beneath									6.38	1
SB-PD-08059	SB-PD-08059-004-032921	03/29/2021	4	6	N	EA08 - Beneath									4.76	1
SB-PD-08061	SB-PD-08061-004-033021	03/30/2021	4	6	N	EA08 - Beneath									4.97	1
SB-PD-08062	SB-PD-08062-001-033021	03/30/2021	1	2	N	EA08 - Beneath									7.41	1
SB-PD-08062	SB-PD-08062-002-033021	03/30/2021	2	4	N	EA08 - Beneath									7.07	1
SB-PD-08062	SB-PD-08062-004-033021	03/30/2021	4	6	N	EA08 - Beneath									7.3	1
SB-PD-08064	SB-PD-08064-001-032921	03/29/2021	1	2	N	EA08 - Beneath									5.98	1
SB-PD-08064	SB-PD-08064-002-032921	03/29/2021	2	4	N	EA08 - Beneath									6.22	1
SB-PD-08066	SB-PD-08066-002-032921	03/29/2021	2	4	N	EA08 - Beneath									6.83	1
SB-PD-08068	SB-PD-08068-001-032921	03/29/2021	1	2	N	EA08 - Beneath									6.68	1
SB-PD-08068	SB-PD-08068-002-032921	03/29/2021	2	4	N	EA08 - Beneath									7.39	1
SB-PD-08070	SB-PD-08070-001-033121	03/31/2021	1	2	N	EA08 - Beneath									6.56	1
SB-PD-08070	SB-PD-08070-002-033121	03/31/2021	2	4	N	EA08 - Beneath									4.34	1
SB-PD-08073	SB-PD-08073-001-033121	03/31/2021	1	2	N	EA08 - Beneath									6.93	1
SB-RI-08001	SBRI08001005-10/11/2005	10/11/2005	6	8	N	EA08 - Beneath	1.9	1	6700	1	74.6	1	0.097	0	4.1	1
SB-RI-08002	SBRI08002005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	2.7	1	7540	1	88.7	1	0.11	0	8.2	1
SB-RI-08002	SBRI08002008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	3.6	1	10300	1	135	1	0.14	0	7.4	1
SB-RI-08003	SBRI08003005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	3	1	7680	1	92.4	1	0.14	0	5.4	1
SB-RI-08003	SBRI08003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	3.7	1	8840	1	120	1	0.11	0	5.2	1

ProUCL Input
AOI-08: Beneath + Exposure Area

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Cobalt	D_Cobalt	Iron	D_Iron	Manganese	D_Manganese	Thallium	D_Thallium	Thorium	D_Thorium
SB-RI-08004	SBRI08004004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	1.9	1	6520	1	66.4	1	0.08	0	4.2	1
SB-RI-08004	SBRI08004008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	2.3	1	8540	1	89.8	1	0.12	0	8	1
SB-RI-08005	SBRI08005004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	2.2	1	6840	1	67.2	1	0.079	0	4.2	1
SB-RI-08005	SBRI08005008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	1.9	1	7050	1	69.9	1	0.084	0	5.6	1
SB-RI-09001	SBRI09001008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	2.4	1	9940	1	98.1	1	0.18	0	7.3	1
SB-RI-09002	SBRI09002004-10/12/2005	10/12/2005	4	6	N	EA08 - Beneath	4.2	1	11900	1	127	1	0.19	0	7.2	1
SB-RI-09002	SBRI09002008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	5.9	1	13400	1	178	1	0.26	1	10.6	1
SB-RI-09003	SBRI09003004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	2.1	1	7440	1	75.6	1	0.097	0	5.5	1
SB-RI-09003	SBRI09003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	1.6	1	6160	1	75.5	1	0.093	0	4.2	1
SB-RI-09004	SBRI09004003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	2.7	1	14000	1	93.2	1	0.099	0	5.7	1
SB-RI-09005	SBRI09005003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	1.9	1	6990	1	65.2	1	0.076	0	5.5	1
SB-RI-09006	SBRI09006000-10/11/2005	10/11/2005	0	1	N	EA08 - Exposure Area	1.7	1	7410	1	60.6	1	0.09	0	3.8	1
SB-RI-09007	SBRI09007003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	4.3	1	14800	1	160	1	0.19	0	6.5	1
SB-RI-09008	SBRI09008003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	4.8	1	13600	1	154	1	0.18	0	7.1	1
SB-RI-09008	SBRI09008008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	2.7	1	8310	1	113	1	0.13	0	8.6	1
SB-RI-09009	SBRI09009003-10/11/2005	10/11/2005	3	5	N	EA08 - Beneath	2.2	1	7200	1	78.7	1	0.095	0	3.6	1
SS-PD-08041	SS-PD-08041-000-101520	10/15/2020	0	1	N	EA08 - Beneath									5.95	1
SS-PD-08042	SS-PD-08042-000-101520	10/15/2020	0	1	N	EA08 - Beneath									6.46	1
SS-PD-08055	SS-PD-08055-000-033021	03/30/2021	0	1	N	EA08 - Beneath									3.67	1
SS-PD-08070	SS-PD-08070-000-033121	03/31/2021	0	1	N	EA08 - Beneath									5.37	1
SS-RI-08002	SSRI08002000-5/5/2005	05/05/2005	0	0.5	N	EA08 - Exposure Area	2.1	1	11500	1	74.8	1	0.093	0	4.5	1
SS-RI-08005	SSRI08005000-5/5/2005	05/05/2005	0	0.5	N	EA08 - Exposure Area	1.5	1	9560	1	37.8	1	0.12	0	3.6	1
SS-RI-08008	SSRI08008000-10/18/2005	10/18/2005	0	1	N	EA08 - Exposure Area	2	1	9270	1	69.5	1	0.084	0	5.6	1
SS-RI-08008	SSRI08008002-10/18/2005	10/18/2005	2	2.5	N	EA08 - Exposure Area	4.2	1	14400	1	141	1	0.16	0	6.5	1
SS-RI-14062	SSRI14062000-10/7/2004	10/07/2004	0	1	N	EA08 - Exposure Area	3.1	1	14900	1	119	1	0.14	0	5.98	1
TP-RI-08001	TPRI08001000-12/1/2004	12/01/2004	0	1	N	EA08 - Exposure Area	4.4	1	12000	1	150	1	0.12	1	4.5	1
TP-RI-08001	TPRI08001002-12/1/2004	12/01/2004	2	3	N	EA08 - Exposure Area	4.7	1	12100	1	148	1	0.12	1	5	1
TP-RI-08001	TPRI08001004-12/1/2004	12/01/2004	4	5	N	EA08 - Exposure Area	2.1	1	10100	1	59	1	0.11	1	5	1
TP-RI-08002	TPRI08002004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	4.5	1	15100	1	189	1	0.089	1	5.6	1
TP-RI-08003	TPRI08003004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	4.9	1	13800	1	235	1	0.071	1	6.7	1
TP-RI-08004	TPRI08004003-11/30/2004	11/30/2004	3	4	N	EA08 - Beneath	2.4	1	11600	1	78.6	1	0.095	1	5.5	1
TP-RI-08009	TPRI08009000-11/30/2004	11/30/2004	0	1	N	EA08 - Exposure Area	3.5	1	13000	1	144	1	0.12	1	5.7	1
TP-RI-08009	TPRI08009002-11/30/2004	11/30/2004	2	3	N	EA08 - Exposure Area	3.4	1	9550	1	202	1	0.096	1	4.3	1
TP-RI-08009	TPRI08009003-11/30/2004	11/30/2004	3	4	N	EA08 - Exposure Area	3.5	1	15600	1	100	1	0.16	1	6.2	1

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Titanium	D_Titanium	Uranium	D_Uranium	Uranium-238	D_Uranium-238	Zirconium	D_Zirconium
SB-PD-08007	SB-PD-08007-002-111620	11/16/2020	2	4	N	EA08 - Exposure Area			0.836	1	0.83	1		
SB-PD-08008	SB-PD-08008-004-111620	11/16/2020	4	6	N	EA08 - Beneath			1.47	1	1.45	1		
SB-PD-08009	SB-PD-08009-002-111620	11/16/2020	2	4	N	EA08 - Beneath			2.74	1	2.73	1		
SB-PD-08010	SB-PD-08010-002-111620	11/16/2020	2	4	N	EA08 - Beneath			1.27	1	1.26	1		
SB-PD-08012	SB-PD-08012-002-111820	11/18/2020	2	4	N	EA08 - Beneath			1.17	1	1.16	1		
SB-PD-08013	SB-PD-08013-002-111820	11/18/2020	2	4	N	EA08 - Beneath			1.1	1	1.09	1		
SB-PD-08016	SB-PD-08016-002-111820	11/18/2020	2	4	N	EA08 - Beneath			0.948	1	0.942	1		
SB-PD-08017	SB-PD-08017-002-111620	11/16/2020	2	4	N	EA08 - Beneath			0.77	1	0.765	1		
SB-PD-08018	SB-PD-08018-004-111620	11/16/2020	4	6	N	EA08 - Beneath			1.13	1	1.12	1		
SB-PD-08020	SB-PD-08020-002-111720	11/17/2020	2	4	N	EA08 - Beneath			1.52	1	1.51	1		
SB-PD-08022	SB-PD-08022-004-111720	11/17/2020	4	6	N	EA08 - Beneath			1.96	1	1.94	1		
SB-PD-08023	SB-PD-08023-002-111720	11/17/2020	2	4	N	EA08 - Beneath			1.2	1	1.19	1		
SB-PD-08024	SB-PD-08024-002-111720	11/17/2020	2	4	N	EA08 - Beneath			1.36	1	1.35	1		
SB-PD-08025	SB-PD-08025-002-111720	11/17/2020	2	4	N	EA08 - Beneath			1.69	1	1.68	1		
SB-PD-08027	SB-PD-08027-004-111720	11/17/2020	4	6	N	EA08 - Beneath			1.38	1	1.37	1		
SB-PD-08033	SB-PD-08033-002-111720	11/17/2020	2	4	N	EA08 - Beneath			1.33	1	1.32	1		
SB-PD-08034	SB-PD-08034-004-111720	11/17/2020	4	6	N	EA08 - Beneath			1.85	1	1.84	1		
SB-PD-08037	SB-PD-08037-002-111820	11/18/2020	2	4	N	EA08 - Beneath			1.34	1	1.33	1		
SB-PD-08043	SB-PD-08043-001-101520	10/15/2020	1	2	N	EA08 - Beneath			2.58	1	2.57	1		
SB-PD-08056	SB-PD-08056-001-032921	03/29/2021	1	2	N	EA08 - Beneath			1.17	1	1.16	1		
SB-PD-08056	SB-PD-08056-002-032921	03/29/2021	2	4	N	EA08 - Beneath			1.13	1	1.12	1		
SB-PD-08056	SB-PD-08056-004-032921	03/29/2021	4	6	N	EA08 - Beneath			1.17	1	1.17	1		
SB-PD-08058	SB-PD-08058-002-033021	03/30/2021	2	4	N	EA08 - Beneath			1.04	1	1.04	1		
SB-PD-08058	SB-PD-08058-004-033021	03/30/2021	4	6	N	EA08 - Beneath			0.836	1	0.83	1		
SB-PD-08059	SB-PD-08059-002-032921	03/29/2021	2	4	N	EA08 - Beneath			2.12	1	2.1	1		
SB-PD-08059	SB-PD-08059-004-032921	03/29/2021	4	6	N	EA08 - Beneath			1.53	1	1.52	1		
SB-PD-08061	SB-PD-08061-004-033021	03/30/2021	4	6	N	EA08 - Beneath			1.43	1	1.42	1		
SB-PD-08062	SB-PD-08062-001-033021	03/30/2021	1	2	N	EA08 - Beneath			1.68	1	1.67	1		
SB-PD-08062	SB-PD-08062-002-033021	03/30/2021	2	4	N	EA08 - Beneath			1.78	1	1.77	1		
SB-PD-08062	SB-PD-08062-004-033021	03/30/2021	4	6	N	EA08 - Beneath			2.01	1	2	1		
SB-PD-08064	SB-PD-08064-001-032921	03/29/2021	1	2	N	EA08 - Beneath			2.18	1	2.16	1		
SB-PD-08064	SB-PD-08064-002-032921	03/29/2021	2	4	N	EA08 - Beneath			1.38	1	1.37	1		
SB-PD-08066	SB-PD-08066-002-032921	03/29/2021	2	4	N	EA08 - Beneath			1.38	1	1.37	1		
SB-PD-08068	SB-PD-08068-001-032921	03/29/2021	1	2	N	EA08 - Beneath			1.59	1	1.58	1		
SB-PD-08068	SB-PD-08068-002-032921	03/29/2021	2	4	N	EA08 - Beneath			1.85	1	1.84	1		
SB-PD-08070	SB-PD-08070-001-033121	03/31/2021	1	2	N	EA08 - Beneath			1.66	1	1.65	1		
SB-PD-08070	SB-PD-08070-002-033121	03/31/2021	2	4	N	EA08 - Beneath			1.57	1	1.56	1		
SB-PD-08073	SB-PD-08073-001-033121	03/31/2021	1	2	N	EA08 - Beneath			1.35	1	1.35	1		
SB-RI-08001	SBRI08001005-10/11/2005	10/11/2005	6	8	N	EA08 - Beneath	333	1	1.1	1	1.1	1	2.3	1
SB-RI-08002	SBRI08002005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	547	1	2.2	1	2.2	1	2.6	1
SB-RI-08002	SBRI08002008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	607	1	2.5	1	2.5	1	2.6	1
SB-RI-08003	SBRI08003005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	394	1	1.2	1	1.2	1	2.1	1
SB-RI-08003	SBRI08003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	463	1	1.5	1	1.5	1	2.4	1

ProUCL Input
AOI-08: Beneath + Exposure Area

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Titanium	D_Titanium	Uranium	D_Uranium	Uranium-238	D_Uranium-238	Zirconium	D_Zirconium
SB-RI-08004	SBRI08004004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	349	1	1	1	1	1	1.9	1
SB-RI-08004	SBRI08004008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	520	1	2.2	1	2.2	1	3.3	1
SB-RI-08005	SBRI08005004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	323	1	1.4	1	1.4	1	1.8	1
SB-RI-08005	SBRI08005008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	365	1	1.4	1	1.4	1	2.3	1
SB-RI-09001	SBRI09001008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	652	1	1.6	1	1.6	1	2.6	1
SB-RI-09002	SBRI09002004-10/12/2005	10/12/2005	4	6	N	EA08 - Beneath	732	1	2.6	1	2.6	1	1.7	1
SB-RI-09002	SBRI09002008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	1170	1	3	1	3	1	5.1	1
SB-RI-09003	SBRI09003004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	387	1	2.5	1	2.5	1	2	1
SB-RI-09003	SBRI09003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	318	1	0.98	1	0.97	1	1.6	1
SB-RI-09004	SBRI09004003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	466	1	3.6	1	3.5	1	2.9	1
SB-RI-09005	SBRI09005003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	327	1	1.3	1	1.3	1	2	1
SB-RI-09006	SBRI09006000-10/11/2005	10/11/2005	0	1	N	EA08 - Exposure Area	391	1	2.5	1	2.5	1	1.3	1
SB-RI-09007	SBRI09007003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	849	1	1.7	1	1.7	1	1.7	1
SB-RI-09008	SBRI09008003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	753	1	2.1	1	2.1	1	2.1	1
SB-RI-09008	SBRI09008008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	633	1	2.2	1	2.1	1	3.7	1
SB-RI-09009	SBRI09009003-10/11/2005	10/11/2005	3	5	N	EA08 - Beneath	390	1	1	1	1	1	1.7	1
SS-PD-08041	SS-PD-08041-000-101520	10/15/2020	0	1	N	EA08 - Beneath			1.77	1	1.76	1		
SS-PD-08042	SS-PD-08042-000-101520	10/15/2020	0	1	N	EA08 - Beneath			2.1	1	2.09	1		
SS-PD-08055	SS-PD-08055-000-033021	03/30/2021	0	1	N	EA08 - Beneath			2	1	1.99	1		
SS-PD-08070	SS-PD-08070-000-033121	03/31/2021	0	1	N	EA08 - Beneath			2.66	1	2.65	1		
SS-RI-08002	SSRI08002000-5/5/2005	05/05/2005	0	0.5	N	EA08 - Exposure Area	505	1	1.4	1	1.4	1	1.4	1
SS-RI-08005	SSRI08005000-5/5/2005	05/05/2005	0	0.5	N	EA08 - Exposure Area	559	1	1.2	1	1.2	1	1.2	1
SS-RI-08008	SSRI08008000-10/18/2005	10/18/2005	0	1	N	EA08 - Exposure Area	451	1	2.5	1	2.5	1	2	1
SS-RI-08008	SSRI08008002-10/18/2005	10/18/2005	2	2.5	N	EA08 - Exposure Area	677	1	1.9	1	1.8	1	1.7	1
SS-RI-14062	SSRI14062000-10/7/2004	10/07/2004	0	1	N	EA08 - Exposure Area	548	1	1.1	1	1.1	1	1.93	0
TP-RI-08001	TPRI08001000-12/1/2004	12/01/2004	0	1	N	EA08 - Exposure Area	388	1	7.5	1	7.5	1	3.2	1
TP-RI-08001	TPRI08001002-12/1/2004	12/01/2004	2	3	N	EA08 - Exposure Area	341	1	9.6	1	9.6	1	2.7	1
TP-RI-08001	TPRI08001004-12/1/2004	12/01/2004	4	5	N	EA08 - Exposure Area	398	1	2.3	1	2.3	1	2.2	1
TP-RI-08002	TPRI08002004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	244	1	2.4	1	2.4	1	4.8	1
TP-RI-08003	TPRI08003004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	232	1	1.8	1	1.8	1	5.2	1
TP-RI-08004	TPRI08004003-11/30/2004	11/30/2004	3	4	N	EA08 - Beneath	422	1	1.6	1	1.6	1	2	1
TP-RI-08009	TPRI08009000-11/30/2004	11/30/2004	0	1	N	EA08 - Exposure Area	455	1	8.6	1	8.6	1	2.4	1
TP-RI-08009	TPRI08009002-11/30/2004	11/30/2004	2	3	N	EA08 - Exposure Area	326	1	10.7	1	10.7	1	1.4	1
TP-RI-08009	TPRI08009003-11/30/2004	11/30/2004	3	4	N	EA08 - Exposure Area	580	1	2	1	2	1	2.4	1

ProUCL Input
AOI-09: Beneath

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Aluminum	D_Aluminum	Arsenic	D_Arsenic	Cobalt	D_Cobalt
SB-PD-09006	SB-PD-09006-001-110420	11/04/2020	1	2	N	EA09 - Beneath	0.00325	1			4.75	1		
SB-RI-09013	SBRI09013003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.017	1	10200	1	4.1	1	2.7	1
SB-RI-09013	SBRI09013008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0112	1	7310	1	4.7	1	2.8	1
SB-RI-09014	SBRI09014003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.1063	1	9100	1	3.6	1	3.1	1
SB-RI-09014	SBRI09014008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.081	1	6580	1	4.8	1	3.5	1
SB-RI-09015	SBRI09015003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.0052	1	7720	1	5.4	1	3.7	1
SB-RI-09015	SBRI09015008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.2733	1	8000	1	6.6	1	3.9	1
SB-RI-09016	SBRI09016003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.026	1	7280	1	4.1	1	2.7	1
SB-RI-09016	SBRI09016008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0299	1	6410	1	4.3	1	2.7	1
SS-PD-09017	SS-PD-09017-000-041421	04/14/2021	0	1	N	EA09 - Beneath	0.0131	1			5.66	1		

ProUCL Input
AOI-09: Beneath

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Iron	D_Iron	Manganese	D_Manganese	Thorium	D_Thorium	Titanium	D_Titanium
SB-PD-09006	SB-PD-09006-001-110420	11/04/2020	1	2	N	EA09 - Beneath					4.97	1		
SB-RI-09013	SBRI09013003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	9790	1	76.3	1	5	1	509	1
SB-RI-09013	SBRI09013008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	8980	1	102	1	6.4	1	424	1
SB-RI-09014	SBRI09014003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	8180	1	86.7	1	4.3	1	521	1
SB-RI-09014	SBRI09014008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	7810	1	113	1	5	1	451	1
SB-RI-09015	SBRI09015003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	7590	1	97.4	1	6.2	1	457	1
SB-RI-09015	SBRI09015008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	9150	1	132	1	6.7	1	478	1
SB-RI-09016	SBRI09016003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	7900	1	80.4	1	6.2	1	404	1
SB-RI-09016	SBRI09016008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	9280	1	116	1	4.9	1	407	1
SS-PD-09017	SS-PD-09017-000-041421	04/14/2021	0	1	N	EA09 - Beneath					5.6	1		

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Uranium	D_Uranium	Uranium-238	D_Uranium-238	Zirconium	D_Zirconium
SB-PD-09006	SB-PD-09006-001-110420	11/04/2020	1	2	N	EA09 - Beneath	1.84	1	1.84	1		
SB-RI-09013	SBRI09013003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	1.1	1	1.1	1	2	1
SB-RI-09013	SBRI09013008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	1.6	1	1.6	1	2.2	1
SB-RI-09014	SBRI09014003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	1.5	1	1.5	1	1.5	1
SB-RI-09014	SBRI09014008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	1.9	1	1.9	1	1.7	1
SB-RI-09015	SBRI09015003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	1.6	1	1.6	1	1.7	1
SB-RI-09015	SBRI09015008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	1.8	1	1.8	1	2	1
SB-RI-09016	SBRI09016003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	1.3	1	1.2	1	2	1
SB-RI-09016	SBRI09016008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	1.7	1	1.7	1	2.4	1
SS-PD-09017	SS-PD-09017-000-041421	04/14/2021	0	1	N	EA09 - Beneath	1.69	1	1.68	1		

ProUCL Input
AOI-09: Beneath + Exposure Area

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Acenaphthylene	D_Acenaphthylene	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Aluminum	D_Aluminum	Arsenic	D_Arsenic
SB-PD-09006	SB-PD-09006-001-110420	11/04/2020	1	2	N	EA09 - Beneath	0.011	0	0.00325	1			4.75	1
SB-RI-09013	SBRI09013003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.0359	0	0.017	1	10200	1	4.1	1
SB-RI-09013	SBRI09013008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0344	0	0.0112	1	7310	1	4.7	1
SB-RI-09014	SBRI09014003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.0374	0	0.1063	1	9100	1	3.6	1
SB-RI-09014	SBRI09014008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0353	0	0.081	1	6580	1	4.8	1
SB-RI-09015	SBRI09015003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.0381	0	0.0052	1	7720	1	5.4	1
SB-RI-09015	SBRI09015008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0348	0	0.2733	1	8000	1	6.6	1
SB-RI-09016	SBRI09016003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.0363	0	0.026	1	7280	1	4.1	1
SB-RI-09016	SBRI09016008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0353	0	0.0299	1	6410	1	4.3	1
SS-PD-09017	SS-PD-09017-000-041421	04/14/2021	0	1	N	EA09 - Beneath	0.0582	0	0.0131	1			5.66	1
SS-PD-09021	SS-PD-09021-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	0.115	0	0.0147	1			6.47	1
SS-PD-09022	SS-PD-09022-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	0.0111	0	0.0124	0			6.16	1
SS-PD-09023	SS-PD-09023-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	0.0109	0	0.0137	1			5.24	1
SS-RI-09029	SSRI09029001-10/26/2005	10/26/2005	1	2	N	EA09 - Exposure Area	0.0784	1	0.004	0	11200	1	6.6	1
SS-RI-09031	SSRI09031000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area			0.0843	1				
SS-RI-09032	SSRI09032000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area			0.0362	0				
SS-RI-09033	SSRI09033000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area			0.0366	0				
SS-RI-14027	SSRI14027000-10/8/2004	10/08/2004	0	1	N	EA09 - Exposure Area					6720	1	4.2	0
SS-RI-14033	SSRI14033000-10/8/2004	10/08/2004	0	1	N	EA09 - Exposure Area					9100	1	6.4	1

ProUCL Input
AOI-09: Beneath + Exposure Area

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Cobalt	D_Cobalt	Iron	D_Iron	Thorium	D_Thorium	Titanium	D_Titanium
SB-PD-09006	SB-PD-09006-001-110420	11/04/2020	1	2	N	EA09 - Beneath					4.97	1		
SB-RI-09013	SBRI09013003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	2.7	1	9790	1	5	1	509	1
SB-RI-09013	SBRI09013008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	2.8	1	8980	1	6.4	1	424	1
SB-RI-09014	SBRI09014003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	3.1	1	8180	1	4.3	1	521	1
SB-RI-09014	SBRI09014008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	3.5	1	7810	1	5	1	451	1
SB-RI-09015	SBRI09015003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	3.7	1	7590	1	6.2	1	457	1
SB-RI-09015	SBRI09015008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	3.9	1	9150	1	6.7	1	478	1
SB-RI-09016	SBRI09016003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	2.7	1	7900	1	6.2	1	404	1
SB-RI-09016	SBRI09016008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	2.7	1	9280	1	4.9	1	407	1
SS-PD-09017	SS-PD-09017-000-041421	04/14/2021	0	1	N	EA09 - Beneath					5.6	1		
SS-PD-09021	SS-PD-09021-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area					5.27	1		
SS-PD-09022	SS-PD-09022-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area					6.95	1		
SS-PD-09023	SS-PD-09023-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area					6.24	1		
SS-RI-09029	SSRI09029001-10/26/2005	10/26/2005	1	2	N	EA09 - Exposure Area	5.6	1	9370	1	8.9	1	613	1
SS-RI-09031	SSRI09031000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area								
SS-RI-09032	SSRI09032000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area								
SS-RI-09033	SSRI09033000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area								
SS-RI-14027	SSRI14027000-10/8/2004	10/08/2004	0	1	N	EA09 - Exposure Area	1.1	1	6730	1	3.03	1	365	1
SS-RI-14033	SSRI14033000-10/8/2004	10/08/2004	0	1	N	EA09 - Exposure Area	1.7	1	8060	1	3.87	1	395	1

ProUCL Input
AOI-09: Beneath + Exposure Area

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Uranium	D_Uranium	Uranium-238	D_Uranium-238	Zirconium	D_Zirconium
SB-PD-09006	SB-PD-09006-001-110420	11/04/2020	1	2	N	EA09 - Beneath	1.84	1	1.84	1		
SB-RI-09013	SBRI09013003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	1.1	1	1.1	1	2	1
SB-RI-09013	SBRI09013008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	1.6	1	1.6	1	2.2	1
SB-RI-09014	SBRI09014003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	1.5	1	1.5	1	1.5	1
SB-RI-09014	SBRI09014008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	1.9	1	1.9	1	1.7	1
SB-RI-09015	SBRI09015003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	1.6	1	1.6	1	1.7	1
SB-RI-09015	SBRI09015008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	1.8	1	1.8	1	2	1
SB-RI-09016	SBRI09016003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	1.3	1	1.2	1	2	1
SB-RI-09016	SBRI09016008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	1.7	1	1.7	1	2.4	1
SS-PD-09017	SS-PD-09017-000-041421	04/14/2021	0	1	N	EA09 - Beneath	1.69	1	1.68	1		
SS-PD-09021	SS-PD-09021-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	1.74	1	1.73	1		
SS-PD-09022	SS-PD-09022-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	1.77	1	1.76	1		
SS-PD-09023	SS-PD-09023-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	2.15	1	2.13	1		
SS-RI-09029	SSRI09029001-10/26/2005	10/26/2005	1	2	N	EA09 - Exposure Area	2	1	2	1	2.4	1
SS-RI-09031	SSRI09031000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area						
SS-RI-09032	SSRI09032000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area						
SS-RI-09033	SSRI09033000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area						
SS-RI-14027	SSRI14027000-10/8/2004	10/08/2004	0	1	N	EA09 - Exposure Area	2	1	2	1	1.14	0
SS-RI-14033	SSRI14033000-10/8/2004	10/08/2004	0	1	N	EA09 - Exposure Area	2.8	1	2.8	1	1.2	0

ProUCL Input
AOI-08: Beneath + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
SB-PD-08008	SB-PD-08008-004-111620	11/16/2020	4	6	N	EA08 - Beneath	0.00116	0	1.47	1
SB-PD-08009	SB-PD-08009-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00124	0	2.74	1
SB-PD-08010	SB-PD-08010-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00127	0	1.27	1
SB-PD-08012	SB-PD-08012-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00562	1	1.17	1
SB-PD-08013	SB-PD-08013-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00244	1	1.1	1
SB-PD-08016	SB-PD-08016-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00621	1	0.948	1
SB-PD-08017	SB-PD-08017-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00117	0	0.77	1
SB-PD-08018	SB-PD-08018-004-111620	11/16/2020	4	6	N	EA08 - Beneath	0.00112	0	1.13	1
SB-PD-08020	SB-PD-08020-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00221	1	1.52	1
SB-PD-08022	SB-PD-08022-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.0018	1	1.96	1
SB-PD-08023	SB-PD-08023-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00455	1	1.2	1
SB-PD-08024	SB-PD-08024-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00116	0	1.36	1
SB-PD-08025	SB-PD-08025-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00376	1	1.69	1
SB-PD-08027	SB-PD-08027-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.00911	1	1.38	1
SB-PD-08033	SB-PD-08033-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00123	0	1.33	1
SB-PD-08034	SB-PD-08034-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.179	1	1.85	1
SB-PD-08037	SB-PD-08037-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.0589	1	1.34	1
SB-PD-08043	SB-PD-08043-001-101520	10/15/2020	1	2	N	EA08 - Beneath	0.00433	1	2.58	1
SB-PD-08056	SB-PD-08056-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0012	0	1.17	1
SB-PD-08056	SB-PD-08056-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00117	0	1.13	1
SB-PD-08056	SB-PD-08056-004-032921	03/29/2021	4	6	N	EA08 - Beneath	0.0012	0	1.17	1
SB-PD-08058	SB-PD-08058-002-033021	03/30/2021	2	4	N	EA08 - Beneath	0.00126	0	1.04	1
SB-PD-08058	SB-PD-08058-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.00119	0	0.836	1
SB-PD-08059	SB-PD-08059-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0187	1	2.12	1
SB-PD-08059	SB-PD-08059-004-032921	03/29/2021	4	6	N	EA08 - Beneath	0.00115	0	1.53	1
SB-PD-08061	SB-PD-08061-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.0032	1	1.43	1
SB-PD-08062	SB-PD-08062-001-033021	03/30/2021	1	2	N	EA08 - Beneath	0.00129	0	1.68	1
SB-PD-08062	SB-PD-08062-002-033021	03/30/2021	2	4	N	EA08 - Beneath	0.00117	0	1.78	1
SB-PD-08062	SB-PD-08062-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.00128	0	2.01	1
SB-PD-08064	SB-PD-08064-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0283	1	2.18	1
SB-PD-08064	SB-PD-08064-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00121	0	1.38	1
SB-PD-08066	SB-PD-08066-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0454	1	1.38	1
SB-PD-08068	SB-PD-08068-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0143	1	1.59	1
SB-PD-08068	SB-PD-08068-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00662	1	1.85	1
SB-PD-08070	SB-PD-08070-001-033121	03/31/2021	1	2	N	EA08 - Beneath	0.00121	0	1.66	1
SB-PD-08070	SB-PD-08070-002-033121	03/31/2021	2	4	N	EA08 - Beneath	0.00117	0	1.57	1

ProUCL Input
AOI-08: Beneath + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
SB-PD-08073	SB-PD-08073-001-033121	03/31/2021	1	2	N	EA08 - Beneath	0.00347	1	1.35	1
SB-RI-08001	SBRI08001005-10/11/2005	10/11/2005	6	8	N	EA08 - Beneath	0.0113	1	1.1	1
SB-RI-08002	SBRI08002005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	0.0037	0	2.2	1
SB-RI-08002	SBRI08002008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0285	1	2.5	1
SB-RI-08003	SBRI08003005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	0.0014	1	1.2	1
SB-RI-08003	SBRI08003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0036	0	1.5	1
SB-RI-08004	SBRI08004004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.0034	0	1	1
SB-RI-08004	SBRI08004008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0037	0	2.2	1
SB-RI-08005	SBRI08005004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.002	1	1.4	1
SB-RI-08005	SBRI08005008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath			1.4	1
SB-RI-09001	SBRI09001008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0037	0	1.6	1
SB-RI-09002	SBRI09002004-10/12/2005	10/12/2005	4	6	N	EA08 - Beneath	0.0035	0	2.6	1
SB-RI-09002	SBRI09002008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0011	1	3	1
SB-RI-09003	SBRI09003004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.0077	1	2.5	1
SB-RI-09003	SBRI09003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0037	0	0.98	1
SB-RI-09004	SBRI09004003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.032	1	3.6	1
SB-RI-09005	SBRI09005003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0034	0	1.3	1
SB-RI-09007	SBRI09007003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0034	0	1.7	1
SB-RI-09008	SBRI09008003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0018	1	2.1	1
SB-RI-09008	SBRI09008008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0037	0	2.2	1
SB-RI-09009	SBRI09009003-10/11/2005	10/11/2005	3	5	N	EA08 - Beneath	0.00343	0	1	1
SS-PD-08041	SS-PD-08041-000-101520	10/15/2020	0	1	N	EA08 - Beneath	0.227	1	1.77	1
SS-PD-08042	SS-PD-08042-000-101520	10/15/2020	0	1	N	EA08 - Beneath	0.0242	1	2.1	1
SS-PD-08055	SS-PD-08055-000-033021	03/30/2021	0	1	N	EA08 - Beneath	0.00419	1	2	1
SS-PD-08070	SS-PD-08070-000-033121	03/31/2021	0	1	N	EA08 - Beneath	0.0401	1	2.66	1
TP-RI-08002	TPRI08002004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	0.2481	1	2.4	1
TP-RI-08003	TPRI08003004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	0.141	1	1.8	1
TP-RI-08004	TPRI08004003-11/30/2004	11/30/2004	3	4	N	EA08 - Beneath	0.0674	1	1.6	1
Bottom Sample1	Bottom Sample1						1	1	4	1
Bottom Sample2	Bottom Sample2						1	1	4	1
Bottom Sample3	Bottom Sample3						1	1	4	1
Bottom Sample4	Bottom Sample4						1	1	4	1
Bottom Sample5	Bottom Sample5						1	1	4	1
Bottom Sample6	Bottom Sample6						1	1	4	1
Bottom Sample7	Bottom Sample7						1	1	4	1
Bottom Sample8	Bottom Sample8						1	1	4	1

ProUCL Input
AOI-08: Beneath + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
Bottom Sample9	Bottom Sample9						1	1	4	1
Bottom Sample10	Bottom Sample10						1	1	4	1
Bottom Sample11	Bottom Sample11						1	1	4	1
Bottom Sample12	Bottom Sample12						1	1	4	1
Bottom Sample13	Bottom Sample13						1	1	4	1
Bottom Sample14	Bottom Sample14						1	1	4	1
Bottom Sample15	Bottom Sample15						1	1	4	1
Bottom Sample16	Bottom Sample16						1	1	4	1
Bottom Sample17	Bottom Sample17						1	1	4	1
Bottom Sample18	Bottom Sample18						1	1	4	1
Bottom Sample19	Bottom Sample19						1	1	4	1
Bottom Sample20	Bottom Sample20						1	1	4	1
Bottom Sample21	Bottom Sample21						1	1	4	1
Bottom Sample22	Bottom Sample22						1	1	4	1
Bottom Sample23	Bottom Sample23						1	1	4	1
Bottom Sample24	Bottom Sample24						1	1	4	1
Bottom Sample25	Bottom Sample25						1	1	4	1
Bottom Sample26	Bottom Sample26						1	1	4	1
Bottom Sample27	Bottom Sample27						1	1	4	1
Bottom Sample28	Bottom Sample28						1	1	4	1
Bottom Sample29	Bottom Sample29						1	1	4	1
Bottom Sample30	Bottom Sample30						1	1	4	1
Bottom Sample31	Bottom Sample31						1	1	4	1
Bottom Sample32	Bottom Sample32						1	1	4	1
Bottom Sample33	Bottom Sample33						1	1	4	1
Bottom Sample34	Bottom Sample34						1	1	4	1
Bottom Sample35	Bottom Sample35						1	1	4	1
Bottom Sample36	Bottom Sample36						1	1	4	1
Bottom Sample37	Bottom Sample37						1	1	4	1
Bottom Sample38	Bottom Sample38						1	1	4	1
Bottom Sample39	Bottom Sample39						1	1	4	1
Bottom Sample40	Bottom Sample40						1	1	4	1
Bottom Sample41	Bottom Sample41						1	1	4	1
Bottom Sample42	Bottom Sample42						1	1	4	1
Bottom Sample43	Bottom Sample43						1	1	4	1
Bottom Sample44	Bottom Sample44						1	1	4	1

ProUCL Input
AOI-08: Beneath + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
Bottom Sample45	Bottom Sample45						1	1	4	1
Bottom Sample46	Bottom Sample46						1	1	4	1
Bottom Sample47	Bottom Sample47						1	1	4	1
Bottom Sample48	Bottom Sample48						1	1	4	1
Bottom Sample49	Bottom Sample49						1	1	4	1
Bottom Sample50	Bottom Sample50						1	1	4	1
Bottom Sample51	Bottom Sample51						1	1	4	1
Bottom Sample52	Bottom Sample52						1	1	4	1
Bottom Sample53	Bottom Sample53						1	1	4	1
Bottom Sample54	Bottom Sample54						1	1	4	1
Bottom Sample55	Bottom Sample55						1	1	4	1
Bottom Sample56	Bottom Sample56						1	1	4	1
Bottom Sample57	Bottom Sample57						1	1	4	1
Bottom Sample58	Bottom Sample58						1	1	4	1
Bottom Sample59	Bottom Sample59						1	1	4	1
Bottom Sample60	Bottom Sample60						1	1	4	1
Bottom Sample61	Bottom Sample61						1	1	4	1
Bottom Sample62	Bottom Sample62						1	1	4	1

ProUCL Input
AOI-08: Beneath + Exposure Area + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
SB-PD-08007	SB-PD-08007-002-111620	11/16/2020	2	4	N	EA08 - Exposure Area	0.00118	0	0.836	1
SB-PD-08008	SB-PD-08008-004-111620	11/16/2020	4	6	N	EA08 - Beneath	0.00116	0	1.47	1
SB-PD-08009	SB-PD-08009-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00124	0	2.74	1
SB-PD-08010	SB-PD-08010-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00127	0	1.27	1
SB-PD-08012	SB-PD-08012-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00562	1	1.17	1
SB-PD-08013	SB-PD-08013-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00244	1	1.1	1
SB-PD-08016	SB-PD-08016-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.00621	1	0.948	1
SB-PD-08017	SB-PD-08017-002-111620	11/16/2020	2	4	N	EA08 - Beneath	0.00117	0	0.77	1
SB-PD-08018	SB-PD-08018-004-111620	11/16/2020	4	6	N	EA08 - Beneath	0.00112	0	1.13	1
SB-PD-08020	SB-PD-08020-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00221	1	1.52	1
SB-PD-08022	SB-PD-08022-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.0018	1	1.96	1
SB-PD-08023	SB-PD-08023-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00455	1	1.2	1
SB-PD-08024	SB-PD-08024-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00116	0	1.36	1
SB-PD-08025	SB-PD-08025-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00376	1	1.69	1
SB-PD-08027	SB-PD-08027-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.00911	1	1.38	1
SB-PD-08033	SB-PD-08033-002-111720	11/17/2020	2	4	N	EA08 - Beneath	0.00123	0	1.33	1
SB-PD-08034	SB-PD-08034-004-111720	11/17/2020	4	6	N	EA08 - Beneath	0.179	1	1.85	1
SB-PD-08037	SB-PD-08037-002-111820	11/18/2020	2	4	N	EA08 - Beneath	0.0589	1	1.34	1
SB-PD-08043	SB-PD-08043-001-101520	10/15/2020	1	2	N	EA08 - Beneath	0.00433	1	2.58	1
SB-PD-08056	SB-PD-08056-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0012	0	1.17	1
SB-PD-08056	SB-PD-08056-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00117	0	1.13	1
SB-PD-08056	SB-PD-08056-004-032921	03/29/2021	4	6	N	EA08 - Beneath	0.0012	0	1.17	1
SB-PD-08058	SB-PD-08058-002-033021	03/30/2021	2	4	N	EA08 - Beneath	0.00126	0	1.04	1
SB-PD-08058	SB-PD-08058-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.00119	0	0.836	1
SB-PD-08059	SB-PD-08059-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0187	1	2.12	1
SB-PD-08059	SB-PD-08059-004-032921	03/29/2021	4	6	N	EA08 - Beneath	0.00115	0	1.53	1
SB-PD-08061	SB-PD-08061-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.0032	1	1.43	1
SB-PD-08062	SB-PD-08062-001-033021	03/30/2021	1	2	N	EA08 - Beneath	0.00129	0	1.68	1
SB-PD-08062	SB-PD-08062-002-033021	03/30/2021	2	4	N	EA08 - Beneath	0.00117	0	1.78	1
SB-PD-08062	SB-PD-08062-004-033021	03/30/2021	4	6	N	EA08 - Beneath	0.00128	0	2.01	1
SB-PD-08064	SB-PD-08064-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0283	1	2.18	1
SB-PD-08064	SB-PD-08064-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00121	0	1.38	1
SB-PD-08066	SB-PD-08066-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.0454	1	1.38	1
SB-PD-08068	SB-PD-08068-001-032921	03/29/2021	1	2	N	EA08 - Beneath	0.0143	1	1.59	1
SB-PD-08068	SB-PD-08068-002-032921	03/29/2021	2	4	N	EA08 - Beneath	0.00662	1	1.85	1
SB-PD-08070	SB-PD-08070-001-033121	03/31/2021	1	2	N	EA08 - Beneath	0.00121	0	1.66	1
SB-PD-08070	SB-PD-08070-002-033121	03/31/2021	2	4	N	EA08 - Beneath	0.00117	0	1.57	1
SB-PD-08073	SB-PD-08073-001-033121	03/31/2021	1	2	N	EA08 - Beneath	0.00347	1	1.35	1

ProUCL Input
AOI-08: Beneath + Exposure Area + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
SB-RI-08001	SBRI08001005-10/11/2005	10/11/2005	6	8	N	EA08 - Beneath	0.0113	1	1.1	1
SB-RI-08002	SBRI08002005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	0.0037	0	2.2	1
SB-RI-08002	SBRI08002008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0285	1	2.5	1
SB-RI-08003	SBRI08003005-10/11/2005	10/11/2005	5	7	N	EA08 - Beneath	0.0014	1	1.2	1
SB-RI-08003	SBRI08003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0036	0	1.5	1
SB-RI-08004	SBRI08004004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.0034	0	1	1
SB-RI-08004	SBRI08004008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0037	0	2.2	1
SB-RI-08005	SBRI08005004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.002	1	1.4	1
SB-RI-08005	SBRI08005008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath			1.4	1
SB-RI-09001	SBRI09001008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0037	0	1.6	1
SB-RI-09002	SBRI09002004-10/12/2005	10/12/2005	4	6	N	EA08 - Beneath	0.0035	0	2.6	1
SB-RI-09002	SBRI09002008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0011	1	3	1
SB-RI-09003	SBRI09003004-10/11/2005	10/11/2005	4	6	N	EA08 - Beneath	0.0077	1	2.5	1
SB-RI-09003	SBRI09003008-10/11/2005	10/11/2005	8	10	N	EA08 - Beneath	0.0037	0	0.98	1
SB-RI-09004	SBRI09004003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.032	1	3.6	1
SB-RI-09005	SBRI09005003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0034	0	1.3	1
SB-RI-09006	SBRI09006000-10/11/2005	10/11/2005	0	1	N	EA08 - Exposure Area	0.004	1	2.5	1
SB-RI-09007	SBRI09007003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0034	0	1.7	1
SB-RI-09008	SBRI09008003-10/12/2005	10/12/2005	3	5	N	EA08 - Beneath	0.0018	1	2.1	1
SB-RI-09008	SBRI09008008-10/12/2005	10/12/2005	8	10	N	EA08 - Beneath	0.0037	0	2.2	1
SB-RI-09009	SBRI09009003-10/11/2005	10/11/2005	3	5	N	EA08 - Beneath	0.00343	0	1	1
SS-PD-08041	SS-PD-08041-000-101520	10/15/2020	0	1	N	EA08 - Beneath	0.227	1	1.77	1
SS-PD-08042	SS-PD-08042-000-101520	10/15/2020	0	1	N	EA08 - Beneath	0.0242	1	2.1	1
SS-PD-08055	SS-PD-08055-000-033021	03/30/2021	0	1	N	EA08 - Beneath	0.00419	1	2	1
SS-PD-08070	SS-PD-08070-000-033121	03/31/2021	0	1	N	EA08 - Beneath	0.0401	1	2.66	1
SS-RI-08002	SSRI08002000-5/5/2005	05/05/2005	0	0.5	N	EA08 - Exposure Area	0.012	1	1.4	1
SS-RI-08005	SSRI08005000-5/5/2005	05/05/2005	0	0.5	N	EA08 - Exposure Area	0.0131	1	1.2	1
SS-RI-08008	SSRI08008000-10/18/2005	10/18/2005	0	1	N	EA08 - Exposure Area	0.0411	1	2.5	1
SS-RI-08008	SSRI08008002-10/18/2005	10/18/2005	2	2.5	N	EA08 - Exposure Area	0.0036	0	1.9	1
SS-RI-14062	SSRI14062000-10/7/2004	10/07/2004	0	1	N	EA08 - Exposure Area			1.1	1
TP-RI-08001	TPRI08001000-12/1/2004	12/01/2004	0	1	N	EA08 - Exposure Area	0.432	1	7.5	1
TP-RI-08001	TPRI08001002-12/1/2004	12/01/2004	2	3	N	EA08 - Exposure Area	0.0775	1	9.6	1
TP-RI-08001	TPRI08001004-12/1/2004	12/01/2004	4	5	N	EA08 - Exposure Area	0.043	1	2.3	1
TP-RI-08002	TPRI08002004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	0.2481	1	2.4	1
TP-RI-08003	TPRI08003004-11/30/2004	11/30/2004	4	5	N	EA08 - Beneath	0.141	1	1.8	1
TP-RI-08004	TPRI08004003-11/30/2004	11/30/2004	3	4	N	EA08 - Beneath	0.0674	1	1.6	1
TP-RI-08009	TPRI08009000-11/30/2004	11/30/2004	0	1	N	EA08 - Exposure Area	0.023	1	8.6	1
TP-RI-08009	TPRI08009002-11/30/2004	11/30/2004	2	3	N	EA08 - Exposure Area	0.2727	1	10.7	1

ProUCL Input
AOI-08: Beneath + Exposure Area + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
TP-RI-08009	TPRI08009003-11/30/2004	11/30/2004	3	4	N	EA08 - Exposure Area	0.00393	0	2	1
Bottom Sample1	Bottom Sample1						1	1	4	1
Bottom Sample2	Bottom Sample2						1	1	4	1
Bottom Sample3	Bottom Sample3						1	1	4	1
Bottom Sample4	Bottom Sample4						1	1	4	1
Bottom Sample5	Bottom Sample5						1	1	4	1
Bottom Sample6	Bottom Sample6						1	1	4	1
Bottom Sample7	Bottom Sample7						1	1	4	1
Bottom Sample8	Bottom Sample8						1	1	4	1
Bottom Sample9	Bottom Sample9						1	1	4	1
Bottom Sample10	Bottom Sample10						1	1	4	1
Bottom Sample11	Bottom Sample11						1	1	4	1
Bottom Sample12	Bottom Sample12						1	1	4	1
Bottom Sample13	Bottom Sample13						1	1	4	1
Bottom Sample14	Bottom Sample14						1	1	4	1
Bottom Sample15	Bottom Sample15						1	1	4	1
Bottom Sample16	Bottom Sample16						1	1	4	1
Bottom Sample17	Bottom Sample17						1	1	4	1
Bottom Sample18	Bottom Sample18						1	1	4	1
Bottom Sample19	Bottom Sample19						1	1	4	1
Bottom Sample20	Bottom Sample20						1	1	4	1
Bottom Sample21	Bottom Sample21						1	1	4	1
Bottom Sample22	Bottom Sample22						1	1	4	1
Bottom Sample23	Bottom Sample23						1	1	4	1
Bottom Sample24	Bottom Sample24						1	1	4	1
Bottom Sample25	Bottom Sample25						1	1	4	1
Bottom Sample26	Bottom Sample26						1	1	4	1
Bottom Sample27	Bottom Sample27						1	1	4	1
Bottom Sample28	Bottom Sample28						1	1	4	1
Bottom Sample29	Bottom Sample29						1	1	4	1
Bottom Sample30	Bottom Sample30						1	1	4	1
Bottom Sample31	Bottom Sample31						1	1	4	1
Bottom Sample32	Bottom Sample32						1	1	4	1
Bottom Sample33	Bottom Sample33						1	1	4	1
Bottom Sample34	Bottom Sample34						1	1	4	1
Bottom Sample35	Bottom Sample35						1	1	4	1
Bottom Sample36	Bottom Sample36						1	1	4	1
Bottom Sample37	Bottom Sample37						1	1	4	1

ProUCL Input
AOI-08: Beneath + Exposure Area + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
Bottom Sample38	Bottom Sample38						1	1	4	1
Bottom Sample39	Bottom Sample39						1	1	4	1
Bottom Sample40	Bottom Sample40						1	1	4	1
Bottom Sample41	Bottom Sample41						1	1	4	1
Bottom Sample42	Bottom Sample42						1	1	4	1
Bottom Sample43	Bottom Sample43						1	1	4	1
Bottom Sample44	Bottom Sample44						1	1	4	1
Bottom Sample45	Bottom Sample45						1	1	4	1
Bottom Sample46	Bottom Sample46						1	1	4	1
Bottom Sample47	Bottom Sample47						1	1	4	1
Bottom Sample48	Bottom Sample48						1	1	4	1
Bottom Sample49	Bottom Sample49						1	1	4	1
Bottom Sample50	Bottom Sample50						1	1	4	1
Bottom Sample51	Bottom Sample51						1	1	4	1
Bottom Sample52	Bottom Sample52						1	1	4	1
Bottom Sample53	Bottom Sample53						1	1	4	1
Bottom Sample54	Bottom Sample54						1	1	4	1
Bottom Sample55	Bottom Sample55						1	1	4	1
Bottom Sample56	Bottom Sample56						1	1	4	1
Bottom Sample57	Bottom Sample57						1	1	4	1
Bottom Sample58	Bottom Sample58						1	1	4	1
Bottom Sample59	Bottom Sample59						1	1	4	1
Bottom Sample60	Bottom Sample60						1	1	4	1
Bottom Sample61	Bottom Sample61						1	1	4	1
Bottom Sample62	Bottom Sample62						1	1	4	1

ProUCL Input
AOI-09: Beneath + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
SB-PD-09006	SB-PD-09006-001-110420	11/04/2020	1	2	N	EA09 - Beneath	0.00325	1	1.84	1
SB-RI-09013	SBRI09013003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.017	1	1.1	1
SB-RI-09013	SBRI09013008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0112	1	1.6	1
SB-RI-09014	SBRI09014003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.1063	1	1.5	1
SB-RI-09014	SBRI09014008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.081	1	1.9	1
SB-RI-09015	SBRI09015003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.0052	1	1.6	1
SB-RI-09015	SBRI09015008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.2733	1	1.8	1
SB-RI-09016	SBRI09016003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.026	1	1.3	1
SB-RI-09016	SBRI09016008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0299	1	1.7	1
SS-PD-09017	SS-PD-09017-000-041421	04/14/2021	0	1	N	EA09 - Beneath	0.0131	1	1.69	1
Bottom Sample1	Bottom Sample1						1	1	2.7	1
Bottom Sample2	Bottom Sample2						1	1	2.7	1
Bottom Sample3	Bottom Sample3						1	1	2.7	1
Bottom Sample4	Bottom Sample4						1	1	2.7	1
Bottom Sample5	Bottom Sample5						1	1	2.7	1
Bottom Sample6	Bottom Sample6						1	1	2.7	1
Bottom Sample7	Bottom Sample7						1	1	2.7	1
Bottom Sample8	Bottom Sample8						1	1	2.7	1
Bottom Sample9	Bottom Sample9						1	1	2.7	1
Bottom Sample10	Bottom Sample10						1	1	2.7	1
Bottom Sample11	Bottom Sample11						1	1	2.7	1
Bottom Sample12	Bottom Sample12						1	1	2.7	1
Bottom Sample13	Bottom Sample13						1	1	2.7	1
Bottom Sample14	Bottom Sample14						1	1	2.7	1
Bottom Sample15	Bottom Sample15						1	1	2.7	1
Bottom Sample16	Bottom Sample16						1	1	2.7	1

ProUCL Input
AOI-09: Beneath + Exposure Area + RAL

sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type_code	custom_field_2	Polychlorinated biphenyls (PCBs)	D_Polychlorinated biphenyls (PCBs)	Uranium	D_Uranium
SB-PD-09006	SB-PD-09006-001-110420	11/04/2020	1	2	N	EA09 - Beneath	0.00325	1	1.84	1
SB-RI-09013	SBRI09013003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.017	1	1.1	1
SB-RI-09013	SBRI09013008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0112	1	1.6	1
SB-RI-09014	SBRI09014003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.1063	1	1.5	1
SB-RI-09014	SBRI09014008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.081	1	1.9	1
SB-RI-09015	SBRI09015003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.0052	1	1.6	1
SB-RI-09015	SBRI09015008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.2733	1	1.8	1
SB-RI-09016	SBRI09016003-10/13/2005	10/13/2005	3	5	N	EA09 - Beneath	0.026	1	1.3	1
SB-RI-09016	SBRI09016008-10/13/2005	10/13/2005	8	10	N	EA09 - Beneath	0.0299	1	1.7	1
SS-PD-09017	SS-PD-09017-000-041421	04/14/2021	0	1	N	EA09 - Beneath	0.0131	1	1.69	1
SS-PD-09021	SS-PD-09021-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	0.0147	1	1.74	1
SS-PD-09022	SS-PD-09022-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	0.0124	0	1.77	1
SS-PD-09023	SS-PD-09023-000-041421	04/14/2021	0	1	N	EA09 - Exposure Area	0.0137	1	2.15	1
SS-RI-09029	SSRI09029001-10/26/2005	10/26/2005	1	2	N	EA09 - Exposure Area	0.004	0	2	1
SS-RI-09031	SSRI09031000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area	0.0843	1		
SS-RI-09032	SSRI09032000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area	0.0362	0		
SS-RI-09033	SSRI09033000-7/16/2007	07/16/2007	0	1	N	EA09 - Exposure Area	0.0366	0		
SS-RI-14027	SSRI14027000-10/8/2004	10/08/2004	0	1	N	EA09 - Exposure Area			2	1
SS-RI-14033	SSRI14033000-10/8/2004	10/08/2004	0	1	N	EA09 - Exposure Area			2.8	1
Bottom Sample1	Bottom Sample1						1	1	2.7	1
Bottom Sample2	Bottom Sample2						1	1	2.7	1
Bottom Sample3	Bottom Sample3						1	1	2.7	1
Bottom Sample4	Bottom Sample4						1	1	2.7	1
Bottom Sample5	Bottom Sample5						1	1	2.7	1
Bottom Sample6	Bottom Sample6						1	1	2.7	1
Bottom Sample7	Bottom Sample7						1	1	2.7	1
Bottom Sample8	Bottom Sample8						1	1	2.7	1
Bottom Sample9	Bottom Sample9						1	1	2.7	1
Bottom Sample10	Bottom Sample10						1	1	2.7	1
Bottom Sample11	Bottom Sample11						1	1	2.7	1
Bottom Sample12	Bottom Sample12						1	1	2.7	1
Bottom Sample13	Bottom Sample13						1	1	2.7	1
Bottom Sample14	Bottom Sample14						1	1	2.7	1
Bottom Sample15	Bottom Sample15						1	1	2.7	1
Bottom Sample16	Bottom Sample16						1	1	2.7	1

ProUCL Output

ProUCL Output
AOI-08 : Beneath

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 8/4/2022 4:26:34 PM
From File	2022-0518_HAI ProUCL Input-EA08-Beneath_.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Polychlorinated biphenyls (PCBs)

General Statistics

Total Number of Observations	63	Number of Distinct Observations	50
		Number of Missing Observations	1
Number of Detects	33	Number of Non-Detects	30
Number of Distinct Detects	32	Number of Distinct Non-Detects	18
Minimum Detect	0.0011	Minimum Non-Detect	0.00112
Maximum Detect	0.248	Maximum Non-Detect	0.0037
Variance Detects	0.00421	Percent Non-Detects	47.62%
Mean Detects	0.0374	SD Detects	0.0649
Median Detects	0.0077	CV Detects	1.733
Skewness Detects	2.365	Kurtosis Detects	4.787
Mean of Logged Detects	-4.482	SD of Logged Detects	1.566

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.597	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.906	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.291	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.177	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0202	KM Standard Error of Mean	0.00635
90KM SD	0.0497	95% KM (BCA) UCL	0.0317
95% KM (t) UCL	0.0308	95% KM (Percentile Bootstrap) UCL	0.0313
95% KM (z) UCL	0.0306	95% KM Bootstrap t UCL	0.0355
90% KM Chebyshev UCL	0.0393	95% KM Chebyshev UCL	0.0479
97.5% KM Chebyshev UCL	0.0599	99% KM Chebyshev UCL	0.0834

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.658	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.809	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.18	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.162	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.526	k star (bias corrected MLE)	0.499

ProUCL Output
AOI-08 : Beneath

Theta hat (MLE)	0.0711	Theta star (bias corrected MLE)	0.0751
nu hat (MLE)	34.74	nu star (bias corrected)	32.92
Mean (detects)	0.0374		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0011	Mean	0.0244
Maximum	0.248	Median	0.01
SD	0.0486	CV	1.994
k hat (MLE)	0.727	k star (bias corrected MLE)	0.703
Theta hat (MLE)	0.0335	Theta star (bias corrected MLE)	0.0347
nu hat (MLE)	91.64	nu star (bias corrected)	88.61
Adjusted Level of Significance (β)	0.0462		
Approximate Chi Square Value (88.61, α)	67.91	Adjusted Chi Square Value (88.61, β)	67.49
95% Gamma Approximate UCL	0.0318	95% Gamma Adjusted UCL	0.032

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0202	SD (KM)	0.0497
Variance (KM)	0.00247	SE of Mean (KM)	0.00635
k hat (KM)	0.165	k star (KM)	0.168
nu hat (KM)	20.84	nu star (KM)	21.18
theta hat (KM)	0.122	theta star (KM)	0.12
80% gamma percentile (KM)	0.0239	90% gamma percentile (KM)	0.0606
95% gamma percentile (KM)	0.109	99% gamma percentile (KM)	0.244

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (21.18, α)	11.72	Adjusted Chi Square Value (21.18, β)	11.56
95% KM Approximate Gamma UCL	0.0365	95% KM Adjusted Gamma UCL	0.037

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.942	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.119	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.139	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Approximate Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0199	Mean in Log Scale	-6.103
SD in Original Scale	0.0502	SD in Log Scale	2.114
95% t UCL (assumes normality of ROS data)	0.0304	95% Percentile Bootstrap UCL	0.0311
95% BCA Bootstrap UCL	0.0329	95% Bootstrap t UCL	0.0364
95% H-UCL (Log ROS)	0.0491		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

ProUCL Output
AOI-08 : Beneath

KM Mean (logged)	-5.56	KM Geo Mean	0.00385
KM SD (logged)	1.596	95% Critical H Value (KM-Log)	2.595
KM Standard Error of Mean (logged)	0.205	95% H-UCL (KM -Log)	0.0233
KM SD (logged)	1.596	95% Critical H Value (KM-Log)	2.595
KM Standard Error of Mean (logged)	0.205		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0201	Mean in Log Scale	-5.69
SD in Original Scale	0.0501	SD in Log Scale	1.741
95% t UCL (Assumes normality)	0.0306	95% H-Stat UCL	0.0283

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 10% Significance Level

Suggested UCL to Use

KM H-UCL 0.0233

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aluminum

General Statistics

Total Number of Observations	23	Number of Distinct Observations	22
		Number of Missing Observations	41
Minimum	4920	Mean	7143
Maximum	12500	Median	6930
SD	2096	Std. Error of Mean	437
Coefficient of Variation	0.293	Skewness	1.318

Normal GOF Test

Shapiro Wilk Test Statistic	0.851	Shapiro Wilk GOF Test
1% Shapiro Wilk Critical Value	0.881	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.159	Lilliefors GOF Test
1% Lilliefors Critical Value	0.209	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL | 95% UCLs (Adjusted for Skewness)

ProUCL Output
AOI-08 : Beneath

95% Student's-t UCL	7893	95% Adjusted-CLT UCL (Chen-1995)	7990
		95% Modified-t UCL (Johnson-1978)	7913

Gamma GOF Test

A-D Test Statistic	0.778	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.743	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.174	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.181	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.05	k star (bias corrected MLE)	12.24
Theta hat (MLE)	508.5	Theta star (bias corrected MLE)	583.4
nu hat (MLE)	646.2	nu star (bias corrected)	563.2
MLE Mean (bias corrected)	7143	MLE Sd (bias corrected)	2041
		Approximate Chi Square Value (0.05)	509.2
Adjusted Level of Significance	0.0389	Adjusted Chi Square Value	505.5

Assuming Gamma Distribution

95% Approximate Gamma UCL	7901	95% Adjusted Gamma UCL	7959

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.928	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.171	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.165	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.501	Mean of logged Data	8.838
Maximum of Logged Data	9.433	SD of logged Data	0.266

Assuming Lognormal Distribution

95% H-UCL	7909	90% Chebyshev (MVUE) UCL	8330
95% Chebyshev (MVUE) UCL	8875	97.5% Chebyshev (MVUE) UCL	9631
99% Chebyshev (MVUE) UCL	11115		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	7862	95% BCA Bootstrap UCL	7926
95% Standard Bootstrap UCL	7834	95% Bootstrap-t UCL	8146
95% Hall's Bootstrap UCL	8190	95% Percentile Bootstrap UCL	7826
90% Chebyshev(Mean, Sd) UCL	8454	95% Chebyshev(Mean, Sd) UCL	9048
97.5% Chebyshev(Mean, Sd) UCL	9872	99% Chebyshev(Mean, Sd) UCL	11491

Suggested UCL to Use

ProUCL Output
AOI-08 : Beneath

95% Student's-t UCL 7893

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic

General Statistics

Total Number of Observations	64	Number of Distinct Observations	57
		Number of Missing Observations	0
Minimum	2.37	Mean	6.174
Maximum	24.2	Median	5.76
SD	3.105	Std. Error of Mean	0.388
Coefficient of Variation	0.503	Skewness	3.808

Normal GOF Test

Shapiro Wilk Test Statistic	0.649	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.128	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6.822	95% Adjusted-CLT UCL (Chen-1995)	7.01
		95% Modified-t UCL (Johnson-1978)	6.852

Gamma GOF Test

A-D Test Statistic	2.935	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.196	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.112	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.802	k star (bias corrected MLE)	6.494
Theta hat (MLE)	0.908	Theta star (bias corrected MLE)	0.951
nu hat (MLE)	870.7	nu star (bias corrected)	831.2
MLE Mean (bias corrected)	6.174	MLE Sd (bias corrected)	2.423
		Approximate Chi Square Value (0.05)	765.3
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	763.8

Assuming Gamma Distribution

95% Approximate Gamma UCL	6.705	95% Adjusted Gamma UCL	6.718

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	8.4703E-5	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.161	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.101	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.863	Mean of logged Data	1.745
Maximum of Logged Data	3.186	SD of logged Data	0.36

Assuming Lognormal Distribution

95% H-UCL	6.622	90% Chebyshev (MVUE) UCL	6.947
95% Chebyshev (MVUE) UCL	7.33	97.5% Chebyshev (MVUE) UCL	7.862
99% Chebyshev (MVUE) UCL	8.906		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	6.812	95% BCA Bootstrap UCL	7
95% Standard Bootstrap UCL	6.785	95% Bootstrap-t UCL	7.15
95% Hall's Bootstrap UCL	9.436	95% Percentile Bootstrap UCL	6.842
90% Chebyshev(Mean, Sd) UCL	7.338	95% Chebyshev(Mean, Sd) UCL	7.866
97.5% Chebyshev(Mean, Sd) UCL	8.598	99% Chebyshev(Mean, Sd) UCL	10.04

Suggested UCL to Use

95% Student's-t UCL	6.822

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	23	Number of Distinct Observations	16
		Number of Missing Observations	41
Minimum	1.6	Mean	3.035
Maximum	5.9	Median	2.7
SD	1.203	Std. Error of Mean	0.251
Coefficient of Variation	0.396	Skewness	0.885

Normal GOF Test

Shapiro Wilk Test Statistic	0.886	**Shapiro Wilk GOF Test**

ProUCL Output
AOI-08 : Beneath

1% Shapiro Wilk Critical Value	0.881	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.218	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.209	Data Not Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.465	95% Adjusted-CLT UCL (Chen-1995)	3.497
		95% Modified-t UCL (Johnson-1978)	3.473

Gamma GOF Test

A-D Test Statistic	0.79	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.183	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.182	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.373	k star (bias corrected MLE)	6.441
Theta hat (MLE)	0.412	Theta star (bias corrected MLE)	0.471
nu hat (MLE)	339.2	nu star (bias corrected)	296.3
MLE Mean (bias corrected)	3.035	MLE Sd (bias corrected)	1.196
		Approximate Chi Square Value (0.05)	257.4
Adjusted Level of Significance	0.0389	Adjusted Chi Square Value	254.8

Assuming Gamma Distribution

95% Approximate Gamma UCL	3.493	95% Adjusted Gamma UCL	3.529

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.928	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.165	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.47	Mean of logged Data	1.041
Maximum of Logged Data	1.775	SD of logged Data	0.374

Assuming Lognormal Distribution

95% H-UCL	3.526	90% Chebyshev (MVUE) UCL	3.751
95% Chebyshev (MVUE) UCL	4.08	97.5% Chebyshev (MVUE) UCL	4.535
99% Chebyshev (MVUE) UCL	5.43		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

ProUCL Output
AOI-08 : Beneath

95% CLT UCL	3.447	95% BCA Bootstrap UCL	3.478
95% Standard Bootstrap UCL	3.427	95% Bootstrap-t UCL	3.548
95% Hall's Bootstrap UCL	3.492	95% Percentile Bootstrap UCL	3.422
90% Chebyshev(Mean, Sd) UCL	3.787	95% Chebyshev(Mean, Sd) UCL	4.128
97.5% Chebyshev(Mean, Sd) UCL	4.601	99% Chebyshev(Mean, Sd) UCL	5.53

Suggested UCL to Use

95% Student's-t UCL 3.465

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron

General Statistics

Total Number of Observations	23	Number of Distinct Observations	23
		Number of Missing Observations	41
Minimum	6160	Mean	9750
Maximum	15100	Median	8540
SD	3064	Std. Error of Mean	638.8
Coefficient of Variation	0.314	Skewness	0.553

Normal GOF Test

Shapiro Wilk Test Statistic	0.869	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.881	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.209	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	10847	95% Adjusted-CLT UCL (Chen-1995)	10879
		95% Modified-t UCL (Johnson-1978)	10859

Gamma GOF Test

A-D Test Statistic	1.048	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.744	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.182	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.181	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.16	k star (bias corrected MLE)	9.733

ProUCL Output
AOI-08 : Beneath

Theta hat (MLE)	873.7	Theta star (bias corrected MLE)	1002
nu hat (MLE)	513.3	nu star (bias corrected)	447.7
MLE Mean (bias corrected)	9750	MLE Sd (bias corrected)	3125
		Approximate Chi Square Value (0.05)	399.7
Adjusted Level of Significance	0.0389	Adjusted Chi Square Value	396.4

Assuming Gamma Distribution

95% Approximate Gamma UCL	10922	95% Adjusted Gamma UCL	11013

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.928	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.171	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.165	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.726	Mean of logged Data	9.14
Maximum of Logged Data	9.622	SD of logged Data	0.305

Assuming Lognormal Distribution

95% H-UCL	10993	90% Chebyshev (MVUE) UCL	11629
95% Chebyshev (MVUE) UCL	12485	97.5% Chebyshev (MVUE) UCL	13672
99% Chebyshev (MVUE) UCL	16005		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	10801	95% BCA Bootstrap UCL	10801
95% Standard Bootstrap UCL	10774	95% Bootstrap-t UCL	10942
95% Hall's Bootstrap UCL	10828	95% Percentile Bootstrap UCL	10741
90% Chebyshev(Mean, Sd) UCL	11666	95% Chebyshev(Mean, Sd) UCL	12535
97.5% Chebyshev(Mean, Sd) UCL	13739	99% Chebyshev(Mean, Sd) UCL	16106

Suggested UCL to Use

95% Student's-t UCL	10847

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese

ProUCL Output
AOI-08 : Beneath

General Statistics

Total Number of Observations	23	Number of Distinct Observations	23
		Number of Missing Observations	41
Minimum	65.2	Mean	109.8
Maximum	235	Median	92.4
SD	45.97	Std. Error of Mean	9.585
Coefficient of Variation	0.419	Skewness	1.276

Normal GOF Test

Shapiro Wilk Test Statistic	0.853	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.881	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.209	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	126.2	95% Adjusted-CLT UCL (Chen-1995)	128.3
		95% Modified-t UCL (Johnson-1978)	126.7

Gamma GOF Test

A-D Test Statistic	0.85	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.182	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.182	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.108	k star (bias corrected MLE)	6.21
Theta hat (MLE)	15.44	Theta star (bias corrected MLE)	17.68
nu hat (MLE)	327	nu star (bias corrected)	285.7
MLE Mean (bias corrected)	109.8	MLE Sd (bias corrected)	44.05
		Approximate Chi Square Value (0.05)	247.5
Adjusted Level of Significance	0.0389	Adjusted Chi Square Value	244.9

Assuming Gamma Distribution

95% Approximate Gamma UCL	126.7	95% Adjusted Gamma UCL	128

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.917	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.928	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.162	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.165	Data appear Lognormal at 10% Significance Level

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.177	Mean of logged Data	4.626
Maximum of Logged Data	5.46	SD of logged Data	0.375

ProUCL Output
AOI-08 : Beneath

Assuming Lognormal Distribution

95% H-UCL	127.3	90% Chebyshev (MVUE) UCL	135.4
95% Chebyshev (MVUE) UCL	147.3	97.5% Chebyshev (MVUE) UCL	163.8
99% Chebyshev (MVUE) UCL	196.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	125.5	95% BCA Bootstrap UCL	128.8
95% Standard Bootstrap UCL	125	95% Bootstrap-t UCL	130.8
95% Hall's Bootstrap UCL	129.8	95% Percentile Bootstrap UCL	125.7
90% Chebyshev(Mean, Sd) UCL	138.5	95% Chebyshev(Mean, Sd) UCL	151.6
97.5% Chebyshev(Mean, Sd) UCL	169.6	99% Chebyshev(Mean, Sd) UCL	205.1

Suggested UCL to Use

95% Student's-t UCL	126.2

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium

General Statistics

Total Number of Observations	23	Number of Distinct Observations	17
		Number of Missing Observations	41
Number of Detects	4	Number of Non-Detects	19
Number of Distinct Detects	4	Number of Distinct Non-Detects	14
Minimum Detect	0.071	Minimum Non-Detect	0.076
Maximum Detect	0.26	Maximum Non-Detect	0.19
Variance Detects	0.00776	Percent Non-Detects	82.61%
Mean Detects	0.129	SD Detects	0.0881
Median Detects	0.092	CV Detects	0.684
Skewness Detects	1.918	Kurtosis Detects	3.751
Mean of Logged Detects	-2.191	SD of Logged Detects	0.576

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.736	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.687	Detected Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.399	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.413	Detected Data appear Normal at 1% Significance Level

Detected Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

ProUCL Output
AOI-08 : Beneath

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0843	KM Standard Error of Mean	0.00972
90KM SD	0.0385	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.101	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.1	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.113	95% KM Chebyshev UCL	0.127
97.5% KM Chebyshev UCL	0.145	99% KM Chebyshev UCL	0.181

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.613	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.397	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.396	Detected Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics on Detected Data Only

k hat (MLE)	3.694	k star (bias corrected MLE)	1.09
Theta hat (MLE)	0.0349	Theta star (bias corrected MLE)	0.118
nu hat (MLE)	29.55	nu star (bias corrected)	8.722
Mean (detects)	0.129		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0337	Mean	0.065
Maximum	0.26	Median	0.0551
SD	0.0473	CV	0.727
k hat (MLE)	3.613	k star (bias corrected MLE)	3.17
Theta hat (MLE)	0.018	Theta star (bias corrected MLE)	0.0205
nu hat (MLE)	166.2	nu star (bias corrected)	145.8
Adjusted Level of Significance (β)	0.0389		
Approximate Chi Square Value (145.84, α)	118.9	Adjusted Chi Square Value (145.84, β)	117.2
95% Gamma Approximate UCL	0.0797	95% Gamma Adjusted UCL	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0843	SD (KM)	0.0385
Variance (KM)	0.00148	SE of Mean (KM)	0.00972
k hat (KM)	4.795	k star (KM)	4.198
nu hat (KM)	220.6	nu star (KM)	193.1
theta hat (KM)	0.0176	theta star (KM)	0.0201
80% gamma percentile (KM)	0.116	90% gamma percentile (KM)	0.139
95% gamma percentile (KM)	0.161	99% gamma percentile (KM)	0.208

ProUCL Output
AOI-08 : Beneath

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (193.12, α)	162	Adjusted Chi Square Value (193.12, β)	159.9
95% KM Approximate Gamma UCL	0.101	95% KM Adjusted Gamma UCL	0.102

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.818	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.792	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.361	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.346	Detected Data Not Lognormal at 10% Significance Level

Detected Data appear Approximate Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.078	Mean in Log Scale	-2.621
SD in Original Scale	0.0416	SD in Log Scale	0.328
95% t UCL (assumes normality of ROS data)	0.0929	95% Percentile Bootstrap UCL	0.0943
95% BCA Bootstrap UCL	0.102	95% Bootstrap t UCL	0.119
95% H-UCL (Log ROS)	0.0873		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.526	KM Geo Mean	0.08
KM SD (logged)	0.274	95% Critical H Value (KM-Log)	1.806
KM Standard Error of Mean (logged)	0.0752	95% H-UCL (KM -Log)	0.0923
KM SD (logged)	0.274	95% Critical H Value (KM-Log)	1.806
KM Standard Error of Mean (logged)	0.0752		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0722	Mean in Log Scale	-2.74
SD in Original Scale	0.0455	SD in Log Scale	0.435
95% t UCL (Assumes normality)	0.0885	95% H-Stat UCL	0.0848

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.101

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thorium

General Statistics

Total Number of Observations	64	Number of Distinct Observations	56

ProUCL Output
AOI-08 : Beneath

		Number of Missing Observations	0
Minimum	2.67	Mean	5.819
Maximum	10.6	Median	5.725
SD	1.416	Std. Error of Mean	0.177
Coefficient of Variation	0.243	Skewness	0.442

Normal GOF Test

Shapiro Wilk Test Statistic	0.981	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0.7	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.0681	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.128	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6.115	95% Adjusted-CLT UCL (Chen-1995)	6.121
		95% Modified-t UCL (Johnson-1978)	6.116

Gamma GOF Test

A-D Test Statistic	0.332	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0731	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.111	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	16.89	k star (bias corrected MLE)	16.11
Theta hat (MLE)	0.344	Theta star (bias corrected MLE)	0.361
nu hat (MLE)	2162	nu star (bias corrected)	2062
MLE Mean (bias corrected)	5.819	MLE Sd (bias corrected)	1.45
		Approximate Chi Square Value (0.05)	1958
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	1956

Assuming Gamma Distribution

95% Approximate Gamma UCL	6.13	95% Adjusted Gamma UCL	6.137

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.983	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0.792	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.082	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.101	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.982	Mean of logged Data	1.731
Maximum of Logged Data	2.361	SD of logged Data	0.25

Assuming Lognormal Distribution

ProUCL Output
AOI-08 : Beneath

95% H-UCL	6.154	90% Chebyshev (MVUE) UCL	6.378
95% Chebyshev (MVUE) UCL	6.629	97.5% Chebyshev (MVUE) UCL	6.977
99% Chebyshev (MVUE) UCL	7.661		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	6.11	95% BCA Bootstrap UCL	6.141
95% Standard Bootstrap UCL	6.112	95% Bootstrap-t UCL	6.126
95% Hall's Bootstrap UCL	6.136	95% Percentile Bootstrap UCL	6.113
90% Chebyshev(Mean, Sd) UCL	6.35	95% Chebyshev(Mean, Sd) UCL	6.591
97.5% Chebyshev(Mean, Sd) UCL	6.924	99% Chebyshev(Mean, Sd) UCL	7.58

Suggested UCL to Use

95% Student's-t UCL 6.115

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Titanium

General Statistics

Total Number of Observations	23	Number of Distinct Observations	23
		Number of Missing Observations	41
Minimum	232	Mean	499
Maximum	1170	Median	422
SD	222.5	Std. Error of Mean	46.39
Coefficient of Variation	0.446	Skewness	1.423

Normal GOF Test

Shapiro Wilk Test Statistic	0.88	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.881	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.168	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.209	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	578.6	95% Adjusted-CLT UCL (Chen-1995)	590
		95% Modified-t UCL (Johnson-1978)	580.9

Gamma GOF Test

A-D Test Statistic	0.422	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.145	**Kolmogorov-Smirnov Gamma GOF Test**

ProUCL Output
AOI-08 : Beneath

5% K-S Critical Value	0.182	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.223	k star (bias corrected MLE)	5.44
Theta hat (MLE)	80.18	Theta star (bias corrected MLE)	91.72
nu hat (MLE)	286.2	nu star (bias corrected)	250.2
MLE Mean (bias corrected)	499	MLE Sd (bias corrected)	213.9
		Approximate Chi Square Value (0.05)	214.6
Adjusted Level of Significance	0.0389	Adjusted Chi Square Value	212.2

Assuming Gamma Distribution

95% Approximate Gamma UCL	581.8	95% Adjusted Gamma UCL	588.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.971	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.928	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.126	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.165	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.447	Mean of logged Data	6.13
Maximum of Logged Data	7.065	SD of logged Data	0.406

Assuming Lognormal Distribution

95% H-UCL	587.8	90% Chebyshev (MVUE) UCL	626.5
95% Chebyshev (MVUE) UCL	685.1	97.5% Chebyshev (MVUE) UCL	766.5
99% Chebyshev (MVUE) UCL	926.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	575.3	95% BCA Bootstrap UCL	586.3
95% Standard Bootstrap UCL	573.1	95% Bootstrap-t UCL	612.9
95% Hall's Bootstrap UCL	624.3	95% Percentile Bootstrap UCL	572.6
90% Chebyshev(Mean, Sd) UCL	638.1	95% Chebyshev(Mean, Sd) UCL	701.1
97.5% Chebyshev(Mean, Sd) UCL	788.6	99% Chebyshev(Mean, Sd) UCL	960.5

Suggested UCL to Use

95% Student's-t UCL	578.6

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

ProUCL Output
AOI-08 : Beneath

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	64	Number of Distinct Observations	49
		Number of Missing Observations	0
Minimum	0.77	Mean	1.673
Maximum	3.6	Median	1.55
SD	0.575	Std. Error of Mean	0.0719
Coefficient of Variation	0.344	Skewness	0.951

Normal GOF Test

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0.00386	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.113	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.128	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.793	95% Adjusted-CLT UCL (Chen-1995)	1.8
		95% Modified-t UCL (Johnson-1978)	1.794

Gamma GOF Test

A-D Test Statistic	0.41	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0835	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.111	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.307	k star (bias corrected MLE)	8.882
Theta hat (MLE)	0.18	Theta star (bias corrected MLE)	0.188
nu hat (MLE)	1191	nu star (bias corrected)	1137
MLE Mean (bias corrected)	1.673	MLE Sd (bias corrected)	0.561
		Approximate Chi Square Value (0.05)	1060
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	1058

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.795	95% Adjusted Gamma UCL	1.798

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0.816	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0673	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.101	Data appear Lognormal at 10% Significance Level

ProUCL Output
AOI-08 : Beneath

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.261	Mean of logged Data	0.46
Maximum of Logged Data	1.281	SD of logged Data	0.331

Assuming Lognormal Distribution

95% H-UCL	1.801	90% Chebyshev (MVUE) UCL	1.884
95% Chebyshev (MVUE) UCL	1.98	97.5% Chebyshev (MVUE) UCL	2.114
99% Chebyshev (MVUE) UCL	2.376		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	1.791	95% BCA Bootstrap UCL	1.796
95% Standard Bootstrap UCL	1.79	95% Bootstrap-t UCL	1.809
95% Hall's Bootstrap UCL	1.81	95% Percentile Bootstrap UCL	1.792
90% Chebyshev(Mean, Sd) UCL	1.889	95% Chebyshev(Mean, Sd) UCL	1.986
97.5% Chebyshev(Mean, Sd) UCL	2.122	99% Chebyshev(Mean, Sd) UCL	2.388

Suggested UCL to Use

95% Student's-t UCL	1.793

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-238

General Statistics

Total Number of Observations	64	Number of Distinct Observations	51
		Number of Missing Observations	0
Minimum	0.765	Mean	1.663
Maximum	3.5	Median	1.54
SD	0.569	Std. Error of Mean	0.0711
Coefficient of Variation	0.342	Skewness	0.911

Normal GOF Test

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0.00448	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.107	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.128	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

ProUCL Output
AOI-08 : Beneath

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.782	95% Adjusted-CLT UCL (Chen-1995)	1.789
		95% Modified-t UCL (Johnson-1978)	1.784

Gamma GOF Test

A-D Test Statistic	0.403	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0784	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.111	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.356	k star (bias corrected MLE)	8.928
Theta hat (MLE)	0.178	Theta star (bias corrected MLE)	0.186
nu hat (MLE)	1198	nu star (bias corrected)	1143
MLE Mean (bias corrected)	1.663	MLE Sd (bias corrected)	0.557
		Approximate Chi Square Value (0.05)	1065
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	1064

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.784	95% Adjusted Gamma UCL	1.787

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.983	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0.796	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0613	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.101	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.268	Mean of logged Data	0.454
Maximum of Logged Data	1.253	SD of logged Data	0.33

Assuming Lognormal Distribution

95% H-UCL	1.791	90% Chebyshev (MVUE) UCL	1.873
95% Chebyshev (MVUE) UCL	1.969	97.5% Chebyshev (MVUE) UCL	2.101
99% Chebyshev (MVUE) UCL	2.362		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	1.78	95% BCA Bootstrap UCL	1.784
95% Standard Bootstrap UCL	1.779	95% Bootstrap-t UCL	1.797
95% Hall's Bootstrap UCL	1.797	95% Percentile Bootstrap UCL	1.78
90% Chebyshev(Mean, Sd) UCL	1.877	95% Chebyshev(Mean, Sd) UCL	1.973

97.5% Chebyshev(Mean, Sd) UCL	2.108	99% Chebyshev(Mean, Sd) UCL	2.371

Suggested UCL to Use

95% Student's-t UCL	1.782

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zirconium

General Statistics

Total Number of Observations	23	Number of Distinct Observations	15
		Number of Missing Observations	41
Minimum	1.6	Mean	2.626
Maximum	5.2	Median	2.3
SD	1.087	Std. Error of Mean	0.227
Coefficient of Variation	0.414	Skewness	1.494

Normal GOF Test

Shapiro Wilk Test Statistic	0.788	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.881	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.249	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.209	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.015	95% Adjusted-CLT UCL (Chen-1995)	3.074
		95% Modified-t UCL (Johnson-1978)	3.027

Gamma GOF Test

A-D Test Statistic	1.23	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.202	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.182	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.678	k star (bias corrected MLE)	6.706
Theta hat (MLE)	0.342	Theta star (bias corrected MLE)	0.392
nu hat (MLE)	353.2	nu star (bias corrected)	308.5
MLE Mean (bias corrected)	2.626	MLE Sd (bias corrected)	1.014
		Approximate Chi Square Value (0.05)	268.8

ProUCL Output
AOI-08 : Beneath

Adjusted Level of Significance	0.0389	Adjusted Chi Square Value	266.1

Assuming Gamma Distribution

95% Approximate Gamma UCL	3.014	95% Adjusted Gamma UCL	3.044

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.928	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.176	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.165	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.47	Mean of logged Data	0.899
Maximum of Logged Data	1.649	SD of logged Data	0.355

Assuming Lognormal Distribution

95% H-UCL	3.013	90% Chebyshev (MVUE) UCL	3.201
95% Chebyshev (MVUE) UCL	3.469	97.5% Chebyshev (MVUE) UCL	3.841
99% Chebyshev (MVUE) UCL	4.572		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	2.999	95% BCA Bootstrap UCL	3.07
95% Standard Bootstrap UCL	2.985	95% Bootstrap-t UCL	3.126
95% Hall's Bootstrap UCL	3.026	95% Percentile Bootstrap UCL	3.004
90% Chebyshev(Mean, Sd) UCL	3.306	95% Chebyshev(Mean, Sd) UCL	3.614
97.5% Chebyshev(Mean, Sd) UCL	4.041	99% Chebyshev(Mean, Sd) UCL	4.881

Suggested UCL to Use

95% Student's-t UCL	3.015

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output
AOI-08 : Beneath + Exposure Area

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 8/4/2022 4:29:51 PM
From File	2022-0518_HAI ProUCL Input-EA08-Beneath+Exposure_Area.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(a)pyrene

General Statistics

Total Number of Observations	65	Number of Distinct Observations	43
		Number of Missing Observations	12
Number of Detects	6	Number of Non-Detects	59
Number of Distinct Detects	6	Number of Distinct Non-Detects	37
Minimum Detect	0.0267	Minimum Non-Detect	0.0101
Maximum Detect	0.183	Maximum Non-Detect	0.376
Variance Detects	0.00282	Percent Non-Detects	90.77%
Mean Detects	0.113	SD Detects	0.0531
Median Detects	0.119	CV Detects	0.47
Skewness Detects	-0.571	Kurtosis Detects	0.826
Mean of Logged Detects	-2.326	SD of Logged Detects	0.681

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.965	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.713	Detected Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.179	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.373	Detected Data appear Normal at 1% Significance Level

Detected Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0199	KM Standard Error of Mean	0.00459
90KM SD	0.0335	95% KM (BCA) UCL	0.0279
95% KM (t) UCL	0.0275	95% KM (Percentile Bootstrap) UCL	0.0276
95% KM (z) UCL	0.0274	95% KM Bootstrap t UCL	0.0263
90% KM Chebyshev UCL	0.0337	95% KM Chebyshev UCL	0.0399
97.5% KM Chebyshev UCL	0.0486	99% KM Chebyshev UCL	0.0656

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.455	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.701	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.256	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.334	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

ProUCL Output
AOI-08 : Beneath + Exposure Area

Gamma Statistics on Detected Data Only

k hat (MLE)	3.558	k star (bias corrected MLE)	1.89
Theta hat (MLE)	0.0318	Theta star (bias corrected MLE)	0.0599
nu hat (MLE)	42.69	nu star (bias corrected)	22.68
Mean (detects)	0.113		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0195
Maximum	0.183	Median	0.01
SD	0.0335	CV	1.719
k hat (MLE)	1.231	k star (bias corrected MLE)	1.184
Theta hat (MLE)	0.0159	Theta star (bias corrected MLE)	0.0165
nu hat (MLE)	160	nu star (bias corrected)	153.9
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (153.93, α)	126.3	Adjusted Chi Square Value (153.93, β)	125.7
95% Gamma Approximate UCL	0.0238	95% Gamma Adjusted UCL	0.0239

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0199	SD (KM)	0.0335
Variance (KM)	0.00112	SE of Mean (KM)	0.00459
k hat (KM)	0.352	k star (KM)	0.346
nu hat (KM)	45.8	nu star (KM)	45.02
theta hat (KM)	0.0564	theta star (KM)	0.0574
80% gamma percentile (KM)	0.0314	90% gamma percentile (KM)	0.0575
95% gamma percentile (KM)	0.0868	99% gamma percentile (KM)	0.162

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (45.02, α)	30.63	Adjusted Chi Square Value (45.02, β)	30.36
95% KM Approximate Gamma UCL	0.0292	95% KM Adjusted Gamma UCL	0.0295

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.821	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.826	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.298	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.298	Detected Data Not Lognormal at 10% Significance Level

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0142	Mean in Log Scale	-5.395
SD in Original Scale	0.0352	SD in Log Scale	1.204
95% t UCL (assumes normality of ROS data)	0.0215	95% Percentile Bootstrap UCL	0.0218
95% BCA Bootstrap UCL	0.0234	95% Bootstrap t UCL	0.0262
95% H-UCL (Log ROS)	0.0131		

ProUCL Output
AOI-08 : Beneath + Exposure Area

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.375	KM Geo Mean	0.0126
KM SD (logged)	0.691	95% Critical H Value (KM-Log)	2.004
KM Standard Error of Mean (logged)	0.0956	95% H-UCL (KM -Log)	0.019
KM SD (logged)	0.691	95% Critical H Value (KM-Log)	2.004
KM Standard Error of Mean (logged)	0.0956		

Note: KM UCLs may be biased low with this dataset. Other substitution method recommended

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0221	Mean in Log Scale	-4.535
SD in Original Scale	0.04	SD in Log Scale	1.003
95% t UCL (Assumes normality)	0.0304	95% H-Stat UCL	0.0235

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0275

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Carbazole

General Statistics

Total Number of Observations	53	Number of Distinct Observations	30
		Number of Missing Observations	24
Number of Detects	1	Number of Non-Detects	52
Number of Distinct Detects	1	Number of Distinct Non-Detects	29

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Carbazole was not processed!

Polychlorinated biphenyls (PCBs)

General Statistics

Total Number of Observations	75	Number of Distinct Observations	61
		Number of Missing Observations	2
Number of Detects	42	Number of Non-Detects	33
Number of Distinct Detects	41	Number of Distinct Non-Detects	20
Minimum Detect	0.0011	Minimum Non-Detect	0.00112

ProUCL Output
AOI-08 : Beneath + Exposure Area

Maximum Detect	0.432	Maximum Non-Detect	0.00393
Variance Detects	0.00834	Percent Non-Detects	44%
Mean Detects	0.0513	SD Detects	0.0913
Median Detects	0.0126	CV Detects	1.78
Skewness Detects	2.675	Kurtosis Detects	7.45
Mean of Logged Detects	-4.214	SD of Logged Detects	1.62

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.585	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.922	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.311	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.157	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0293	KM Standard Error of Mean	0.00841
90KM SD	0.0719	95% KM (BCA) UCL	0.0463
95% KM (t) UCL	0.0433	95% KM (Percentile Bootstrap) UCL	0.0436
95% KM (z) UCL	0.0431	95% KM Bootstrap t UCL	0.0509
90% KM Chebyshev UCL	0.0545	95% KM Chebyshev UCL	0.0659
97.5% KM Chebyshev UCL	0.0818	99% KM Chebyshev UCL	0.113

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.753	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.812	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.149	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.144	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.509	k star (bias corrected MLE)	0.489
Theta hat (MLE)	0.101	Theta star (bias corrected MLE)	0.105
nu hat (MLE)	42.78	nu star (bias corrected)	41.05
Mean (detects)	0.0513		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0011	Mean	0.0331
Maximum	0.432	Median	0.01
SD	0.071	CV	2.145
k hat (MLE)	0.627	k star (bias corrected MLE)	0.611
Theta hat (MLE)	0.0528	Theta star (bias corrected MLE)	0.0542
nu hat (MLE)	94.09	nu star (bias corrected)	91.66
Adjusted Level of Significance (β)	0.0468		

ProUCL Output
AOI-08 : Beneath + Exposure Area

Approximate Chi Square Value (91.66, α)	70.59	Adjusted Chi Square Value (91.66, β)	70.22
95% Gamma Approximate UCL	0.043	95% Gamma Adjusted UCL	0.0432

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0293	SD (KM)	0.0719
Variance (KM)	0.00518	SE of Mean (KM)	0.00841
k hat (KM)	0.165	k star (KM)	0.168
nu hat (KM)	24.81	nu star (KM)	25.15
theta hat (KM)	0.177	theta star (KM)	0.175
80% gamma percentile (KM)	0.0346	90% gamma percentile (KM)	0.0878
95% gamma percentile (KM)	0.157	99% gamma percentile (KM)	0.355

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (25.15, α)	14.73	Adjusted Chi Square Value (25.15, β)	14.57
95% KM Approximate Gamma UCL	0.05	95% KM Adjusted Gamma UCL	0.0505

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.903	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.951	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.0999	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.124	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Approximate Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.029	Mean in Log Scale	-5.773
SD in Original Scale	0.0725	SD in Log Scale	2.196
95% t UCL (assumes normality of ROS data)	0.0429	95% Percentile Bootstrap UCL	0.0433
95% BCA Bootstrap UCL	0.0466	95% Bootstrap t UCL	0.049
95% H-UCL (Log ROS)	0.0885		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.326	KM Geo Mean	0.00486
KM SD (logged)	1.741	95% Critical H Value (KM-Log)	3.093
KM Standard Error of Mean (logged)	0.204	95% H-UCL (KM -Log)	0.0414
KM SD (logged)	1.741	95% Critical H Value (KM-Log)	3.093
KM Standard Error of Mean (logged)	0.204		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0292	Mean in Log Scale	-5.434
SD in Original Scale	0.0725	SD in Log Scale	1.871
95% t UCL (Assumes normality)	0.0431	95% H-Stat UCL	0.0511

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 10% Significance Level

Suggested UCL to Use

ProUCL Output
AOI-08 : Beneath + Exposure Area

KM H-UCL 0.0414

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aluminum

General Statistics

Total Number of Observations	35	Number of Distinct Observations	33
		Number of Missing Observations	42
Minimum	4920	Mean	8175
Maximum	13800	Median	7720
SD	2610	Std. Error of Mean	441.2
Coefficient of Variation	0.319	Skewness	0.699

Normal GOF Test

Shapiro Wilk Test Statistic	0.907	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.91	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.153	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.172	Data appear Normal at 1% Significance Level

Data appear Approximate Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	8922	95% Adjusted-CLT UCL (Chen-1995)	8957
		95% Modified-t UCL (Johnson-1978)	8930

Gamma GOF Test

A-D Test Statistic	0.647	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.112	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.149	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.74	k star (bias corrected MLE)	9.839
Theta hat (MLE)	761.2	Theta star (bias corrected MLE)	830.9
nu hat (MLE)	751.8	nu star (bias corrected)	688.7
MLE Mean (bias corrected)	8175	MLE Sd (bias corrected)	2606
		Approximate Chi Square Value (0.05)	628.8
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	626.1

ProUCL Output
AOI-08 : Beneath + Exposure Area

Assuming Gamma Distribution

95% Approximate Gamma UCL	8954	95% Adjusted Gamma UCL	8993

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.944	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.114	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.136	Data appear Lognormal at 10% Significance Level

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.501	Mean of logged Data	8.962
Maximum of Logged Data	9.532	SD of logged Data	0.309

Assuming Lognormal Distribution

95% H-UCL	9003	90% Chebyshev (MVUE) UCL	9473
95% Chebyshev (MVUE) UCL	10064	97.5% Chebyshev (MVUE) UCL	10884
99% Chebyshev (MVUE) UCL	12495		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	8901	95% BCA Bootstrap UCL	8925
95% Standard Bootstrap UCL	8875	95% Bootstrap-t UCL	8971
95% Hall's Bootstrap UCL	8935	95% Percentile Bootstrap UCL	8899
90% Chebyshev(Mean, Sd) UCL	9499	95% Chebyshev(Mean, Sd) UCL	10099
97.5% Chebyshev(Mean, Sd) UCL	10931	99% Chebyshev(Mean, Sd) UCL	12566

Suggested UCL to Use

95% Student's-t UCL	8922

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic

General Statistics

Total Number of Observations	77	Number of Distinct Observations	65
Number of Detects	76	Number of Non-Detects	1
Number of Distinct Detects	65	Number of Distinct Non-Detects	1
Minimum Detect	2.37	Minimum Non-Detect	6.1
Maximum Detect	24.2	Maximum Non-Detect	6.1

ProUCL Output
AOI-08 : Beneath + Exposure Area

Variance Detects	8.267	Percent Non-Detects	1.299%
Mean Detects	6.157	SD Detects	2.875
Median Detects	5.81	CV Detects	0.467
Skewness Detects	4.032	Kurtosis Detects	21.8
Mean of Logged Detects	1.752	SD of Logged Detects	0.336

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.647	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.253	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.118	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	6.142	KM Standard Error of Mean	0.326
90KM SD	2.842	95% KM (BCA) UCL	6.778
95% KM (t) UCL	6.685	95% KM (Percentile Bootstrap) UCL	6.731
95% KM (z) UCL	6.678	95% KM Bootstrap t UCL	6.95
90% KM Chebyshev UCL	7.12	95% KM Chebyshev UCL	7.564
97.5% KM Chebyshev UCL	8.179	99% KM Chebyshev UCL	9.388

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.414	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.184	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.102	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.795	k star (bias corrected MLE)	7.496
Theta hat (MLE)	0.79	Theta star (bias corrected MLE)	0.821
nu hat (MLE)	1185	nu star (bias corrected)	1139
Mean (detects)	6.157		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.37	Mean	6.14
Maximum	24.2	Median	5.8
SD	2.86	CV	0.466
k hat (MLE)	7.855	k star (bias corrected MLE)	7.558
Theta hat (MLE)	0.782	Theta star (bias corrected MLE)	0.812
nu hat (MLE)	1210	nu star (bias corrected)	1164
Adjusted Level of Significance (β)	0.0469		
Approximate Chi Square Value (N/A, α)	1086	Adjusted Chi Square Value (N/A, β)	1084

ProUCL Output
AOI-08 : Beneath + Exposure Area

95% Gamma Approximate UCL	6.582	95% Gamma Adjusted UCL	6.591

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	6.142	SD (KM)	2.842
Variance (KM)	8.079	SE of Mean (KM)	0.326
k hat (KM)	4.669	k star (KM)	4.495
nu hat (KM)	719	nu star (KM)	692.3
theta hat (KM)	1.316	theta star (KM)	1.366
80% gamma percentile (KM)	8.355	90% gamma percentile (KM)	10.02
95% gamma percentile (KM)	11.55	99% gamma percentile (KM)	14.79

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (692.28, α)	632.2	Adjusted Chi Square Value (692.28, β)	631.2
95% KM Approximate Gamma UCL	6.725	95% KM Adjusted Gamma UCL	6.736

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.908	**Shapiro Wilk GOF Test**
10% Shapiro Wilk P Value	7.0878E-6	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.152	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.093	Detected Data Not Lognormal at 10% Significance Level

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	6.141	Mean in Log Scale	1.75
SD in Original Scale	2.859	SD in Log Scale	0.334
95% t UCL (assumes normality of ROS data)	6.684	95% Percentile Bootstrap UCL	6.716
95% BCA Bootstrap UCL	6.812	95% Bootstrap t UCL	6.962
95% H-UCL (Log ROS)	6.512		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.75	KM Geo Mean	5.754
KM SD (logged)	0.333	95% Critical H Value (KM-Log)	1.763
KM Standard Error of Mean (logged)	0.0383	95% H-UCL (KM -Log)	6.506
KM SD (logged)	0.333	95% Critical H Value (KM-Log)	1.763
KM Standard Error of Mean (logged)	0.0383		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	6.116	Mean in Log Scale	1.744
SD in Original Scale	2.878	SD in Log Scale	0.342
95% t UCL (Assumes normality)	6.663	95% H-Stat UCL	6.497

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL	6.685

ProUCL Output
AOI-08 : Beneath + Exposure Area

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	35	Number of Distinct Observations	24
		Number of Missing Observations	42
Minimum	1.5	Mean	3.029
Maximum	5.9	Median	2.7
SD	1.155	Std. Error of Mean	0.195
Coefficient of Variation	0.381	Skewness	0.649

Normal GOF Test

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.91	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.172	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.359	95% Adjusted-CLT UCL (Chen-1995)	3.373
		95% Modified-t UCL (Johnson-1978)	3.362

Gamma GOF Test

A-D Test Statistic	0.779	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.749	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.144	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.149	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.434	k star (bias corrected MLE)	6.816
Theta hat (MLE)	0.407	Theta star (bias corrected MLE)	0.444
nu hat (MLE)	520.4	nu star (bias corrected)	477.1
MLE Mean (bias corrected)	3.029	MLE Sd (bias corrected)	1.16
		Approximate Chi Square Value (0.05)	427.5
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	425.2

Assuming Gamma Distribution

95% Approximate Gamma UCL	3.38	95% Adjusted Gamma UCL	3.398

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk Lognormal GOF Test**

ProUCL Output
AOI-08 : Beneath + Exposure Area

10% Shapiro Wilk Critical Value	0.944	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.126	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.136	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.405	Mean of logged Data	1.039
Maximum of Logged Data	1.775	SD of logged Data	0.375

Assuming Lognormal Distribution

95% H-UCL	3.416	90% Chebyshev (MVUE) UCL	3.618
95% Chebyshev (MVUE) UCL	3.885	97.5% Chebyshev (MVUE) UCL	4.257
99% Chebyshev (MVUE) UCL	4.986		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	3.35	95% BCA Bootstrap UCL	3.36
95% Standard Bootstrap UCL	3.344	95% Bootstrap-t UCL	3.392
95% Hall's Bootstrap UCL	3.373	95% Percentile Bootstrap UCL	3.34
90% Chebyshev(Mean, Sd) UCL	3.614	95% Chebyshev(Mean, Sd) UCL	3.88
97.5% Chebyshev(Mean, Sd) UCL	4.248	99% Chebyshev(Mean, Sd) UCL	4.971

Suggested UCL to Use

95% Student's-t UCL	3.359

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron

General Statistics

Total Number of Observations	35	Number of Distinct Observations	35
		Number of Missing Observations	42
Minimum	6160	Mean	10390
Maximum	15600	Median	9940
SD	2993	Std. Error of Mean	506
Coefficient of Variation	0.288	Skewness	0.249

Normal GOF Test

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.91	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.132	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.172	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

ProUCL Output
AOI-08 : Beneath + Exposure Area

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	11245	95% Adjusted-CLT UCL (Chen-1995)	11245
		95% Modified-t UCL (Johnson-1978)	11249

Gamma GOF Test

A-D Test Statistic	0.83	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.149	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	12.32	k star (bias corrected MLE)	11.28
Theta hat (MLE)	843.4	Theta star (bias corrected MLE)	920.9
nu hat (MLE)	862.4	nu star (bias corrected)	789.8
MLE Mean (bias corrected)	10390	MLE Sd (bias corrected)	3093
		Approximate Chi Square Value (0.05)	725.6
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	722.6

Assuming Gamma Distribution

95% Approximate Gamma UCL	11309	95% Adjusted Gamma UCL	11355

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.944	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.128	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.136	Data appear Lognormal at 10% Significance Level

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.726	Mean of logged Data	9.207
Maximum of Logged Data	9.655	SD of logged Data	0.293

Assuming Lognormal Distribution

95% H-UCL	11390	90% Chebyshev (MVUE) UCL	11962
95% Chebyshev (MVUE) UCL	12673	97.5% Chebyshev (MVUE) UCL	13659
99% Chebyshev (MVUE) UCL	15595		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	11222	95% BCA Bootstrap UCL	11206
95% Standard Bootstrap UCL	11199	95% Bootstrap-t UCL	11333
95% Hall's Bootstrap UCL	11278	95% Percentile Bootstrap UCL	11170
90% Chebyshev(Mean, Sd) UCL	11908	95% Chebyshev(Mean, Sd) UCL	12595

ProUCL Output
AOI-08 : Beneath + Exposure Area

97.5% Chebyshev(Mean, Sd) UCL	13550	99% Chebyshev(Mean, Sd) UCL	15424

Suggested UCL to Use

95% Student's-t UCL	11245

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese

General Statistics

Total Number of Observations	35	Number of Distinct Observations	35
		Number of Missing Observations	42
Minimum	37.8	Mean	109.4
Maximum	235	Median	93.2
SD	46.47	Std. Error of Mean	7.854
Coefficient of Variation	0.425	Skewness	0.873

Normal GOF Test

Shapiro Wilk Test Statistic	0.923	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.91	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.152	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.172	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	122.7	95% Adjusted-CLT UCL (Chen-1995)	123.6
		95% Modified-t UCL (Johnson-1978)	122.9

Gamma GOF Test

A-D Test Statistic	0.566	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.137	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.149	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.111	k star (bias corrected MLE)	5.606
Theta hat (MLE)	17.91	Theta star (bias corrected MLE)	19.52
nu hat (MLE)	427.7	nu star (bias corrected)	392.4
MLE Mean (bias corrected)	109.4	MLE Sd (bias corrected)	46.23
		Approximate Chi Square Value (0.05)	347.5
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	345.5

Assuming Gamma Distribution

95% Approximate Gamma UCL	123.6	95% Adjusted Gamma UCL	124.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.944	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.123	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.136	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.632	Mean of logged Data	4.611
Maximum of Logged Data	5.46	SD of logged Data	0.416

Assuming Lognormal Distribution

95% H-UCL	125.5	90% Chebyshev (MVUE) UCL	133.3
95% Chebyshev (MVUE) UCL	144.1	97.5% Chebyshev (MVUE) UCL	159.1
99% Chebyshev (MVUE) UCL	188.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	122.4	95% BCA Bootstrap UCL	123
95% Standard Bootstrap UCL	122.1	95% Bootstrap-t UCL	124.3
95% Hall's Bootstrap UCL	124.1	95% Percentile Bootstrap UCL	121.6
90% Chebyshev(Mean, Sd) UCL	133	95% Chebyshev(Mean, Sd) UCL	143.7
97.5% Chebyshev(Mean, Sd) UCL	158.5	99% Chebyshev(Mean, Sd) UCL	187.6

Suggested UCL to Use

95% Student's-t UCL	122.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium

General Statistics

Total Number of Observations	35	Number of Distinct Observations	20
		Number of Missing Observations	42
Number of Detects	10	Number of Non-Detects	25
Number of Distinct Detects	8	Number of Distinct Non-Detects	16
Minimum Detect	0.071	Minimum Non-Detect	0.076
Maximum Detect	0.26	Maximum Non-Detect	0.19
Variance Detects	0.00285	Percent Non-Detects	71.43%
Mean Detects	0.124	SD Detects	0.0534
Median Detects	0.115	CV Detects	0.431
Skewness Detects	2.106	Kurtosis Detects	5.129

ProUCL Output
AOI-08 : Beneath + Exposure Area

Mean of Logged Detects	-2.151	SD of Logged Detects	0.357

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.768	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.781	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.331	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.304	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0913	KM Standard Error of Mean	0.00699
90KM SD	0.0362	95% KM (BCA) UCL	0.108
95% KM (t) UCL	0.103	95% KM (Percentile Bootstrap) UCL	0.105
95% KM (z) UCL	0.103	95% KM Bootstrap t UCL	0.107
90% KM Chebyshev UCL	0.112	95% KM Chebyshev UCL	0.122
97.5% KM Chebyshev UCL	0.135	99% KM Chebyshev UCL	0.161

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.627	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.727	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.29	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.267	Detected Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.945	k star (bias corrected MLE)	5.628
Theta hat (MLE)	0.0156	Theta star (bias corrected MLE)	0.0221
nu hat (MLE)	158.9	nu star (bias corrected)	112.6
Mean (detects)	0.124		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0274	Mean	0.0745
Maximum	0.26	Median	0.0643
SD	0.045	CV	0.604
k hat (MLE)	3.889	k star (bias corrected MLE)	3.574
Theta hat (MLE)	0.0191	Theta star (bias corrected MLE)	0.0208
nu hat (MLE)	272.2	nu star (bias corrected)	250.2
Adjusted Level of Significance (β)	0.0425		
Approximate Chi Square Value (250.21, α)	214.6	Adjusted Chi Square Value (250.21, β)	213
95% Gamma Approximate UCL	0.0868	95% Gamma Adjusted UCL	0.0875

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0913	SD (KM)	0.0362

ProUCL Output
AOI-08 : Beneath + Exposure Area

Variance (KM)	0.00131	SE of Mean (KM)	0.00699
k hat (KM)	6.355	k star (KM)	5.829
nu hat (KM)	444.8	nu star (KM)	408.1
theta hat (KM)	0.0144	theta star (KM)	0.0157
80% gamma percentile (KM)	0.121	90% gamma percentile (KM)	0.142
95% gamma percentile (KM)	0.161	99% gamma percentile (KM)	0.201

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (408.05, α)	362.2	Adjusted Chi Square Value (408.05, β)	360.2
95% KM Approximate Gamma UCL	0.103	95% KM Adjusted Gamma UCL	0.103

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.904	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.869	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.266	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.241	Detected Data Not Lognormal at 10% Significance Level

Detected Data appear Approximate Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0852	Mean in Log Scale	-2.527
SD in Original Scale	0.0385	SD in Log Scale	0.335
95% t UCL (assumes normality of ROS data)	0.0963	95% Percentile Bootstrap UCL	0.0968
95% BCA Bootstrap UCL	0.0994	95% Bootstrap t UCL	0.104
95% H-UCL (Log ROS)	0.0938		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.444	KM Geo Mean	0.0868
KM SD (logged)	0.292	95% Critical H Value (KM-Log)	1.796
KM Standard Error of Mean (logged)	0.0602	95% H-UCL (KM -Log)	0.0991
KM SD (logged)	0.292	95% Critical H Value (KM-Log)	1.796
KM Standard Error of Mean (logged)	0.0602		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.078	Mean in Log Scale	-2.66
SD in Original Scale	0.0432	SD in Log Scale	0.448
95% t UCL (Assumes normality)	0.0903	95% H-Stat UCL	0.0895

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.103	95% GROS Adjusted Gamma UCL	0.0875

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

ProUCL Output
AOI-08 : Beneath + Exposure Area

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thorium

General Statistics

Total Number of Observations	77	Number of Distinct Observations	61
		Number of Missing Observations	0
Minimum	2.67	Mean	5.681
Maximum	10.6	Median	5.6
SD	1.376	Std. Error of Mean	0.157
Coefficient of Variation	0.242	Skewness	0.546

Normal GOF Test

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0.474	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.0555	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.117	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5.942	95% Adjusted-CLT UCL (Chen-1995)	5.95
		95% Modified-t UCL (Johnson-1978)	5.944

Gamma GOF Test

A-D Test Statistic	0.305	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0563	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.102	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.34	k star (bias corrected MLE)	16.67
Theta hat (MLE)	0.328	Theta star (bias corrected MLE)	0.341
nu hat (MLE)	2670	nu star (bias corrected)	2567
MLE Mean (bias corrected)	5.681	MLE Sd (bias corrected)	1.391
		Approximate Chi Square Value (0.05)	2451
Adjusted Level of Significance	0.0469	Adjusted Chi Square Value	2449

Assuming Gamma Distribution

95% Approximate Gamma UCL	5.952	95% Adjusted Gamma UCL	5.957

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.987	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0.907	Data appear Lognormal at 10% Significance Level

ProUCL Output
AOI-08 : Beneath + Exposure Area

Lilliefors Test Statistic	0.0662	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.0924	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.982	Mean of logged Data	1.708
Maximum of Logged Data	2.361	SD of logged Data	0.245

Assuming Lognormal Distribution

95% H-UCL	5.969	90% Chebyshev (MVUE) UCL	6.167
95% Chebyshev (MVUE) UCL	6.386	97.5% Chebyshev (MVUE) UCL	6.689
99% Chebyshev (MVUE) UCL	7.285		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	5.939	95% BCA Bootstrap UCL	5.931
95% Standard Bootstrap UCL	5.936	95% Bootstrap-t UCL	5.95
95% Hall's Bootstrap UCL	5.956	95% Percentile Bootstrap UCL	5.94
90% Chebyshev(Mean, Sd) UCL	6.152	95% Chebyshev(Mean, Sd) UCL	6.365
97.5% Chebyshev(Mean, Sd) UCL	6.66	99% Chebyshev(Mean, Sd) UCL	7.241

Suggested UCL to Use

95% Student's-t UCL	5.942

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Titanium

General Statistics

Total Number of Observations	35	Number of Distinct Observations	35
		Number of Missing Observations	42
Minimum	232	Mean	488.4
Maximum	1170	Median	451
SD	189.6	Std. Error of Mean	32.05
Coefficient of Variation	0.388	Skewness	1.587

Normal GOF Test

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk GOF Test**	
1% Shapiro Wilk Critical Value	0.91	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.147	**Lilliefors GOF Test**	
1% Lilliefors Critical Value	0.172	Data appear Normal at 1% Significance Level	

Data appear Approximate Normal at 1% Significance Level

ProUCL Output
AOI-08 : Beneath + Exposure Area

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	542.6	95% Adjusted-CLT UCL (Chen-1995)	550.3
		95% Modified-t UCL (Johnson-1978)	544.1

Gamma GOF Test

A-D Test Statistic	0.477	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.129	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.149	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.129	k star (bias corrected MLE)	7.451
Theta hat (MLE)	60.08	Theta star (bias corrected MLE)	65.55
nu hat (MLE)	569	nu star (bias corrected)	521.6
MLE Mean (bias corrected)	488.4	MLE Sd (bias corrected)	178.9
		Approximate Chi Square Value (0.05)	469.6
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	467.3

Assuming Gamma Distribution

95% Approximate Gamma UCL	542.5	95% Adjusted Gamma UCL	545.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.944	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.114	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.136	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.447	Mean of logged Data	6.128
Maximum of Logged Data	7.065	SD of logged Data	0.351

Assuming Lognormal Distribution

95% H-UCL	544.8	90% Chebyshev (MVUE) UCL	575.6
95% Chebyshev (MVUE) UCL	615.8	97.5% Chebyshev (MVUE) UCL	671.6
99% Chebyshev (MVUE) UCL	781.1		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	541.1	95% BCA Bootstrap UCL	552.1
95% Standard Bootstrap UCL	541	95% Bootstrap-t UCL	555.5
95% Hall's Bootstrap UCL	565.4	95% Percentile Bootstrap UCL	544.1
90% Chebyshev(Mean, Sd) UCL	584.6	95% Chebyshev(Mean, Sd) UCL	628.1
97.5% Chebyshev(Mean, Sd) UCL	688.6	99% Chebyshev(Mean, Sd) UCL	807.3

ProUCL Output
AOI-08 : Beneath + Exposure Area

Suggested UCL to Use

95% Student's-t UCL	542.6

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	77	Number of Distinct Observations	55
		Number of Missing Observations	0
Minimum	0.77	Mean	2.068
Maximum	10.7	Median	1.6
SD	1.771	Std. Error of Mean	0.202
Coefficient of Variation	0.857	Skewness	3.62

Normal GOF Test

Shapiro Wilk Test Statistic	0.537	Shapiro Wilk GOF Test
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.278	Lilliefors GOF Test
1% Lilliefors Critical Value	0.117	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.404	95% Adjusted-CLT UCL (Chen-1995)	2.489
		95% Modified-t UCL (Johnson-1978)	2.418

Gamma GOF Test

A-D Test Statistic	5.003	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.174	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.102	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.059	k star (bias corrected MLE)	2.949
Theta hat (MLE)	0.676	Theta star (bias corrected MLE)	0.701
nu hat (MLE)	471.1	nu star (bias corrected)	454.1
MLE Mean (bias corrected)	2.068	MLE Sd (bias corrected)	1.204
		Approximate Chi Square Value (0.05)	405.7
Adjusted Level of Significance	0.0469	Adjusted Chi Square Value	404.8

ProUCL Output
AOI-08 : Beneath + Exposure Area

Assuming Gamma Distribution

95% Approximate Gamma UCL	2.314	95% Adjusted Gamma UCL	2.319

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.861	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	9.091E-10	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.115	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0924	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.261	Mean of logged Data	0.554
Maximum of Logged Data	2.37	SD of logged Data	0.509

Assuming Lognormal Distribution

95% H-UCL	2.208	90% Chebyshev (MVUE) UCL	2.34
95% Chebyshev (MVUE) UCL	2.505	97.5% Chebyshev (MVUE) UCL	2.733
99% Chebyshev (MVUE) UCL	3.182		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	2.4	95% BCA Bootstrap UCL	2.474
95% Standard Bootstrap UCL	2.396	95% Bootstrap-t UCL	2.556
95% Hall's Bootstrap UCL	2.453	95% Percentile Bootstrap UCL	2.419
90% Chebyshev(Mean, Sd) UCL	2.673	95% Chebyshev(Mean, Sd) UCL	2.947
97.5% Chebyshev(Mean, Sd) UCL	3.328	99% Chebyshev(Mean, Sd) UCL	4.076

Suggested UCL to Use

95% Student's-t UCL	2.404

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-238

General Statistics

Total Number of Observations	77	Number of Distinct Observations	56
		Number of Missing Observations	0
Minimum	0.765	Mean	2.058
Maximum	10.7	Median	1.6
SD	1.771	Std. Error of Mean	0.202
Coefficient of Variation	0.861	Skewness	3.631

ProUCL Output
AOI-08 : Beneath + Exposure Area

Normal GOF Test

Shapiro Wilk Test Statistic	0.535	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.278	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.117	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.394	95% Adjusted-CLT UCL (Chen-1995)	2.48
		95% Modified-t UCL (Johnson-1978)	2.408

Gamma GOF Test

A-D Test Statistic	5.052	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.171	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.102	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.046	k star (bias corrected MLE)	2.936
Theta hat (MLE)	0.676	Theta star (bias corrected MLE)	0.701
nu hat (MLE)	469	nu star (bias corrected)	452.1
MLE Mean (bias corrected)	2.058	MLE Sd (bias corrected)	1.201
		Approximate Chi Square Value (0.05)	403.8
Adjusted Level of Significance	0.0469	Adjusted Chi Square Value	402.9

Assuming Gamma Distribution

95% Approximate Gamma UCL	2.304	95% Adjusted Gamma UCL	2.309

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.86	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	7.500E-10	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.111	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0924	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.268	Mean of logged Data	0.549
Maximum of Logged Data	2.37	SD of logged Data	0.509

Assuming Lognormal Distribution

95% H-UCL	2.198	90% Chebyshev (MVUE) UCL	2.329
95% Chebyshev (MVUE) UCL	2.493	97.5% Chebyshev (MVUE) UCL	2.72
99% Chebyshev (MVUE) UCL	3.167		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

ProUCL Output
AOI-08 : Beneath + Exposure Area

Nonparametric Distribution Free UCLs

95% CLT UCL	2.39	95% BCA Bootstrap UCL	2.467
95% Standard Bootstrap UCL	2.386	95% Bootstrap-t UCL	2.544
95% Hall's Bootstrap UCL	2.442	95% Percentile Bootstrap UCL	2.409
90% Chebyshev(Mean, Sd) UCL	2.664	95% Chebyshev(Mean, Sd) UCL	2.938
97.5% Chebyshev(Mean, Sd) UCL	3.319	99% Chebyshev(Mean, Sd) UCL	4.067

Suggested UCL to Use

95% Student's-t UCL	2.394

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zirconium

General Statistics

Total Number of Observations	35	Number of Distinct Observations	22
		Number of Missing Observations	42
Number of Detects	34	Number of Non-Detects	1
Number of Distinct Detects	21	Number of Distinct Non-Detects	1
Minimum Detect	1.2	Minimum Non-Detect	1.93
Maximum Detect	5.2	Maximum Non-Detect	1.93
Variance Detects	1.007	Percent Non-Detects	2.857%
Mean Detects	2.421	SD Detects	1.003
Median Detects	2.15	CV Detects	0.414
Skewness Detects	1.576	Kurtosis Detects	2.263
Mean of Logged Detects	0.815	SD of Logged Detects	0.363

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.831	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.194	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.175	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.397	KM Standard Error of Mean	0.169
90KM SD	0.985	95% KM (BCA) UCL	2.674
95% KM (t) UCL	2.683	95% KM (Percentile Bootstrap) UCL	2.671
95% KM (z) UCL	2.675	95% KM Bootstrap t UCL	2.762
90% KM Chebyshev UCL	2.904	95% KM Chebyshev UCL	3.134
97.5% KM Chebyshev UCL	3.453	99% KM Chebyshev UCL	4.079

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.86	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.748	Detected Data Not Gamma Distributed at 5% Significance Level

ProUCL Output
AOI-08 : Beneath + Exposure Area

K-S Test Statistic	0.14	Kolmogorov-Smirnov GOF	
5% K-S Critical Value	0.151	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.418	k star (bias corrected MLE)	6.783
Theta hat (MLE)	0.326	Theta star (bias corrected MLE)	0.357
nu hat (MLE)	504.4	nu star (bias corrected)	461.3
Mean (detects)	2.421		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.2	Mean	2.393
Maximum	5.2	Median	2.1
SD	1.002	CV	0.419
k hat (MLE)	7.298	k star (bias corrected MLE)	6.692
Theta hat (MLE)	0.328	Theta star (bias corrected MLE)	0.358
nu hat (MLE)	510.9	nu star (bias corrected)	468.4
Adjusted Level of Significance (β)	0.0425		
Approximate Chi Square Value (468.41, α)	419.2	Adjusted Chi Square Value (468.41, β)	417
95% Gamma Approximate UCL	2.674	95% Gamma Adjusted UCL	2.688

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.397	SD (KM)	0.985
Variance (KM)	0.97	SE of Mean (KM)	0.169
k hat (KM)	5.922	k star (KM)	5.434
nu hat (KM)	414.6	nu star (KM)	380.4
theta hat (KM)	0.405	theta star (KM)	0.441
80% gamma percentile (KM)	3.192	90% gamma percentile (KM)	3.772
95% gamma percentile (KM)	4.299	99% gamma percentile (KM)	5.409

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (380.37, α)	336.2	Adjusted Chi Square Value (380.37, β)	334.2
95% KM Approximate Gamma UCL	2.712	95% KM Adjusted Gamma UCL	2.728

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk GOF Test	
10% Shapiro Wilk Critical Value	0.943	Detected Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.114	Lilliefors GOF Test	
10% Lilliefors Critical Value	0.137	Detected Data appear Lognormal at 10% Significance Level	

Detected Data appear Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.396	Mean in Log Scale	0.805

ProUCL Output
AOI-08 : Beneath + Exposure Area

SD in Original Scale	0.999	SD in Log Scale	0.363
95% t UCL (assumes normality of ROS data)	2.682	95% Percentile Bootstrap UCL	2.683
95% BCA Bootstrap UCL	2.711	95% Bootstrap t UCL	2.74
95% H-UCL (Log ROS)	2.679		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.805	KM Geo Mean	2.236
KM SD (logged)	0.359	95% Critical H Value (KM-Log)	1.839
KM Standard Error of Mean (logged)	0.0617	95% H-UCL (KM -Log)	2.67
KM SD (logged)	0.359	95% Critical H Value (KM-Log)	1.839
KM Standard Error of Mean (logged)	0.0617		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.379	Mean in Log Scale	0.791
SD in Original Scale	1.019	SD in Log Scale	0.386
95% t UCL (Assumes normality)	2.67	95% H-Stat UCL	2.686

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	2.728	95% GROS Adjusted Gamma UCL	2.688

When a data set follows an approximate distribution passing only one of the GOF tests,
it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output
AOI-08 : Beneath + RAL

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 8/4/2022 4:28:06 PM
From File	2022-0518_HAI ProUCL Input-EA08-Beneath_RAL.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Polychlorinated biphenyls (PCBs)

General Statistics

Total Number of Observations	125	Number of Distinct Observations	51
		Number of Missing Observations	1
Number of Detects	95	Number of Non-Detects	30
Number of Distinct Detects	33	Number of Distinct Non-Detects	18
Minimum Detect	0.0011	Minimum Non-Detect	0.00112
Maximum Detect	1	Maximum Non-Detect	0.0037
Variance Detects	0.214	Percent Non-Detects	24%
Mean Detects	0.666	SD Detects	0.462
Median Detects	1	CV Detects	0.695
Skewness Detects	-0.671	Kurtosis Detects	-1.562
Mean of Logged Detects	-1.557	SD of Logged Detects	2.332

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.602	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.418	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.105	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.506	KM Standard Error of Mean	0.0442
90KM SD	0.491	95% KM (BCA) UCL	0.58
95% KM (t) UCL	0.579	95% KM (Percentile Bootstrap) UCL	0.581
95% KM (z) UCL	0.579	95% KM Bootstrap t UCL	0.578
90% KM Chebyshev UCL	0.639	95% KM Chebyshev UCL	0.699
97.5% KM Chebyshev UCL	0.782	99% KM Chebyshev UCL	0.946

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	16.48	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.814	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.431	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0968	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.545	k star (bias corrected MLE)	0.535

ProUCL Output
AOI-08 : Beneath + RAL

Theta hat (MLE)	1.221	Theta star (bias corrected MLE)	1.244
nu hat (MLE)	103.6	nu star (bias corrected)	101.6
Mean (detects)	0.666		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0011	Mean	0.607
Maximum	1	Median	0.438
SD	0.416	CV	0.686
k hat (MLE)	0.68	k star (bias corrected MLE)	0.669
Theta hat (MLE)	0.892	Theta star (bias corrected MLE)	0.906
nu hat (MLE)	170.1	nu star (bias corrected)	167.3
Adjusted Level of Significance (β)	0.0481		
Approximate Chi Square Value (167.34, α)	138.4	Adjusted Chi Square Value (167.34, β)	138.1
95% Gamma Approximate UCL	0.733	95% Gamma Adjusted UCL	0.735

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.506	SD (KM)	0.491
Variance (KM)	0.241	SE of Mean (KM)	0.0442
k hat (KM)	1.062	k star (KM)	1.042
nu hat (KM)	265.5	nu star (KM)	260.5
theta hat (KM)	0.477	theta star (KM)	0.486
80% gamma percentile (KM)	0.812	90% gamma percentile (KM)	1.154
95% gamma percentile (KM)	1.495	99% gamma percentile (KM)	2.283

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (260.49, α)	224.1	Adjusted Chi Square Value (260.49, β)	223.7
95% KM Approximate Gamma UCL	0.588	95% KM Adjusted Gamma UCL	0.589

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.663	**Shapiro Wilk GOF Test**
10% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.4	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.0834	Detected Data Not Lognormal at 10% Significance Level

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.507	Mean in Log Scale	-2.467
SD in Original Scale	0.492	SD in Log Scale	2.616
95% t UCL (assumes normality of ROS data)	0.58	95% Percentile Bootstrap UCL	0.578
95% BCA Bootstrap UCL	0.579	95% Bootstrap t UCL	0.582
95% H-UCL (Log ROS)	6.676		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

ProUCL Output
AOI-08 : Beneath + RAL

KM Mean (logged)	-2.802	KM Geo Mean	0.0607
KM SD (logged)	3.002	95% Critical H Value (KM-Log)	4.508
KM Standard Error of Mean (logged)	0.27	95% H-UCL (KM -Log)	18.51
KM SD (logged)	3.002	95% Critical H Value (KM-Log)	4.508
KM Standard Error of Mean (logged)	0.27		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.506	Mean in Log Scale	-2.868
SD in Original Scale	0.493	SD in Log Scale	3.11
95% t UCL (Assumes normality)	0.579	95% H-Stat UCL	26.24

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 0.579

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	126	Number of Distinct Observations	50
		Number of Missing Observations	0
Minimum	0.77	Mean	2.818
Maximum	4	Median	3.3
SD	1.237	Std. Error of Mean	0.11
Coefficient of Variation	0.439	Skewness	-0.233

Normal GOF Test

Shapiro Wilk Test Statistic	0.746	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.322	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.0917	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.001	95% Adjusted-CLT UCL (Chen-1995)	2.997
		95% Modified-t UCL (Johnson-1978)	3

Gamma GOF Test

A-D Test Statistic	11.22	**Anderson-Darling Gamma GOF Test**

ProUCL Output
AOI-08 : Beneath + RAL

5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.316	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.083	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.317	k star (bias corrected MLE)	4.219
Theta hat (MLE)	0.653	Theta star (bias corrected MLE)	0.668
nu hat (MLE)	1088	nu star (bias corrected)	1063
MLE Mean (bias corrected)	2.818	MLE Sd (bias corrected)	1.372
		Approximate Chi Square Value (0.05)	988.6
Adjusted Level of Significance	0.0481	Adjusted Chi Square Value	987.8

Assuming Gamma Distribution

95% Approximate Gamma UCL	3.031	95% Adjusted Gamma UCL	3.034

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.784	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.309	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0725	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.261	Mean of logged Data	0.916
Maximum of Logged Data	1.386	SD of logged Data	0.521

Assuming Lognormal Distribution

95% H-UCL	3.117	90% Chebyshev (MVUE) UCL	3.281
95% Chebyshev (MVUE) UCL	3.472	97.5% Chebyshev (MVUE) UCL	3.738
99% Chebyshev (MVUE) UCL	4.259		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	2.999	95% BCA Bootstrap UCL	2.996
95% Standard Bootstrap UCL	2.997	95% Bootstrap-t UCL	2.992
95% Hall's Bootstrap UCL	2.99	95% Percentile Bootstrap UCL	3
90% Chebyshev(Mean, Sd) UCL	3.149	95% Chebyshev(Mean, Sd) UCL	3.299
97.5% Chebyshev(Mean, Sd) UCL	3.506	99% Chebyshev(Mean, Sd) UCL	3.915

Suggested UCL to Use

95% Student's-t UCL	3.001

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output
AOI-08 : Beneath + RAL

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL Output
AOI-08 : Beneath + Exposure Area + RAL

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 8/4/2022 4:35:10 PM
From File	2022-0518_HAI ProUCL Input-EA08-Beneath+Exposure_Area_RAL.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Polychlorinated biphenyls (PCBs)

General Statistics

Total Number of Observations	137	Number of Distinct Observations	62
		Number of Missing Observations	2
Number of Detects	104	Number of Non-Detects	33
Number of Distinct Detects	42	Number of Distinct Non-Detects	20
Minimum Detect	0.0011	Minimum Non-Detect	0.00112
Maximum Detect	1	Maximum Non-Detect	0.00393
Variance Detects	0.222	Percent Non-Detects	24.09%
Mean Detects	0.617	SD Detects	0.471
Median Detects	1	CV Detects	0.764
Skewness Detects	-0.436	Kurtosis Detects	-1.809
Mean of Logged Detects	-1.702	SD of Logged Detects	2.316

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.631	**Normal GOF Test on Detected Observations Only**
1% Shapiro Wilk P Value	0	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.388	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.101	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.469	KM Standard Error of Mean	0.0417
90KM SD	0.486	95% KM (BCA) UCL	0.541
95% KM (t) UCL	0.538	95% KM (Percentile Bootstrap) UCL	0.54
95% KM (z) UCL	0.537	95% KM Bootstrap t UCL	0.538
90% KM Chebyshev UCL	0.594	95% KM Chebyshev UCL	0.65
97.5% KM Chebyshev UCL	0.729	99% KM Chebyshev UCL	0.884

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	14.83	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.817	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.393	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0934	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.518	k star (bias corrected MLE)	0.51

ProUCL Output
AOI-08 : Beneath + Exposure Area + RAL

Theta hat (MLE)	1.19	Theta star (bias corrected MLE)	1.21
nu hat (MLE)	107.8	nu star (bias corrected)	106
Mean (detects)	0.617		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0011	Mean	0.554
Maximum	1	Median	0.357
SD	0.425	CV	0.768
k hat (MLE)	0.643	k star (bias corrected MLE)	0.634
Theta hat (MLE)	0.86	Theta star (bias corrected MLE)	0.873
nu hat (MLE)	176.3	nu star (bias corrected)	173.8
Adjusted Level of Significance (β)	0.0482		
Approximate Chi Square Value (173.77, α)	144.3	Adjusted Chi Square Value (173.77, β)	144
95% Gamma Approximate UCL	0.667	95% Gamma Adjusted UCL	0.668

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.469	SD (KM)	0.486
Variance (KM)	0.236	SE of Mean (KM)	0.0417
k hat (KM)	0.929	k star (KM)	0.914
nu hat (KM)	254.6	nu star (KM)	250.4
theta hat (KM)	0.504	theta star (KM)	0.513
80% gamma percentile (KM)	0.759	90% gamma percentile (KM)	1.103
95% gamma percentile (KM)	1.449	99% gamma percentile (KM)	2.259

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (250.35, α)	214.7	Adjusted Chi Square Value (250.35, β)	214.4
95% KM Approximate Gamma UCL	0.546	95% KM Adjusted Gamma UCL	0.547

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.707	**Shapiro Wilk GOF Test**
10% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.365	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.0798	Detected Data Not Lognormal at 10% Significance Level

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.469	Mean in Log Scale	-2.651
SD in Original Scale	0.487	SD in Log Scale	2.647
95% t UCL (assumes normality of ROS data)	0.538	95% Percentile Bootstrap UCL	0.538
95% BCA Bootstrap UCL	0.542	95% Bootstrap t UCL	0.543
95% H-UCL (Log ROS)	5.91		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

ProUCL Output
AOI-08 : Beneath + Exposure Area + RAL

KM Mean (logged)	-2.916	KM Geo Mean	0.0542
KM SD (logged)	2.948	95% Critical H Value (KM-Log)	4.466
KM Standard Error of Mean (logged)	0.253	95% H-UCL (KM -Log)	12.9
KM SD (logged)	2.948	95% Critical H Value (KM-Log)	4.466
KM Standard Error of Mean (logged)	0.253		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.469	Mean in Log Scale	-2.975
SD in Original Scale	0.488	SD in Log Scale	3.045
95% t UCL (Assumes normality)	0.538	95% H-Stat UCL	17.5

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 0.538

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	139	Number of Distinct Observations	56
		Number of Missing Observations	0
Minimum	0.77	Mean	2.93
Maximum	10.7	Median	2.66
SD	1.63	Std. Error of Mean	0.138
Coefficient of Variation	0.556	Skewness	1.526

Normal GOF Test

Shapiro Wilk Test Statistic	0.785	Shapiro Wilk GOF Test
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.227	Lilliefors GOF Test
1% Lilliefors Critical Value	0.0873	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.158	95% Adjusted-CLT UCL (Chen-1995)	3.176
		95% Modified-t UCL (Johnson-1978)	3.161

Gamma GOF Test

A-D Test Statistic	7.775	Anderson-Darling Gamma GOF Test

ProUCL Output

AOI-08 : Beneath + Exposure Area + RAL

5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.26	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0798	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.502	k star (bias corrected MLE)	3.431
Theta hat (MLE)	0.837	Theta star (bias corrected MLE)	0.854
nu hat (MLE)	973.5	nu star (bias corrected)	953.9
MLE Mean (bias corrected)	2.93	MLE Sd (bias corrected)	1.582
		Approximate Chi Square Value (0.05)	883.2
Adjusted Level of Significance	0.0483	Adjusted Chi Square Value	882.5

Assuming Gamma Distribution

95% Approximate Gamma UCL	3.164	95% Adjusted Gamma UCL	3.167

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.872	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	0	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.269	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0691	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.261	Mean of logged Data	0.925
Maximum of Logged Data	2.37	SD of logged Data	0.561

Assuming Lognormal Distribution

95% H-UCL	3.228	90% Chebyshev (MVUE) UCL	3.4
95% Chebyshev (MVUE) UCL	3.604	97.5% Chebyshev (MVUE) UCL	3.888
99% Chebyshev (MVUE) UCL	4.445		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	3.157	95% BCA Bootstrap UCL	3.193
95% Standard Bootstrap UCL	3.159	95% Bootstrap-t UCL	3.174
95% Hall's Bootstrap UCL	3.177	95% Percentile Bootstrap UCL	3.177
90% Chebyshev(Mean, Sd) UCL	3.344	95% Chebyshev(Mean, Sd) UCL	3.532
97.5% Chebyshev(Mean, Sd) UCL	3.793	99% Chebyshev(Mean, Sd) UCL	4.305

Suggested UCL to Use

95% Student's-t UCL	3.158

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output
AOI-09 : Beneath

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 8/4/2022 10:31:03 PM
From File	2022-0518_HAI ProUCL Input-EA09-Beneath.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Polychlorinated biphenyls (PCBs)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.00325	Mean	0.0566
Maximum	0.273	Median	0.0215
SD	0.0835	Std. Error of Mean	0.0264
Coefficient of Variation	1.474	Skewness	2.326

Normal GOF Test

Shapiro Wilk Test Statistic	0.674	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.781	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.326	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.304	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.105	95% Adjusted-CLT UCL (Chen-1995)	0.121
		95% Modified-t UCL (Johnson-1978)	0.108

Gamma GOF Test

A-D Test Statistic	0.437	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.76	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.231	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.277	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.718	k star (bias corrected MLE)	0.569
Theta hat (MLE)	0.0789	Theta star (bias corrected MLE)	0.0995
nu hat (MLE)	14.36	nu star (bias corrected)	11.38
MLE Mean (bias corrected)	0.0566	MLE Sd (bias corrected)	0.0751
		Approximate Chi Square Value (0.05)	4.824
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	4.108

Assuming Gamma Distribution

ProUCL Output
AOI-09 : Beneath

95% Approximate Gamma UCL	0.134	95% Adjusted Gamma UCL	0.157

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.869	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.142	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.241	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.729	Mean of logged Data	-3.71
Maximum of Logged Data	-1.297	SD of logged Data	1.377

Assuming Lognormal Distribution

95% H-UCL	0.382	90% Chebyshev (MVUE) UCL	0.129
95% Chebyshev (MVUE) UCL	0.163	97.5% Chebyshev (MVUE) UCL	0.21
99% Chebyshev (MVUE) UCL	0.303		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	0.1	95% BCA Bootstrap UCL	0.13
95% Standard Bootstrap UCL	0.0991	95% Bootstrap-t UCL	0.187
95% Hall's Bootstrap UCL	0.243	95% Percentile Bootstrap UCL	0.103
90% Chebyshev(Mean, Sd) UCL	0.136	95% Chebyshev(Mean, Sd) UCL	0.172
97.5% Chebyshev(Mean, Sd) UCL	0.221	99% Chebyshev(Mean, Sd) UCL	0.319

Suggested UCL to Use

95% Adjusted Gamma UCL	0.157

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aluminum

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	1
Minimum	6410	Mean	7825
Maximum	10200	Median	7515

ProUCL Output
AOI-09 : Beneath

SD	1277	Std. Error of Mean	451.6
Coefficient of Variation	0.163	Skewness	0.951

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	8681	95% Adjusted-CLT UCL (Chen-1995)	8730
		95% Modified-t UCL (Johnson-1978)	8706

Gamma GOF Test

A-D Test Statistic	0.3	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.171	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.293	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	45.41	k star (bias corrected MLE)	28.47
Theta hat (MLE)	172.3	Theta star (bias corrected MLE)	274.9
nu hat (MLE)	726.6	nu star (bias corrected)	455.5
MLE Mean (bias corrected)	7825	MLE Sd (bias corrected)	1467
		Approximate Chi Square Value (0.05)	407
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	395.3

Assuming Gamma Distribution

95% Approximate Gamma UCL	8757	95% Adjusted Gamma UCL	9015

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

ProUCL Output
AOI-09 : Beneath

Lognormal Statistics

Minimum of Logged Data	8.766	Mean of logged Data	8.954
Maximum of Logged Data	9.23	SD of logged Data	0.157

Assuming Lognormal Distribution

95% H-UCL	8770	90% Chebyshev (MVUE) UCL	9126
95% Chebyshev (MVUE) UCL	9717	97.5% Chebyshev (MVUE) UCL	10537
99% Chebyshev (MVUE) UCL	12147		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	8568	95% BCA Bootstrap UCL	8658
95% Standard Bootstrap UCL	8513	95% Bootstrap-t UCL	9217
95% Hall's Bootstrap UCL	12649	95% Percentile Bootstrap UCL	8548
90% Chebyshev(Mean, Sd) UCL	9180	95% Chebyshev(Mean, Sd) UCL	9794
97.5% Chebyshev(Mean, Sd) UCL	10645	99% Chebyshev(Mean, Sd) UCL	12319

Suggested UCL to Use

95% Student's-t UCL	8681

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	3.6	Mean	4.801
Maximum	6.6	Median	4.725
SD	0.883	Std. Error of Mean	0.279
Coefficient of Variation	0.184	Skewness	0.831

Normal GOF Test

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.781	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.2	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.304	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.313	95% Adjusted-CLT UCL (Chen-1995)	5.339

ProUCL Output
AOI-09 : Beneath

		95% Modified-t UCL (Johnson-1978)	5.325

Gamma GOF Test

A-D Test Statistic	0.245	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.178	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	34.53	k star (bias corrected MLE)	24.24
Theta hat (MLE)	0.139	Theta star (bias corrected MLE)	0.198
nu hat (MLE)	690.6	nu star (bias corrected)	484.7
MLE Mean (bias corrected)	4.801	MLE Sd (bias corrected)	0.975
		Approximate Chi Square Value (0.05)	434.7
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	426.4

Assuming Gamma Distribution

95% Approximate Gamma UCL	5.354	95% Adjusted Gamma UCL	5.457

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.869	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.168	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.241	Data appear Lognormal at 10% Significance Level	

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.281	Mean of logged Data	1.554
Maximum of Logged Data	1.887	SD of logged Data	0.178

Assuming Lognormal Distribution

95% H-UCL	5.369	90% Chebyshev (MVUE) UCL	5.613
95% Chebyshev (MVUE) UCL	5.981	97.5% Chebyshev (MVUE) UCL	6.492
99% Chebyshev (MVUE) UCL	7.496		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	5.26	95% BCA Bootstrap UCL	5.305
95% Standard Bootstrap UCL	5.249	95% Bootstrap-t UCL	5.479
95% Hall's Bootstrap UCL	5.503	95% Percentile Bootstrap UCL	5.261
90% Chebyshev(Mean, Sd) UCL	5.639	95% Chebyshev(Mean, Sd) UCL	6.019
97.5% Chebyshev(Mean, Sd) UCL	6.545	99% Chebyshev(Mean, Sd) UCL	7.58

Suggested UCL to Use

95% Student's-t UCL	5.313

ProUCL Output
AOI-09 : Beneath

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	8	Number of Distinct Observations	6
		Number of Missing Observations	1
Minimum	2.7	Mean	3.138
Maximum	3.9	Median	2.95
SD	0.496	Std. Error of Mean	0.175
Coefficient of Variation	0.158	Skewness	0.594

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.836	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.252	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level
Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.469	95% Adjusted-CLT UCL (Chen-1995)	3.465
		95% Modified-t UCL (Johnson-1978)	3.476

Gamma GOF Test

A-D Test Statistic	0.65	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.264	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.293	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level
Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	47.47	k star (bias corrected MLE)	29.75
Theta hat (MLE)	0.0661	Theta star (bias corrected MLE)	0.105
nu hat (MLE)	759.5	nu star (bias corrected)	476
MLE Mean (bias corrected)	3.138	MLE Sd (bias corrected)	0.575

ProUCL Output
AOI-09 : Beneath

		Approximate Chi Square Value (0.05)	426.4
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	414.5

Assuming Gamma Distribution

95% Approximate Gamma UCL	3.502	95% Adjusted Gamma UCL	3.603

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.837	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.851	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.248	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level

Data appear Approximate Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	1.133
Maximum of Logged Data	1.361	SD of logged Data	0.154

Assuming Lognormal Distribution

95% H-UCL	3.509	90% Chebyshev (MVUE) UCL	3.65
95% Chebyshev (MVUE) UCL	3.883	97.5% Chebyshev (MVUE) UCL	4.206
99% Chebyshev (MVUE) UCL	4.84		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	3.426	95% BCA Bootstrap UCL	3.45
95% Standard Bootstrap UCL	3.41	95% Bootstrap-t UCL	3.562
95% Hall's Bootstrap UCL	3.389	95% Percentile Bootstrap UCL	3.425
90% Chebyshev(Mean, Sd) UCL	3.663	95% Chebyshev(Mean, Sd) UCL	3.901
97.5% Chebyshev(Mean, Sd) UCL	4.232	99% Chebyshev(Mean, Sd) UCL	4.881

Suggested UCL to Use

95% Student's-t UCL	3.469

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	1
Minimum	7590	Mean	8585
Maximum	9790	Median	8580

ProUCL Output
AOI-09 : Beneath

SD	813.7	Std. Error of Mean	287.7
Coefficient of Variation	0.0948	Skewness	0.173

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.191	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level
Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	9130	95% Adjusted-CLT UCL (Chen-1995)	9077
		95% Modified-t UCL (Johnson-1978)	9133

Gamma GOF Test

A-D Test Statistic	0.417	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.206	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level
Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	127.7	k star (bias corrected MLE)	79.9
Theta hat (MLE)	67.23	Theta star (bias corrected MLE)	107.5
nu hat (MLE)	2043	nu star (bias corrected)	1278
MLE Mean (bias corrected)	8585	MLE Sd (bias corrected)	960.4
		Approximate Chi Square Value (0.05)	1196
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	1176

Assuming Gamma Distribution

95% Approximate Gamma UCL	9174	95% Adjusted Gamma UCL	9331

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.197	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level
Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	8.935	Mean of logged Data	9.054
Maximum of Logged Data	9.189	SD of logged Data	0.0946

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	9447
95% Chebyshev (MVUE) UCL	9837	97.5% Chebyshev (MVUE) UCL	10379
99% Chebyshev (MVUE) UCL	11443		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	9058	95% BCA Bootstrap UCL	9043
95% Standard Bootstrap UCL	9031	95% Bootstrap-t UCL	9156
95% Hall's Bootstrap UCL	8993	95% Percentile Bootstrap UCL	9046
90% Chebyshev(Mean, Sd) UCL	9448	95% Chebyshev(Mean, Sd) UCL	9839
97.5% Chebyshev(Mean, Sd) UCL	10381	99% Chebyshev(Mean, Sd) UCL	11447

Suggested UCL to Use

95% Student's-t UCL 9130

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	1
Minimum	76.3	Mean	100.5
Maximum	132	Median	99.7
SD	19.2	Std. Error of Mean	6.789
Coefficient of Variation	0.191	Skewness	0.328

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.138	**Lilliefors GOF Test**

ProUCL Output
AOI-09 : Beneath

1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	113.3	95% Adjusted-CLT UCL (Chen-1995)	112.5
		95% Modified-t UCL (Johnson-1978)	113.5

Gamma GOF Test

A-D Test Statistic	0.203	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.716	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.148	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	31.53	k star (bias corrected MLE)	19.79
Theta hat (MLE)	3.187	Theta star (bias corrected MLE)	5.078
nu hat (MLE)	504.4	nu star (bias corrected)	316.6
MLE Mean (bias corrected)	100.5	MLE Sd (bias corrected)	22.59
		Approximate Chi Square Value (0.05)	276.4
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	266.8

Assuming Gamma Distribution

95% Approximate Gamma UCL	115.1	95% Adjusted Gamma UCL	119.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.966	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.133	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	4.335	Mean of logged Data	4.594
Maximum of Logged Data	4.883	SD of logged Data	0.191

Assuming Lognormal Distribution

95% H-UCL	115.8	90% Chebyshev (MVUE) UCL	120.9
95% Chebyshev (MVUE) UCL	130.1	97.5% Chebyshev (MVUE) UCL	142.9
99% Chebyshev (MVUE) UCL	168.1		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

ProUCL Output
AOI-09 : Beneath

Nonparametric Distribution Free UCLs

95% CLT UCL	111.6	95% BCA Bootstrap UCL	110.9
95% Standard Bootstrap UCL	111.2	95% Bootstrap-t UCL	115.1
95% Hall's Bootstrap UCL	112.6	95% Percentile Bootstrap UCL	111
90% Chebyshev(Mean, Sd) UCL	120.8	95% Chebyshev(Mean, Sd) UCL	130.1
97.5% Chebyshev(Mean, Sd) UCL	142.9	99% Chebyshev(Mean, Sd) UCL	168

Suggested UCL to Use

95% Student's-t UCL	113.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thorium

General Statistics

Total Number of Observations	10	Number of Distinct Observations	8
		Number of Missing Observations	0
Minimum	4.3	Mean	5.527
Maximum	6.7	Median	5.3
SD	0.804	Std. Error of Mean	0.254
Coefficient of Variation	0.145	Skewness	0.0883

Normal GOF Test

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.781	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.304	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5.993	95% Adjusted-CLT UCL (Chen-1995)	5.953
		95% Modified-t UCL (Johnson-1978)	5.994

Gamma GOF Test

A-D Test Statistic	0.515	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.247	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	52.23	k star (bias corrected MLE)	36.63
Theta hat (MLE)	0.106	Theta star (bias corrected MLE)	0.151
nu hat (MLE)	1045	nu star (bias corrected)	732.6

ProUCL Output
AOI-09 : Beneath

MLE Mean (bias corrected)	5.527	MLE Sd (bias corrected)	0.913
		Approximate Chi Square Value (0.05)	670.8
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	660.5

Assuming Gamma Distribution

95% Approximate Gamma UCL	6.036	95% Adjusted Gamma UCL	6.13

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.916	Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk Critical Value	0.869	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.232	Lilliefors Lognormal GOF Test
10% Lilliefors Critical Value	0.241	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.459	Mean of logged Data	1.7
Maximum of Logged Data	1.902	SD of logged Data	0.146

Assuming Lognormal Distribution

95% H-UCL	6.052	90% Chebyshev (MVUE) UCL	6.297
95% Chebyshev (MVUE) UCL	6.645	97.5% Chebyshev (MVUE) UCL	7.129
99% Chebyshev (MVUE) UCL	8.079		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	5.945	95% BCA Bootstrap UCL	5.94
95% Standard Bootstrap UCL	5.935	95% Bootstrap-t UCL	6.01
95% Hall's Bootstrap UCL	5.901	95% Percentile Bootstrap UCL	5.947
90% Chebyshev(Mean, Sd) UCL	6.289	95% Chebyshev(Mean, Sd) UCL	6.635
97.5% Chebyshev(Mean, Sd) UCL	7.114	99% Chebyshev(Mean, Sd) UCL	8.056

Suggested UCL to Use

95% Student's-t UCL	5.993

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Titanium

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	1
Minimum	404	Mean	456.4
Maximum	521	Median	454

ProUCL Output
AOI-09 : Beneath

SD	44.19	Std. Error of Mean	15.63
Coefficient of Variation	0.0968	Skewness	0.282

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level
Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	486	95% Adjusted-CLT UCL (Chen-1995)	483.7
		95% Modified-t UCL (Johnson-1978)	486.2

Gamma GOF Test

A-D Test Statistic	0.277	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.156	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level
Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	122.9	k star (bias corrected MLE)	76.88
Theta hat (MLE)	3.714	Theta star (bias corrected MLE)	5.936
nu hat (MLE)	1966	nu star (bias corrected)	1230
MLE Mean (bias corrected)	456.4	MLE Sd (bias corrected)	52.05
		Approximate Chi Square Value (0.05)	1150
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	1130

Assuming Gamma Distribution

95% Approximate Gamma UCL	488.3	95% Adjusted Gamma UCL	496.9

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.14	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level
Note GOF tests may be unreliable for small sample sizes

ProUCL Output
AOI-09 : Beneath

Lognormal Statistics

Minimum of Logged Data	6.001	Mean of logged Data	6.119
Maximum of Logged Data	6.256	SD of logged Data	0.0964

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	503
95% Chebyshev (MVUE) UCL	524.2	97.5% Chebyshev (MVUE) UCL	553.5
99% Chebyshev (MVUE) UCL	611.1		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	482.1	95% BCA Bootstrap UCL	480.6
95% Standard Bootstrap UCL	480.2	95% Bootstrap-t UCL	490.3
95% Hall's Bootstrap UCL	486.2	95% Percentile Bootstrap UCL	480
90% Chebyshev(Mean, Sd) UCL	503.3	95% Chebyshev(Mean, Sd) UCL	524.5
97.5% Chebyshev(Mean, Sd) UCL	554	99% Chebyshev(Mean, Sd) UCL	611.8

Suggested UCL to Use

95% Student's-t UCL 486

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	1.1	Mean	1.603
Maximum	1.9	Median	1.645
SD	0.248	Std. Error of Mean	0.0786
Coefficient of Variation	0.155	Skewness	-0.973

Normal GOF Test

Shapiro Wilk Test Statistic	0.925	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.781	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.195	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.304	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.747	95% Adjusted-CLT UCL (Chen-1995)	1.706

ProUCL Output
AOI-09 : Beneath

		95% Modified-t UCL (Johnson-1978)	1.743

Gamma GOF Test

A-D Test Statistic	0.455	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.216	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	41.54	k star (bias corrected MLE)	29.14
Theta hat (MLE)	0.0386	Theta star (bias corrected MLE)	0.055
nu hat (MLE)	830.7	nu star (bias corrected)	582.8
MLE Mean (bias corrected)	1.603	MLE Sd (bias corrected)	0.297
		Approximate Chi Square Value (0.05)	527.8
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	518.7

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.77	95% Adjusted Gamma UCL	1.801

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.887	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.869	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.224	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.241	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.46
Maximum of Logged Data	0.642	SD of logged Data	0.169

Assuming Lognormal Distribution

95% H-UCL	1.783	90% Chebyshev (MVUE) UCL	1.862
95% Chebyshev (MVUE) UCL	1.978	97.5% Chebyshev (MVUE) UCL	2.14
99% Chebyshev (MVUE) UCL	2.458		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	1.732	95% BCA Bootstrap UCL	1.707
95% Standard Bootstrap UCL	1.725	95% Bootstrap-t UCL	1.733
95% Hall's Bootstrap UCL	1.717	95% Percentile Bootstrap UCL	1.718
90% Chebyshev(Mean, Sd) UCL	1.839	95% Chebyshev(Mean, Sd) UCL	1.945
97.5% Chebyshev(Mean, Sd) UCL	2.094	99% Chebyshev(Mean, Sd) UCL	2.385

Suggested UCL to Use

95% Student's-t UCL	1.747

ProUCL Output
AOI-09 : Beneath

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Uranium-238

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	1.1	Mean	1.592
Maximum	1.9	Median	1.64
SD	0.263	Std. Error of Mean	0.0832
Coefficient of Variation	0.165	Skewness	-0.95

Normal GOF Test		
Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.781	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.304	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.745	95% Adjusted-CLT UCL (Chen-1995)	1.702
		95% Modified-t UCL (Johnson-1978)	1.74

Gamma GOF Test		
A-D Test Statistic	0.583	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.234	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics			
k hat (MLE)	36.4	k star (bias corrected MLE)	25.55
Theta hat (MLE)	0.0437	Theta star (bias corrected MLE)	0.0623
nu hat (MLE)	728.1	nu star (bias corrected)	511
MLE Mean (bias corrected)	1.592	MLE Sd (bias corrected)	0.315
		Approximate Chi Square Value (0.05)	459.6
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	451.1

Assuming Gamma Distribution			
95% Approximate Gamma UCL	1.77	95% Adjusted Gamma UCL	1.803

ProUCL Output
AOI-09 : Beneath

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.863	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.869	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.242	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.241	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.451
Maximum of Logged Data	0.642	SD of logged Data	0.18

Assuming Lognormal Distribution

95% H-UCL	1.785	90% Chebyshev (MVUE) UCL	1.867
95% Chebyshev (MVUE) UCL	1.99	97.5% Chebyshev (MVUE) UCL	2.162
99% Chebyshev (MVUE) UCL	2.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	1.729	95% BCA Bootstrap UCL	1.702
95% Standard Bootstrap UCL	1.721	95% Bootstrap-t UCL	1.727
95% Hall's Bootstrap UCL	1.71	95% Percentile Bootstrap UCL	1.714
90% Chebyshev(Mean, Sd) UCL	1.842	95% Chebyshev(Mean, Sd) UCL	1.955
97.5% Chebyshev(Mean, Sd) UCL	2.112	99% Chebyshev(Mean, Sd) UCL	2.42

Suggested UCL to Use

95% Student's-t UCL	1.745

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Zirconium

General Statistics

Total Number of Observations	8	Number of Distinct Observations	5
		Number of Missing Observations	1
Minimum	1.5	Mean	1.938
Maximum	2.4	Median	2
SD	0.292	Std. Error of Mean	0.103
Coefficient of Variation	0.151	Skewness	0.055

ProUCL Output
AOI-09 : Beneath

Note: Sample size is small (e.g., <10), if data are collected using incremental sampling methodology (ISM) approach,
refer also to ITRC Tech Reg Guide on ISM (ITRC 2020 and ITRC 2012) for additional guidance,
but note that ITRC may recommend the t-UCL or the Chebyshev UCL for small sample sizes (n < 7).
The Chebyshev UCL often results in gross overestimates of the mean.
Refer to the ProUCL 5.2 Technical Guide for a discussion of the Chebyshev UCL.

Normal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.749	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.21	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.333	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.133	95% Adjusted-CLT UCL (Chen-1995)	2.11
		95% Modified-t UCL (Johnson-1978)	2.134

Gamma GOF Test

A-D Test Statistic	0.329	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.232	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.293	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics

k hat (MLE)	49.49	k star (bias corrected MLE)	31.01
Theta hat (MLE)	0.0392	Theta star (bias corrected MLE)	0.0625
nu hat (MLE)	791.8	nu star (bias corrected)	496.2
MLE Mean (bias corrected)	1.938	MLE Sd (bias corrected)	0.348
		Approximate Chi Square Value (0.05)	445.6
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	433.4

Assuming Gamma Distribution

95% Approximate Gamma UCL	2.158	95% Adjusted Gamma UCL	2.219

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.851	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.233	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.265	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal Statistics

Minimum of Logged Data	0.405	Mean of logged Data	0.651

ProUCL Output

AOI-09 : Beneath

Maximum of Logged Data	0.875	SD of logged Data	0.153

Assuming Lognormal Distribution

95% H-UCL	2.165	90% Chebyshev (MVUE) UCL	2.252
95% Chebyshev (MVUE) UCL	2.395	97.5% Chebyshev (MVUE) UCL	2.593
99% Chebyshev (MVUE) UCL	2.982		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	2.108	95% BCA Bootstrap UCL	2.088
95% Standard Bootstrap UCL	2.098	95% Bootstrap-t UCL	2.128
95% Hall's Bootstrap UCL	2.124	95% Percentile Bootstrap UCL	2.1
90% Chebyshev(Mean, Sd) UCL	2.248	95% Chebyshev(Mean, Sd) UCL	2.388
97.5% Chebyshev(Mean, Sd) UCL	2.583	99% Chebyshev(Mean, Sd) UCL	2.966

Suggested UCL to Use

95% Student's-t UCL	2.133

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output
AOI-09 : Beneath + RAL

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 8/4/2022 10:36:48 PM
From File	2022-0518_HAI ProUCL Input-EA09-Beneath_RAL.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Polychlorinated biphenyls (PCBs)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	0.00325	Mean	0.637
Maximum	1	Median	1
SD	0.471	Std. Error of Mean	0.0923
Coefficient of Variation	0.739	Skewness	-0.537

Normal GOF Test

Shapiro Wilk Test Statistic	0.646	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.891	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.395	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.199	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.795	95% Adjusted-CLT UCL (Chen-1995)	0.779
		95% Modified-t UCL (Johnson-1978)	0.793

Gamma GOF Test

A-D Test Statistic	3.888	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.796	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.403	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.18	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.629	k star (bias corrected MLE)	0.582
Theta hat (MLE)	1.014	Theta star (bias corrected MLE)	1.095
nu hat (MLE)	32.69	nu star (bias corrected)	30.25
MLE Mean (bias corrected)	0.637	MLE Sd (bias corrected)	0.835
		Approximate Chi Square Value (0.05)	18.69
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	18.09

Assuming Gamma Distribution

ProUCL Output
AOI-09 : Beneath + RAL

95% Approximate Gamma UCL	1.031	95% Adjusted Gamma UCL	1.066

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.715	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.933	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.376	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.156	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.729	Mean of logged Data	-1.427
Maximum of Logged Data	0	SD of logged Data	2.018

Assuming Lognormal Distribution

95% H-UCL	9.367	90% Chebyshev (MVUE) UCL	3.842
95% Chebyshev (MVUE) UCL	4.901	97.5% Chebyshev (MVUE) UCL	6.37
99% Chebyshev (MVUE) UCL	9.256		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	0.789	95% BCA Bootstrap UCL	0.783
95% Standard Bootstrap UCL	0.788	95% Bootstrap-t UCL	0.783
95% Hall's Bootstrap UCL	0.772	95% Percentile Bootstrap UCL	0.785
90% Chebyshev(Mean, Sd) UCL	0.914	95% Chebyshev(Mean, Sd) UCL	1.04
97.5% Chebyshev(Mean, Sd) UCL	1.214	99% Chebyshev(Mean, Sd) UCL	1.556

Suggested UCL to Use

95% Student's-t UCL	0.795

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Uranium

General Statistics

Total Number of Observations	26	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	1.1	Mean	2.278
Maximum	2.7	Median	2.7
SD	0.564	Std. Error of Mean	0.111
Coefficient of Variation	0.248	Skewness	-0.749

ProUCL Output
AOI-09 : Beneath + RAL

Normal GOF Test

Shapiro Wilk Test Statistic	0.718	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.891	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.388	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.199	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.467	95% Adjusted-CLT UCL (Chen-1995)	2.443
		95% Modified-t UCL (Johnson-1978)	2.464

Gamma GOF Test

A-D Test Statistic	3.424	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.744	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.389	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.171	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.35	k star (bias corrected MLE)	12.72
Theta hat (MLE)	0.159	Theta star (bias corrected MLE)	0.179
nu hat (MLE)	746	nu star (bias corrected)	661.3
MLE Mean (bias corrected)	2.278	MLE Sd (bias corrected)	0.639
		Approximate Chi Square Value (0.05)	602.6
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	598.9

Assuming Gamma Distribution

95% Approximate Gamma UCL	2.5	95% Adjusted Gamma UCL	2.515

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.731	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.933	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.381	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.156	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.788
Maximum of Logged Data	0.993	SD of logged Data	0.283

Assuming Lognormal Distribution

95% H-UCL	2.536	90% Chebyshev (MVUE) UCL	2.672
95% Chebyshev (MVUE) UCL	2.847	97.5% Chebyshev (MVUE) UCL	3.09
99% Chebyshev (MVUE) UCL	3.567		

Nonparametric Distribution Free UCL Statistics

ProUCL Output
AOI-09 : Beneath + RAL

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	2.46	95% BCA Bootstrap UCL	2.448
95% Standard Bootstrap UCL	2.458	95% Bootstrap-t UCL	2.45
95% Hall's Bootstrap UCL	2.438	95% Percentile Bootstrap UCL	2.455
90% Chebyshev(Mean, Sd) UCL	2.61	95% Chebyshev(Mean, Sd) UCL	2.76
97.5% Chebyshev(Mean, Sd) UCL	2.969	99% Chebyshev(Mean, Sd) UCL	3.379

Suggested UCL to Use

95% Student's-t UCL	2.467

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

ProUCL Output
AOI-09 : Beneath + Exposure Area

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 8/4/2022 10:41:46 PM
From File	2022-0518_HAI ProUCL Input-EA09-Beneath+Exposure_Area.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Acenaphthylene

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
Number of Detects	1	Number of Non-Detects	13
Number of Distinct Detects	1	Number of Distinct Non-Detects	12

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Acenaphthylene was not processed!

Polychlorinated biphenyls (PCBs)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Number of Detects	13	Number of Non-Detects	4
Number of Distinct Detects	13	Number of Distinct Non-Detects	4
Minimum Detect	0.00325	Minimum Non-Detect	0.004
Maximum Detect	0.273	Maximum Non-Detect	0.0366
Variance Detects	0.00557	Percent Non-Detects	23.53%
Mean Detects	0.0522	SD Detects	0.0746
Median Detects	0.017	CV Detects	1.429
Skewness Detects	2.487	Kurtosis Detects	6.846
Mean of Logged Detects	-3.699	SD of Logged Detects	1.265

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.66	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.814	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.31	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.271	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.042	KM Standard Error of Mean	0.0165
90KM SD	0.0654	95% KM (BCA) UCL	0.0745
95% KM (t) UCL	0.0709	95% KM (Percentile Bootstrap) UCL	0.0728
95% KM (z) UCL	0.0692	95% KM Bootstrap t UCL	0.104

ProUCL Output
AOI-09 : Beneath + Exposure Area

90% KM Chebyshev UCL	0.0916	95% KM Chebyshev UCL	0.114
97.5% KM Chebyshev UCL	0.145	99% KM Chebyshev UCL	0.207

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.633	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.768	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.218	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.245	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.795	k star (bias corrected MLE)	0.663
Theta hat (MLE)	0.0657	Theta star (bias corrected MLE)	0.0788
nu hat (MLE)	20.68	nu star (bias corrected)	17.24
Mean (detects)	0.0522		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00325	Mean	0.0423
Maximum	0.273	Median	0.0137
SD	0.0672	CV	1.589
k hat (MLE)	0.793	k star (bias corrected MLE)	0.693
Theta hat (MLE)	0.0533	Theta star (bias corrected MLE)	0.0611
nu hat (MLE)	26.97	nu star (bias corrected)	23.55
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (23.55, α)	13.5	Adjusted Chi Square Value (23.55, β)	12.71
95% Gamma Approximate UCL	0.0737	95% Gamma Adjusted UCL	0.0783

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.042	SD (KM)	0.0654
Variance (KM)	0.00428	SE of Mean (KM)	0.0165
k hat (KM)	0.412	k star (KM)	0.378
nu hat (KM)	14	nu star (KM)	12.86
theta hat (KM)	0.102	theta star (KM)	0.111
80% gamma percentile (KM)	0.0673	90% gamma percentile (KM)	0.12
95% gamma percentile (KM)	0.178	99% gamma percentile (KM)	0.325

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (12.86, α)	5.801	Adjusted Chi Square Value (12.86, β)	5.31
95% KM Approximate Gamma UCL	0.0931	95% KM Adjusted Gamma UCL	0.102

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.889	Detected Data appear Lognormal at 10% Significance Level

ProUCL Output
AOI-09 : Beneath + Exposure Area

Lilliefors Test Statistic	0.155	Lilliefors GOF Test	
10% Lilliefors Critical Value	0.215	Detected Data appear Lognormal at 10% Significance Level	

Detected Data appear Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0417	Mean in Log Scale	-4.027
SD in Original Scale	0.0675	SD in Log Scale	1.295
95% t UCL (assumes normality of ROS data)	0.0703	95% Percentile Bootstrap UCL	0.0692
95% BCA Bootstrap UCL	0.082	95% Bootstrap t UCL	0.106
95% H-UCL (Log ROS)	0.114		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.019	KM Geo Mean	0.018
KM SD (logged)	1.265	95% Critical H Value (KM-Log)	3.086
KM Standard Error of Mean (logged)	0.33	95% H-UCL (KM -Log)	0.106
KM SD (logged)	1.265	95% Critical H Value (KM-Log)	3.086
KM Standard Error of Mean (logged)	0.33		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0426	Mean in Log Scale	-3.964
SD in Original Scale	0.0672	SD in Log Scale	1.285
95% t UCL (Assumes normality)	0.071	95% H-Stat UCL	0.118

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL 0.102

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.
Please verify the data were collected from random locations.
If the data were collected using judgmental or other non-random methods,
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Aluminum

General Statistics

Total Number of Observations	11	Number of Distinct Observations	10
		Number of Missing Observations	8
Minimum	6410	Mean	8147
Maximum	11200	Median	7720

ProUCL Output
AOI-09 : Beneath + Exposure Area

SD	1566	Std. Error of Mean	472.1
Coefficient of Variation	0.192	Skewness	0.812

Normal GOF Test

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.792	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.174	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.291	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	9003	95% Adjusted-CLT UCL (Chen-1995)	9047
		95% Modified-t UCL (Johnson-1978)	9022

Gamma GOF Test

A-D Test Statistic	0.369	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.16	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	31.58	k star (bias corrected MLE)	23.03
Theta hat (MLE)	257.9	Theta star (bias corrected MLE)	353.7
nu hat (MLE)	694.9	nu star (bias corrected)	506.7
MLE Mean (bias corrected)	8147	MLE Sd (bias corrected)	1698
		Approximate Chi Square Value (0.05)	455.5
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	447.6

Assuming Gamma Distribution

95% Approximate Gamma UCL	9063	95% Adjusted Gamma UCL	9224

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.876	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.146	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.231	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.766	Mean of logged Data	8.99
Maximum of Logged Data	9.324	SD of logged Data	0.185

Assuming Lognormal Distribution

95% H-UCL	9087	90% Chebyshev (MVUE) UCL	9509
95% Chebyshev (MVUE) UCL	10128	97.5% Chebyshev (MVUE) UCL	10986
99% Chebyshev (MVUE) UCL	12672		

ProUCL Output
AOI-09 : Beneath + Exposure Area

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	8924	95% BCA Bootstrap UCL	8917
95% Standard Bootstrap UCL	8870	95% Bootstrap-t UCL	9177
95% Hall's Bootstrap UCL	9162	95% Percentile Bootstrap UCL	8861
90% Chebyshev(Mean, Sd) UCL	9564	95% Chebyshev(Mean, Sd) UCL	10205
97.5% Chebyshev(Mean, Sd) UCL	11096	99% Chebyshev(Mean, Sd) UCL	12845

Suggested UCL to Use

95% Student's-t UCL	9003

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
		Number of Missing Observations	3
Number of Detects	15	Number of Non-Detects	1
Number of Distinct Detects	13	Number of Distinct Non-Detects	1
Minimum Detect	3.6	Minimum Non-Detect	4.2
Maximum Detect	6.6	Maximum Non-Detect	4.2
Variance Detects	1.036	Percent Non-Detects	6.25%
Mean Detects	5.259	SD Detects	1.018
Median Detects	5.24	CV Detects	0.194
Skewness Detects	-0.00527	Kurtosis Detects	-1.388
Mean of Logged Detects	1.642	SD of Logged Detects	0.198

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.924	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.835	Detected Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.145	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.255	Detected Data appear Normal at 1% Significance Level

Detected Data appear Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	5.176	KM Standard Error of Mean	0.261
90KM SD	1.006	95% KM (BCA) UCL	5.613
95% KM (t) UCL	5.633	95% KM (Percentile Bootstrap) UCL	5.6
95% KM (z) UCL	5.605	95% KM Bootstrap t UCL	5.637
90% KM Chebyshev UCL	5.959	95% KM Chebyshev UCL	6.313
97.5% KM Chebyshev UCL	6.806	99% KM Chebyshev UCL	7.773

ProUCL Output
AOI-09 : Beneath + Exposure Area

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.416	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.735	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.155	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.221	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	27.89	k star (bias corrected MLE)	22.36
Theta hat (MLE)	0.189	Theta star (bias corrected MLE)	0.235
nu hat (MLE)	836.8	nu star (bias corrected)	670.8
Mean (detects)	5.259		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	3.6	Mean	5.175
Maximum	6.6	Median	5.02
SD	1.038	CV	0.201
k hat (MLE)	26.19	k star (bias corrected MLE)	21.32
Theta hat (MLE)	0.198	Theta star (bias corrected MLE)	0.243
nu hat (MLE)	838	nu star (bias corrected)	682.2
Adjusted Level of Significance (β)	0.0335		
Approximate Chi Square Value (682.19, α)	622.6	Adjusted Chi Square Value (682.19, β)	616.1
95% Gamma Approximate UCL	5.671	95% Gamma Adjusted UCL	5.73

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	5.176	SD (KM)	1.006
Variance (KM)	1.013	SE of Mean (KM)	0.261
k hat (KM)	26.46	k star (KM)	21.54
nu hat (KM)	846.6	nu star (KM)	689.2
theta hat (KM)	0.196	theta star (KM)	0.24
80% gamma percentile (KM)	6.084	90% gamma percentile (KM)	6.647
95% gamma percentile (KM)	7.136	99% gamma percentile (KM)	8.117

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (689.22, α)	629.3	Adjusted Chi Square Value (689.22, β)	622.8
95% KM Approximate Gamma UCL	5.669	95% KM Adjusted Gamma UCL	5.728

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.146	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

ProUCL Output
AOI-09 : Beneath + Exposure Area

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.176	Mean in Log Scale	1.625
SD in Original Scale	1.037	SD in Log Scale	0.203
95% t UCL (assumes normality of ROS data)	5.631	95% Percentile Bootstrap UCL	5.589
95% BCA Bootstrap UCL	5.586	95% Bootstrap t UCL	5.645
95% H-UCL (Log ROS)	5.698		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.625	KM Geo Mean	5.077
KM SD (logged)	0.198	95% Critical H Value (KM-Log)	1.798
KM Standard Error of Mean (logged)	0.0513	95% H-UCL (KM -Log)	5.674
KM SD (logged)	0.198	95% Critical H Value (KM-Log)	1.798
KM Standard Error of Mean (logged)	0.0513		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	5.061	Mean in Log Scale	1.586
SD in Original Scale	1.261	SD in Log Scale	0.295
95% t UCL (Assumes normality)	5.614	95% H-Stat UCL	5.881

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL	5.633

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	11	Number of Distinct Observations	9
		Number of Missing Observations	8
Minimum	1.1	Mean	3.045
Maximum	5.6	Median	2.8
SD	1.179	Std. Error of Mean	0.356
Coefficient of Variation	0.387	Skewness	0.576

Normal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.792	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.203	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.291	Data appear Normal at 1% Significance Level

ProUCL Output
AOI-09 : Beneath + Exposure Area

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.69	95% Adjusted-CLT UCL (Chen-1995)	3.696
		95% Modified-t UCL (Johnson-1978)	3.7

Gamma GOF Test

A-D Test Statistic	0.407	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	Kolmogorov-Smirnov Gamma GOF Test
5% K-S Critical Value	0.256	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.721	k star (bias corrected MLE)	4.949
Theta hat (MLE)	0.453	Theta star (bias corrected MLE)	0.615
nu hat (MLE)	147.9	nu star (bias corrected)	108.9
MLE Mean (bias corrected)	3.045	MLE Sd (bias corrected)	1.369
		Approximate Chi Square Value (0.05)	85.78
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	82.45

Assuming Gamma Distribution

95% Approximate Gamma UCL	3.865	95% Adjusted Gamma UCL	4.021

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.918	Shapiro Wilk Lognormal GOF Test
10% Shapiro Wilk Critical Value	0.876	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.277	Lilliefors Lognormal GOF Test
10% Lilliefors Critical Value	0.231	Data Not Lognormal at 10% Significance Level

Data appear Approximate Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	1.037
Maximum of Logged Data	1.723	SD of logged Data	0.431

Assuming Lognormal Distribution

95% H-UCL	4.115	90% Chebyshev (MVUE) UCL	4.282
95% Chebyshev (MVUE) UCL	4.832	97.5% Chebyshev (MVUE) UCL	5.595
99% Chebyshev (MVUE) UCL	7.094		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	3.63	95% BCA Bootstrap UCL	3.673
95% Standard Bootstrap UCL	3.612	95% Bootstrap-t UCL	3.785
95% Hall's Bootstrap UCL	4.013	95% Percentile Bootstrap UCL	3.609

ProUCL Output
AOI-09 : Beneath + Exposure Area

90% Chebyshev(Mean, Sd) UCL	4.112	95% Chebyshev(Mean, Sd) UCL	4.595
97.5% Chebyshev(Mean, Sd) UCL	5.266	99% Chebyshev(Mean, Sd) UCL	6.583

Suggested UCL to Use

95% Student's-t UCL	3.69

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	8
Minimum	6730	Mean	8440
Maximum	9790	Median	8180
SD	934.7	Std. Error of Mean	281.8
Coefficient of Variation	0.111	Skewness	-0.258

Normal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.792	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.291	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8951	95% Adjusted-CLT UCL (Chen-1995)	8880
		95% Modified-t UCL (Johnson-1978)	8947

Gamma GOF Test

A-D Test Statistic	0.354	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.726	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.187	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.254	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	87.42	k star (bias corrected MLE)	63.64
Theta hat (MLE)	96.55	Theta star (bias corrected MLE)	132.6
nu hat (MLE)	1923	nu star (bias corrected)	1400
MLE Mean (bias corrected)	8440	MLE Sd (bias corrected)	1058
		Approximate Chi Square Value (0.05)	1314
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	1301

ProUCL Output
AOI-09 : Beneath + Exposure Area

Assuming Gamma Distribution

95% Approximate Gamma UCL	8992	95% Adjusted Gamma UCL	9086

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.876	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.18	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.231	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.814	Mean of logged Data	9.035
Maximum of Logged Data	9.189	SD of logged Data	0.113

Assuming Lognormal Distribution

95% H-UCL	9006	90% Chebyshev (MVUE) UCL	9305
95% Chebyshev (MVUE) UCL	9697	97.5% Chebyshev (MVUE) UCL	10241
99% Chebyshev (MVUE) UCL	11309		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	8904	95% BCA Bootstrap UCL	8875
95% Standard Bootstrap UCL	8889	95% Bootstrap-t UCL	8929
95% Hall's Bootstrap UCL	8863	95% Percentile Bootstrap UCL	8875
90% Chebyshev(Mean, Sd) UCL	9285	95% Chebyshev(Mean, Sd) UCL	9668
97.5% Chebyshev(Mean, Sd) UCL	10200	99% Chebyshev(Mean, Sd) UCL	11244

Suggested UCL to Use

95% Student's-t UCL	8951

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Thorium

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
		Number of Missing Observations	3
Minimum	3.03	Mean	5.596
Maximum	8.9	Median	5.435
SD	1.383	Std. Error of Mean	0.346

ProUCL Output
AOI-09 : Beneath + Exposure Area

Coefficient of Variation	0.247	Skewness	0.458

Normal GOF Test

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.844	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.12	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.248	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.202	95% Adjusted-CLT UCL (Chen-1995)	6.207
		95% Modified-t UCL (Johnson-1978)	6.208

Gamma GOF Test

A-D Test Statistic	0.283	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.737	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.137	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.12	k star (bias corrected MLE)	13.95
Theta hat (MLE)	0.327	Theta star (bias corrected MLE)	0.401
nu hat (MLE)	548	nu star (bias corrected)	446.6
MLE Mean (bias corrected)	5.596	MLE Sd (bias corrected)	1.498
		Approximate Chi Square Value (0.05)	398.6
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	393.4

Assuming Gamma Distribution

95% Approximate Gamma UCL	6.269	95% Adjusted Gamma UCL	6.352

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.906	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.196	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.109	Mean of logged Data	1.693
Maximum of Logged Data	2.186	SD of logged Data	0.255

Assuming Lognormal Distribution

95% H-UCL	6.333	90% Chebyshev (MVUE) UCL	6.68
95% Chebyshev (MVUE) UCL	7.17	97.5% Chebyshev (MVUE) UCL	7.848
99% Chebyshev (MVUE) UCL	9.182		

ProUCL Output
AOI-09 : Beneath + Exposure Area

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	6.164	95% BCA Bootstrap UCL	6.178
95% Standard Bootstrap UCL	6.138	95% Bootstrap-t UCL	6.258
95% Hall's Bootstrap UCL	6.321	95% Percentile Bootstrap UCL	6.151
90% Chebyshev(Mean, Sd) UCL	6.633	95% Chebyshev(Mean, Sd) UCL	7.103
97.5% Chebyshev(Mean, Sd) UCL	7.755	99% Chebyshev(Mean, Sd) UCL	9.036

Suggested UCL to Use

95% Student's-t UCL 6.202

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Titanium

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	8
Minimum	365	Mean	456.7
Maximum	613	Median	451
SD	70.94	Std. Error of Mean	21.39
Coefficient of Variation	0.155	Skewness	1.001

Normal GOF Test

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.792	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.135	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.291	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	495.5	95% Adjusted-CLT UCL (Chen-1995)	498.8
		95% Modified-t UCL (Johnson-1978)	496.6

Gamma GOF Test

A-D Test Statistic	0.25	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.728	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

ProUCL Output
AOI-09 : Beneath + Exposure Area

k hat (MLE)	48.46	k star (bias corrected MLE)	35.31
Theta hat (MLE)	9.424	Theta star (bias corrected MLE)	12.94
nu hat (MLE)	1066	nu star (bias corrected)	776.7
MLE Mean (bias corrected)	456.7	MLE Sd (bias corrected)	76.87
		Approximate Chi Square Value (0.05)	713
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	703.1

Assuming Gamma Distribution

95% Approximate Gamma UCL	497.5	95% Adjusted Gamma UCL	504.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.876	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.123	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.231	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.9	Mean of logged Data	6.114
Maximum of Logged Data	6.418	SD of logged Data	0.149

Assuming Lognormal Distribution

95% H-UCL	498	90% Chebyshev (MVUE) UCL	518.3
95% Chebyshev (MVUE) UCL	546.2	97.5% Chebyshev (MVUE) UCL	585
99% Chebyshev (MVUE) UCL	661.1		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	491.9	95% BCA Bootstrap UCL	494.5
95% Standard Bootstrap UCL	490.1	95% Bootstrap-t UCL	507.5
95% Hall's Bootstrap UCL	509.1	95% Percentile Bootstrap UCL	491.5
90% Chebyshev(Mean, Sd) UCL	520.9	95% Chebyshev(Mean, Sd) UCL	550
97.5% Chebyshev(Mean, Sd) UCL	590.3	99% Chebyshev(Mean, Sd) UCL	669.5

Suggested UCL to Use

95% Student's-t UCL	495.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14

ProUCL Output
AOI-09 : Beneath + Exposure Area

		Number of Missing Observations	3
Minimum	1.1	Mean	1.781
Maximum	2.8	Median	1.755
SD	0.378	Std. Error of Mean	0.0945
Coefficient of Variation	0.212	Skewness	0.946

Normal GOF Test

Shapiro Wilk Test Statistic	0.924	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.844	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.156	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.248	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.946	95% Adjusted-CLT UCL (Chen-1995)	1.96
		95% Modified-t UCL (Johnson-1978)	1.95

Gamma GOF Test

A-D Test Statistic	0.385	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.138	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	24.61	k star (bias corrected MLE)	20.04
Theta hat (MLE)	0.0724	Theta star (bias corrected MLE)	0.0889
nu hat (MLE)	787.5	nu star (bias corrected)	641.2
MLE Mean (bias corrected)	1.781	MLE Sd (bias corrected)	0.398
		Approximate Chi Square Value (0.05)	583.4
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	577.2

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.957	95% Adjusted Gamma UCL	1.978

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.906	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.152	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.196	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.557
Maximum of Logged Data	1.03	SD of logged Data	0.209

Assuming Lognormal Distribution

ProUCL Output
AOI-09 : Beneath + Exposure Area

95% H-UCL	1.966	90% Chebyshev (MVUE) UCL	2.061
95% Chebyshev (MVUE) UCL	2.188	97.5% Chebyshev (MVUE) UCL	2.365
99% Chebyshev (MVUE) UCL	2.712		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	1.936	95% BCA Bootstrap UCL	1.958
95% Standard Bootstrap UCL	1.93	95% Bootstrap-t UCL	1.975
95% Hall's Bootstrap UCL	2.063	95% Percentile Bootstrap UCL	1.939
90% Chebyshev(Mean, Sd) UCL	2.064	95% Chebyshev(Mean, Sd) UCL	2.193
97.5% Chebyshev(Mean, Sd) UCL	2.371	99% Chebyshev(Mean, Sd) UCL	2.721

Suggested UCL to Use

95% Student's-t UCL	1.946

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-238

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
		Number of Missing Observations	3
Minimum	1.1	Mean	1.771
Maximum	2.8	Median	1.745
SD	0.386	Std. Error of Mean	0.0966
Coefficient of Variation	0.218	Skewness	0.848

Normal GOF Test

Shapiro Wilk Test Statistic	0.92	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.844	Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.152	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.248	Data appear Normal at 1% Significance Level

Data appear Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.941	95% Adjusted-CLT UCL (Chen-1995)	1.952
		95% Modified-t UCL (Johnson-1978)	1.944

Gamma GOF Test

A-D Test Statistic	0.449	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.153	**Kolmogorov-Smirnov Gamma GOF Test**

ProUCL Output
AOI-09 : Beneath + Exposure Area

5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	23.05	k star (bias corrected MLE)	18.77
Theta hat (MLE)	0.0768	Theta star (bias corrected MLE)	0.0944
nu hat (MLE)	737.6	nu star (bias corrected)	600.7
MLE Mean (bias corrected)	1.771	MLE Sd (bias corrected)	0.409
		Approximate Chi Square Value (0.05)	544.8
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	538.8

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.953	95% Adjusted Gamma UCL	1.975

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk Critical Value	0.906	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.169	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.196	Data appear Lognormal at 10% Significance Level

Data appear Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.55
Maximum of Logged Data	1.03	SD of logged Data	0.217

Assuming Lognormal Distribution

95% H-UCL	1.963	90% Chebyshev (MVUE) UCL	2.061
95% Chebyshev (MVUE) UCL	2.192	97.5% Chebyshev (MVUE) UCL	2.375
99% Chebyshev (MVUE) UCL	2.732		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	1.93	95% BCA Bootstrap UCL	1.947
95% Standard Bootstrap UCL	1.924	95% Bootstrap-t UCL	1.965
95% Hall's Bootstrap UCL	2.044	95% Percentile Bootstrap UCL	1.935
90% Chebyshev(Mean, Sd) UCL	2.061	95% Chebyshev(Mean, Sd) UCL	2.192
97.5% Chebyshev(Mean, Sd) UCL	2.374	99% Chebyshev(Mean, Sd) UCL	2.732

Suggested UCL to Use

95% Student's-t UCL	1.941

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zirconium

ProUCL Output
AOI-09 : Beneath + Exposure Area

General Statistics

Total Number of Observations	11	Number of Distinct Observations	7
		Number of Missing Observations	8
Number of Detects	9	Number of Non-Detects	2
Number of Distinct Detects	5	Number of Distinct Non-Detects	2
Minimum Detect	1.5	Minimum Non-Detect	1.14
Maximum Detect	2.4	Maximum Non-Detect	1.2
Variance Detects	0.0986	Percent Non-Detects	18.18%
Mean Detects	1.989	SD Detects	0.314
Median Detects	2	CV Detects	0.158
Skewness Detects	-0.0866	Kurtosis Detects	-0.986
Mean of Logged Detects	0.676	SD of Logged Detects	0.161

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.764	Detected Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.181	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.316	Detected Data appear Normal at 1% Significance Level

Detected Data appear Normal at 1% Significance Level

Note GOF tests may be unreliable for small sample sizes

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.835	KM Standard Error of Mean	0.135
90KM SD	0.423	95% KM (BCA) UCL	2.036
95% KM (t) UCL	2.08	95% KM (Percentile Bootstrap) UCL	2.045
95% KM (z) UCL	2.057	95% KM Bootstrap t UCL	2.062
90% KM Chebyshev UCL	2.24	95% KM Chebyshev UCL	2.424
97.5% KM Chebyshev UCL	2.679	99% KM Chebyshev UCL	3.18

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.363	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Note GOF tests may be unreliable for small sample sizes

Gamma Statistics on Detected Data Only

k hat (MLE)	44.01	k star (bias corrected MLE)	29.42
Theta hat (MLE)	0.0452	Theta star (bias corrected MLE)	0.0676
nu hat (MLE)	792.3	nu star (bias corrected)	529.5
Mean (detects)	1.989		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

ProUCL Output
AOI-09 : Beneath + Exposure Area

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.305	Mean	1.865
Maximum	2.4	Median	2
SD	0.394	CV	0.211
k hat (MLE)	23.54	k star (bias corrected MLE)	17.18
Theta hat (MLE)	0.0792	Theta star (bias corrected MLE)	0.109
nu hat (MLE)	517.8	nu star (bias corrected)	377.9
Adjusted Level of Significance (β)	0.0278		
Approximate Chi Square Value (377.95, α)	333.9	Adjusted Chi Square Value (377.95, β)	327.1
95% Gamma Approximate UCL	2.111	95% Gamma Adjusted UCL	2.154

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.835	SD (KM)	0.423
Variance (KM)	0.179	SE of Mean (KM)	0.135
k hat (KM)	18.81	k star (KM)	13.74
nu hat (KM)	413.8	nu star (KM)	302.3
theta hat (KM)	0.0975	theta star (KM)	0.134
80% gamma percentile (KM)	2.233	90% gamma percentile (KM)	2.49
95% gamma percentile (KM)	2.717	99% gamma percentile (KM)	3.177

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (302.31, α)	263	Adjusted Chi Square Value (302.31, β)	257.1
95% KM Approximate Gamma UCL	2.108	95% KM Adjusted Gamma UCL	2.158

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.926	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.252	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

Note GOF tests may be unreliable for small sample sizes

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.872	Mean in Log Scale	0.607
SD in Original Scale	0.383	SD in Log Scale	0.21
95% t UCL (assumes normality of ROS data)	2.081	95% Percentile Bootstrap UCL	2.055
95% BCA Bootstrap UCL	2.054	95% Bootstrap t UCL	2.069
95% H-UCL (Log ROS)	2.125		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.577	KM Geo Mean	1.781
KM SD (logged)	0.251	95% Critical H Value (KM-Log)	1.904
KM Standard Error of Mean (logged)	0.0804	95% H-UCL (KM -Log)	2.138
KM SD (logged)	0.251	95% Critical H Value (KM-Log)	1.904
KM Standard Error of Mean (logged)	0.0804		

DL/2 Statistics

ProUCL Output
AOI-09 : Beneath + Exposure Area

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.734	Mean in Log Scale	0.456
SD in Original Scale	0.634	SD in Log Scale	0.511
95% t UCL (Assumes normality)	2.08	95% H-Stat UCL	2.562

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.08

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output
AOI-09 : Beneath + Exposure Area + RAL

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 8/4/2022 10:46:42 PM
From File	2022-0518_HAI ProUCL Input-EA09-Beneath+Exposure_Area_RAL.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Polychlorinated biphenyls (PCBs)

General Statistics

Total Number of Observations	33	Number of Distinct Observations	18
Number of Detects	29	Number of Non-Detects	4
Number of Distinct Detects	14	Number of Distinct Non-Detects	4
Minimum Detect	0.00325	Minimum Non-Detect	0.004
Maximum Detect	1	Maximum Non-Detect	0.0366
Variance Detects	0.232	Percent Non-Detects	12.12%
Mean Detects	0.575	SD Detects	0.482
Median Detects	1	CV Detects	0.838
Skewness Detects	-0.248	Kurtosis Detects	-2.054
Mean of Logged Detects	-1.658	SD of Logged Detects	2.047

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.663	**Shapiro Wilk GOF Test**
1% Shapiro Wilk Critical Value	0.898	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.363	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.189	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.506	KM Standard Error of Mean	0.0852
90KM SD	0.481	95% KM (BCA) UCL	0.647
95% KM (t) UCL	0.651	95% KM (Percentile Bootstrap) UCL	0.65
95% KM (z) UCL	0.647	95% KM Bootstrap t UCL	0.655
90% KM Chebyshev UCL	0.762	95% KM Chebyshev UCL	0.878
97.5% KM Chebyshev UCL	1.039	99% KM Chebyshev UCL	1.354

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.61	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.804	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.364	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.171	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.564	k star (bias corrected MLE)	0.529
Theta hat (MLE)	1.019	Theta star (bias corrected MLE)	1.087

ProUCL Output
AOI-09 : Beneath + Exposure Area + RAL

nu hat (MLE)	32.73	nu star (bias corrected)	30.68
Mean (detects)	0.575		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00325	Mean	0.54
Maximum	1	Median	0.291
SD	0.461	CV	0.855
k hat (MLE)	0.619	k star (bias corrected MLE)	0.583
Theta hat (MLE)	0.872	Theta star (bias corrected MLE)	0.926
nu hat (MLE)	40.84	nu star (bias corrected)	38.46
Adjusted Level of Significance (β)	0.0419		
Approximate Chi Square Value (38.46, α)	25.26	Adjusted Chi Square Value (38.46, β)	24.71
95% Gamma Approximate UCL	0.822	95% Gamma Adjusted UCL	0.84

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.506	SD (KM)	0.481
Variance (KM)	0.231	SE of Mean (KM)	0.0852
k hat (KM)	1.108	k star (KM)	1.028
nu hat (KM)	73.15	nu star (KM)	67.84
theta hat (KM)	0.457	theta star (KM)	0.493
80% gamma percentile (KM)	0.813	90% gamma percentile (KM)	1.158
95% gamma percentile (KM)	1.503	99% gamma percentile (KM)	2.301

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (67.84, α)	49.88	Adjusted Chi Square Value (67.84, β)	49.09
95% KM Approximate Gamma UCL	0.689	95% KM Adjusted Gamma UCL	0.7

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.758	**Shapiro Wilk GOF Test**
10% Shapiro Wilk Critical Value	0.937	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.343	**Lilliefors GOF Test**
10% Lilliefors Critical Value	0.148	Detected Data Not Lognormal at 10% Significance Level

Detected Data Not Lognormal at 10% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.507	Mean in Log Scale	-2.004
SD in Original Scale	0.488	SD in Log Scale	2.152
95% t UCL (assumes normality of ROS data)	0.651	95% Percentile Bootstrap UCL	0.645
95% BCA Bootstrap UCL	0.647	95% Bootstrap t UCL	0.66
95% H-UCL (Log ROS)	6.459		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.07	KM Geo Mean	0.126

ProUCL Output
AOI-09 : Beneath + Exposure Area + RAL

KM SD (logged)	2.204	95% Critical H Value (KM-Log)	4.168
KM Standard Error of Mean (logged)	0.393	95% H-UCL (KM -Log)	7.26
KM SD (logged)	2.204	95% Critical H Value (KM-Log)	4.168
KM Standard Error of Mean (logged)	0.393		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.507	Mean in Log Scale	-2.042
SD in Original Scale	0.488	SD in Log Scale	2.208
95% t UCL (Assumes normality)	0.651	95% H-Stat UCL	7.566

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Suggested UCL to Use

95% KM (t) UCL 0.651

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	32	Number of Distinct Observations	15
		Number of Missing Observations	3
Minimum	1.1	Mean	2.24
Maximum	2.8	Median	2.7
SD	0.536	Std. Error of Mean	0.0948
Coefficient of Variation	0.239	Skewness	-0.511

Normal GOF Test

Shapiro Wilk Test Statistic	0.795	Shapiro Wilk GOF Test
1% Shapiro Wilk Critical Value	0.904	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.336	Lilliefors GOF Test
1% Lilliefors Critical Value	0.18	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.401	95% Adjusted-CLT UCL (Chen-1995)	2.387
		95% Modified-t UCL (Johnson-1978)	2.4

Gamma GOF Test

A-D Test Statistic	2.854	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.746	Data Not Gamma Distributed at 5% Significance Level

ProUCL Output
AOI-09 : Beneath + Exposure Area + RAL

K-S Test Statistic	0.334	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.155	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	15.92	k star (bias corrected MLE)	14.45
Theta hat (MLE)	0.141	Theta star (bias corrected MLE)	0.155
nu hat (MLE)	1019	nu star (bias corrected)	924.7
MLE Mean (bias corrected)	2.24	MLE Sd (bias corrected)	0.589
		Approximate Chi Square Value (0.05)	855.1
Adjusted Level of Significance	0.0416	Adjusted Chi Square Value	851.6

Assuming Gamma Distribution

95% Approximate Gamma UCL	2.423	95% Adjusted Gamma UCL	2.433

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.803	**Shapiro Wilk Lognormal GOF Test**	
10% Shapiro Wilk Critical Value	0.941	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.326	**Lilliefors Lognormal GOF Test**	
10% Lilliefors Critical Value	0.142	Data Not Lognormal at 10% Significance Level	

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.775
Maximum of Logged Data	1.03	SD of logged Data	0.265

Assuming Lognormal Distribution

95% H-UCL	2.446	90% Chebyshev (MVUE) UCL	2.566
95% Chebyshev (MVUE) UCL	2.71	97.5% Chebyshev (MVUE) UCL	2.912
99% Chebyshev (MVUE) UCL	3.307		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	2.396	95% BCA Bootstrap UCL	2.39
95% Standard Bootstrap UCL	2.394	95% Bootstrap-t UCL	2.386
95% Hall's Bootstrap UCL	2.379	95% Percentile Bootstrap UCL	2.397
90% Chebyshev(Mean, Sd) UCL	2.525	95% Chebyshev(Mean, Sd) UCL	2.653
97.5% Chebyshev(Mean, Sd) UCL	2.832	99% Chebyshev(Mean, Sd) UCL	3.183

Suggested UCL to Use

95% Student's-t UCL	2.401

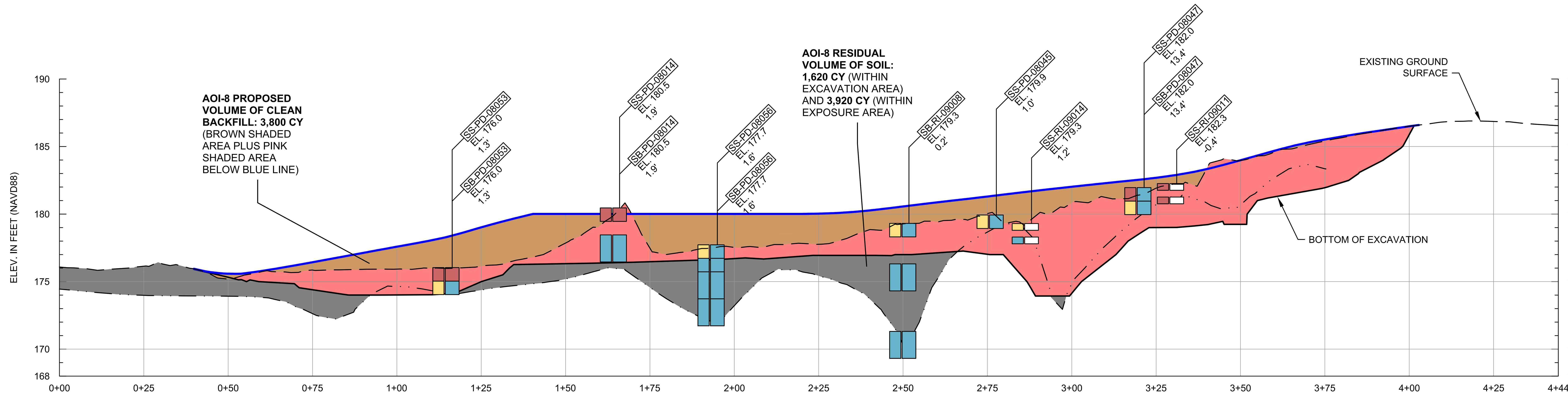
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output

AOI-09 : Beneath + Exposure Area + RAL

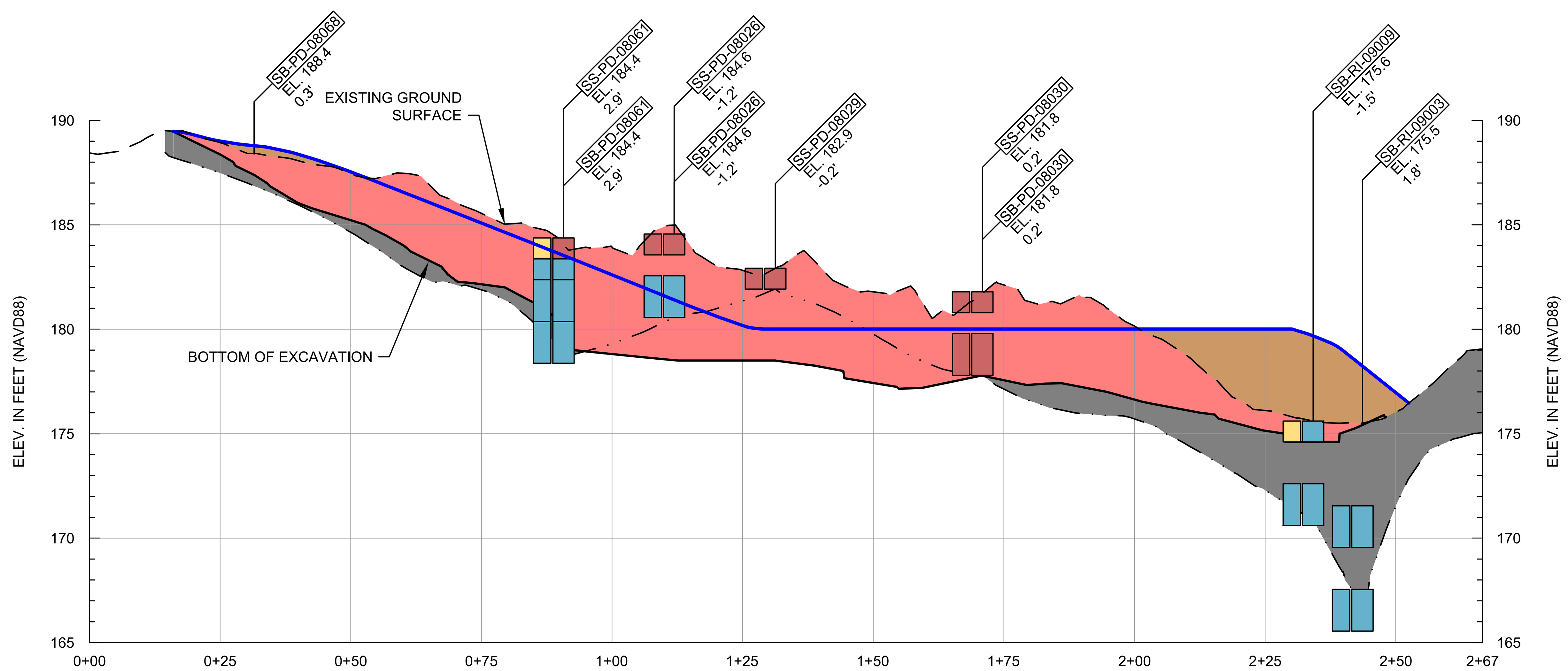
Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

PART 4
RESIDUAL VOLUME CALCULATIONS



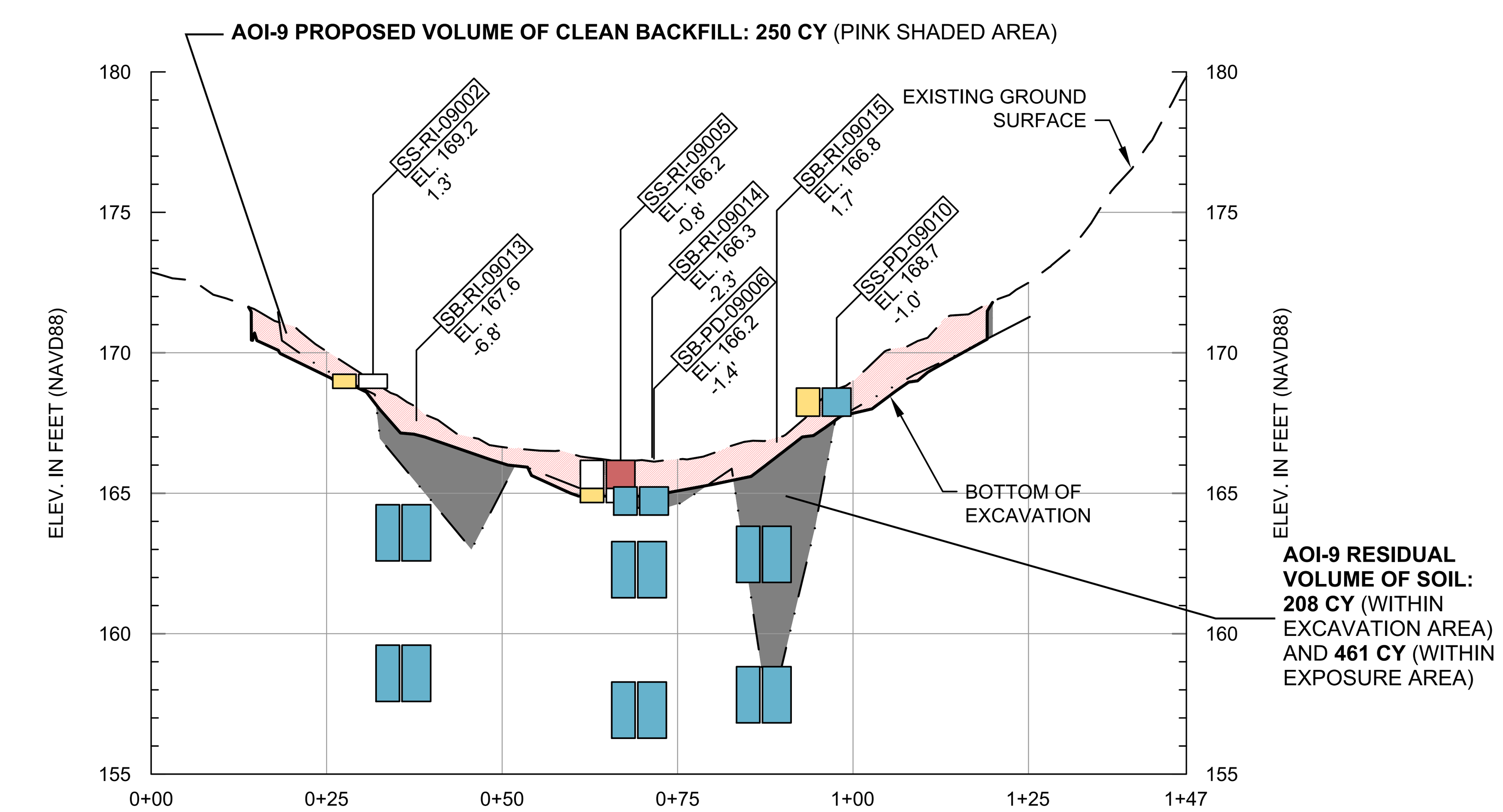
SECTION AOI8-1

SCALE AS SHOWN



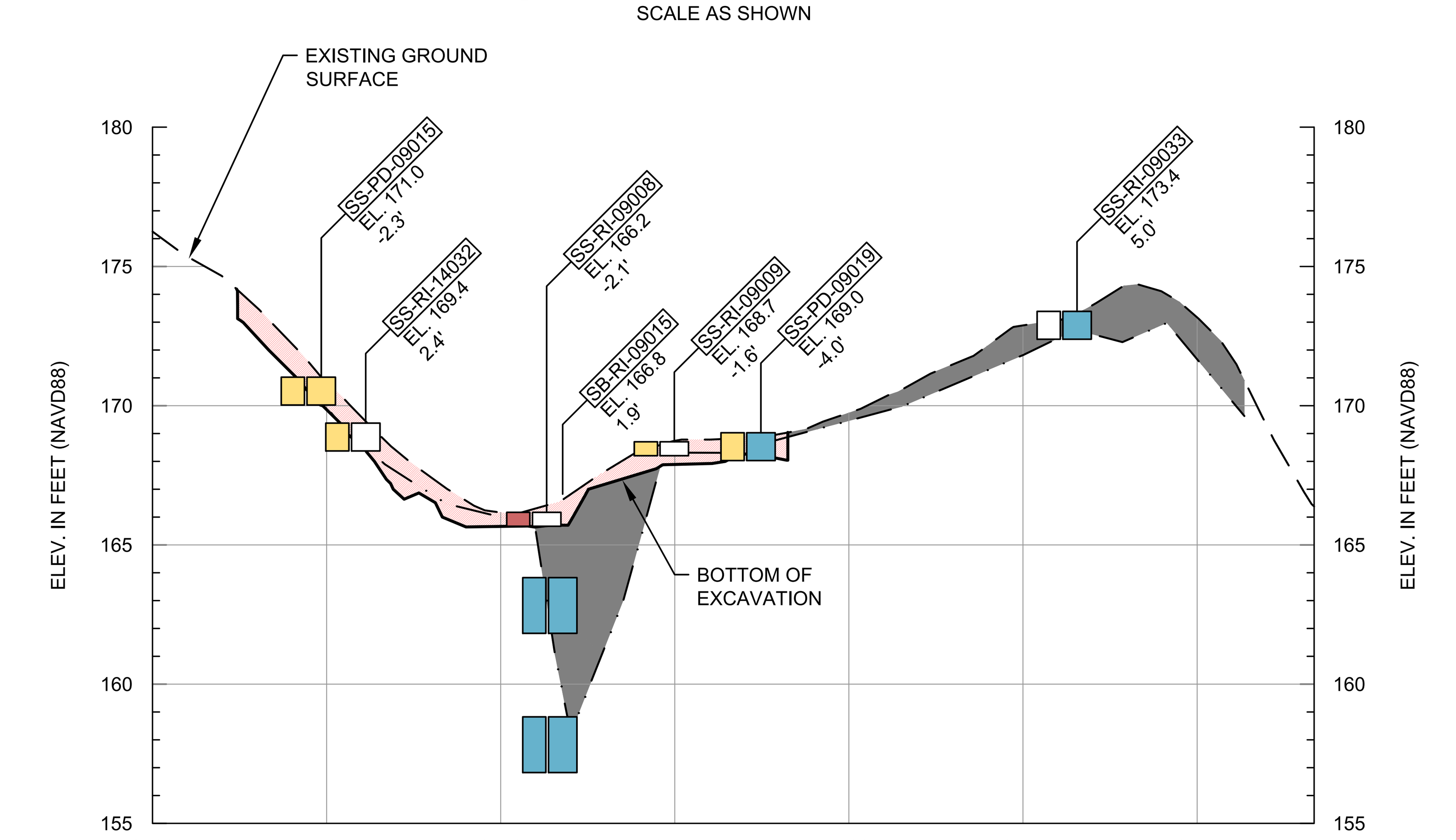
SECTION AOI8-2

SCALE AS SHOWN



SECTION AOI9-1

SCALE AS SHOWN



SECTION AOI9-2

SCALE AS SHOWN

SAMPLE LEGEND

SB-RI-09003 / EL. 175.5 / 1.8'
- LOCATION ID
- ELEVATION (NAVD88, FT)
- OFFSET (FT) (-) INDICATES LEFT OF SECTION LINE

URANIUM (MG/KG)	TOTAL PCBs (MG/KG)
< 2.7	< 1
>= 2.7 AND < 13.5	>= 1 AND < 1.5
>= 13.5	>= 1.5
NO SAMPLE COLLECTED	NO SAMPLE COLLECTED

NOTES

1. CY: CUBIC YARDS

SECTION LEGEND

- EXISTING GROUND SURFACE
- PROPOSED BOTTOM OF EXCAVATION AND ASSOCIATED CUT AREAS
- PROPOSED RESTORED GRADE AND ASSOCIATED FILL AREAS
- RESIDUAL SOIL REMAINING

HORIZ. 0 20 40 60 80
VERT. 0 5 10 15 20
SCALE IN FEET

HALEY ALDRICH

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www.haleyaldrich.com

Project No.:	131884
Scale:	SHOWN
Date:	SEPTEMBER 2022
Drawn By:	HA
Designed By:	HA
Checked By:	HA
Approved By:	HA
Stamp:	

Rev.	Description	By	Date
B	100% DESIGN	H&A	09/26/22
A	95% DESIGN	H&A	08/16/22

REMEDIAL DESIGN
100% DESIGN

2229 MAIN STREET
CONCORD, MASSACHUSETTS

ATTACHMENT C-1
PART 4 FIGURE -
CLEAN BACKFILL AND RESIDUAL VOLUME CALCULATIONS

ATTACHMENT C-1
PART 4 FIGURE

Sheet: of

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Part 4: Residual Volume Calculations

Part 4 provides documentation of the residual volume of soil remaining beneath each excavation area and within each exposure area where soil excavation activities were performed. These soil volumes are used in the volume-weighted EPC calculations.

PART 5
RESIDUAL RISKS

Part 5: Residual Risks

Part 5, Table 1 provides risk-based values and cleanup levels published in the ROD. It is noted that the values that USEPA selected as cleanup levels represented both risk-based values and background values. Specifically, USEPA compared the lowest risk-based value (i.e., the lower of the risk-based values derived for an ILCR of 1E-06 and an HI of 1) to the background value developed in the RI, and then selected the higher of the two as the cleanup level. As documented in the ROD, arsenic and thorium in Site soil were determined to be a background condition; therefore, the cleanup levels for arsenic and thorium were based on the Site-specific soil background values. For PCBs, a USEPA policy-based value was selected as the cleanup level. For benzo(a)pyrene, the Site-specific background value was higher than the risk-based value, so the background value was selected as the cleanup level.

Residual risks were calculated using a ratio method wherein the EPC is compared to *risk-based values* and expressed as a ratio which is then converted to a risk estimate. Specifically, the hazard quotient (HQ) and ILCR values are calculated as:

$$HQ = 1 \times EPC \,/\, \text{non-cancer risk-based value}$$
(where: 1 is the target HQ that the risk-based value is derived for)

$$ILCR = 1\text{x}10^{-6} \times EPC \,/\, \text{cancer risk-based value}$$
(where: $1\text{x}10^{-6}$ is the target ILCR that the risk-based value is derived for)

The risk-based values for COCs used in this calculation are presented in Part 5, Table 1 and are as follows:

- For arsenic, PCBs, thorium, and uranium, the risk-based values are presented in the ROD. The risk-based values were derived for a target HQ of 1 and a target ILCR of $1\text{x}10^{-6}$.
- For PAHs, the risk-based values presented in the ROD are based on toxicity values that have subsequently been updated by USEPA. Therefore, the RSL calculator was used to derive new risk-based values for a target HQ of 1 and a target ILCR of $1\text{x}10^{-6}$.

The risk-based values for COPCs used in this calculation are presented in Part 5, Table 2 and are as follows:

- For COPCs retained for the cumulative risk calculations in the residual risk assessment, the RSL calculator was used to derive risk-based target values for a target HQ of 1 and a target ILCR of $1\text{x}10^{-6}$ (risk-based target values are not typically derived in the Feasibility Study or presented in the ROD for constituents that are not retained as COCs).

The site-specific residential exposure frequency (161 days/year) and climactic zone for deriving wind-borne particulate estimates (Hartford, CT) that were used in the HHRA and to establish the risk-based values in the ROD were also used in the RSL calculator to derive the risk-based values for PAHs and the COPCs. The RSL calculator input and output values are provided in Attachment 1 to Part 5.

The EPCs used in the residual risk calculations are as follows:

- COCs: Final residual EPC, which include RI, PDI, and confirmatory or verification data, calculated using the methodology provided in Section 6.5 of the CQA report.
- COPCs: EPCs based on RI and PDI data representative of soil conditions that exist outside of the design cut lines. These EPCs do not include confirmatory or verification sampling data since confirmatory sampling is not required for constituents that are not COCs.

Residual Risks

Residual risk calculations for each remediation area are provided in the Attachment 2 to Part 5 of this Attachment. The tables provided in the Attachment 2 are grouped by excavation area.

Residual Risk Analysis

PART 5, TABLE 1
CLEANUP LEVELS AND RISK-BASED VALUES FOR CHEMICALS OF CONCERN
NUCLEAR METALS
CONCORD, MASSACHUSETTS
FILE NO. 131884

Soil Cleanup Levels for the Protection of Human Health					
COC	**Cancer (1E-06) (mg/kg)**	**Non-Cancer (HI=1) (mg/kg)**	**Background (mg/kg)**	**Selected Cleanup Level (mg/kg)**	
Benzo(a)anthracene	0.34	3900	0.033	0.34	ILCR
Benzo(a)pyrene	0.034	3900	0.22	0.22	Background
Benzo(b)fluoranthene	0.34	3900	0.066	0.34	ILCR
Indeno(1,2,3-cd)pyrene	0.34	3900	not detected	0.34	ILCR
PCBs	0.54	2.6	not applicable	1	Policy
Arsenic	1.5	76	13.7	13.7	Background
Thorium	0.084	NA	7.4	7.4	Background
Uranium	2.7	100	1.3	2.7	ILCR

PAH Risk-Based Values: Updated Toxicity Values	
Cancer (1E-06) (mg/kg)	**Non-Cancer (HI=1) (mg/kg)**
0.57	
0.25	39
2.5	
2.5	

Source of updated values:
RSL Calculator output - see attachment 1 of Appendix Part 4

Source of cleanup levels: Record of Decision Nuclear Metals Inc. Superfund Site (September 2015), Appendix E.
COC - chemical of concern
ILCR - incremental lifetime cancer risk
HI - hazard index
mg/kg - milligram per kilogram

PART 5, TABLE 2
RISK-BASED VALUES FOR CHEMICALS OF POTENTIAL CONCERN
NUCLEAR METALS
CONCORD, MASSACHUSETTS
FILE NO. 131884

Risk-based Values for the Protection of Human Health		
COC	**Cancer (1E-06) (mg/kg)**	**Non-Cancer (HI=1) (mg/kg)**
Dibenz(a,h)anthracene	0.25	3900
Aluminum		170000
Cobalt	7450	51
Iron		119000
Manganese		4070
Thallium		1.7
Titanium		NA
Zirconium		13.6

Source of updated values:
RSL Calculator output - see attachment 1 of Appendix Part 4
NA - Not applicable (no toxicity values are available to calculate a value)
HI - hazard index
mg/kg - milligram per kilogram

Attachment 1
Risk-Based Concentrations

Site-specific
Resident Soil Inputs
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Variable	Resident Soil Default Value	Site-Specific Value
A (PEF Dispersion Constant)	16.2302	12.5907
A (VF Dispersion Constant)	11.911	12.5907
A (VF Dispersion Constant - mass limit)	11.911	12.5907
B (PEF Dispersion Constant)	18.7762	18.8368
B (VF Dispersion Constant)	18.4385	18.8368
B (VF Dispersion Constant - mass limit)	18.4385	18.8368
City (PEF Climate Zone) Selection	Default	Hartford, CT (8
City (VF Climate Zone) Selection	Default	Hartford, CT (8
C (PEF Dispersion Constant)	216.108	215.4377
C (VF Dispersion Constant)	209.7845	215.4377
C (VF Dispersion Constant - mass limit)	209.7845	215.4377
d_s (depth of source) m	0	2
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.0345
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	10982401742
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	73.95044953
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	73.95044953
Q/C_{vol} (g/m^2-s per kg/m^3 - mass limit)	68.18	73.95044953
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{res-a} (skin adherence factor - adult) mg/cm^2	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm^2	0.2	0.2
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	47559.4
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	196999.6
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	161
EF_{0-2} (mutagenic exposure frequency) days/year	350	161
EF_{2-6} (mutagenic exposure frequency) days/year	350	161
EF_{6-16} (mutagenic exposure frequency) days/year	350	161
EF_{16-26} (mutagenic exposure frequency) days/year	350	161
EF_{res-a} (exposure frequency - adult) days/year	350	161
EF_{res-c} (exposure frequency - child) days/year	350	161
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24
THQ (target hazard quotient) unitless	0.1	1
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	16905
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	76743.333
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	0.000001	0.000001
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	3.84
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5
VF_{ml} (volitization factor - mass limit) m^3/kg	0	20211.54526

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Site-specific

Resident Regional Screening Levels (RSL) for Soil

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)
Aluminum	7429-90-5	No	No	Inorganics	-		-		1.00E+00	P	5.00E-03	P	#######	-	1.00E+00	-
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	#######	3.00E-02	6.00E-01	-
Benz[a]anthracene	56-55-3	Yes	Yes	Organics	1.00E-01	E	6.00E-05	E	-		-		#######	1.30E-01	1.00E+00	-
Benzo[a]pyrene	50-32-8	Yes	No	Organics	1.00E+00	I	6.00E-04	I	3.00E-04	I	2.00E-06	I	#######	1.30E-01	1.00E+00	-
Benzo[b]fluoranthene	205-99-2	Yes	No	Organics	1.00E-01	E	6.00E-05	E	-		-		#######	1.30E-01	1.00E+00	-
Cobalt	7440-48-4	No	No	Inorganics	-		9.00E-03	P	3.00E-04	P	6.00E-06	P	#######	-	1.00E+00	-
Dibenz[a,h]anthracene	53-70-3	Yes	No	Organics	1.00E+00	E	6.00E-04	E	-		-		#######	1.30E-01	1.00E+00	-
Indeno[1,2,3-cd]pyrene	193-39-5	Yes	No	Organics	1.00E-01	E	6.00E-05	E	-		-		#######	1.30E-01	1.00E+00	-
Iron	7439-89-6	No	No	Inorganics	-		-		7.00E-01	P	-		#######	-	1.00E+00	-
Manganese (Non-diet)	7439-96-5	No	No	Inorganics	-		-		2.40E-02	G	5.00E-05	I	4.00E-02	-	1.00E+00	-
Thallium (Soluble Salts)	7440-28-0	No	No	Inorganics	-		-		1.00E-05	X	-		#######	-	1.00E+00	-
Thorium	7440-29-1	No	No	Inorganics	-		-		-		-		#######	-	1.00E+00	-
Titanium	7440-32-6	No	No	Inorganics	-		-		-		-		#######	-	1.00E+00	-
Uranium	7440-61-1	No	No	Inorganics	-		-		2.00E-04	A	4.00E-05	A	#######	-	1.00E+00	-
Zirconium	7440-67-7	No	No	Inorganics	-		-		8.00E-05	X	-		#######	-	1.00E+00	-

Chemical	S (mg/L)	K_{oc} (cm^3/g)	K_d (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature T_C (K)	T_C Ref	Chemical Type	D_{ia} (cm^2/s)	D_{iw} (cm^2/s)	D_A (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor Unlimited Reservoir (m^3/kg)	Volatilization Factor Mass Limit (m^3/kg)	Volatilization Factor Selected (m^3/kg)
Aluminum	-	-	1.50E+03	-	-		2.79E+03	CRC	6.70E+03	CRC	INORGANIC	-	-	-	1.10E+10	-	-	-
Arsenic, Inorganic	-	-	2.90E+01	-	-		8.88E+02	PHYSPROP	1.67E+03	CRC	INORGANIC	-	-	-	1.10E+10	-	-	-
Benz[a]anthracene	9.40E-03	1.77E+05	1.06E+03	1.20E-05	4.91E-04	PHYSPROP	7.11E+02	PHYSPROP	9.79E+02	YAWS	PAH	2.61E-02	6.75E-06	6.83E-10	1.10E+10	4.78E+06	2.02E+04	4.78E+06
Benzo[a]pyrene	1.62E-03	5.87E+05	-	4.57E-07	1.87E-05	PHYSPROP	7.68E+02	PHYSPROP	9.69E+02	EPA 2001 Fact Sheet	PAH	2.55E-02	6.58E-06	-	1.10E+10	-	-	-
Benzo[b]fluoranthene	1.50E-03	5.99E+05	-	6.57E-07	2.69E-05	PHYSPROP	7.16E+02	EPI	9.69E+02	EPA 2001 Fact Sheet	PAH	2.50E-02	6.43E-06	-	1.10E+10	-	-	-
Cobalt	-	-	4.50E+01	-	-		3.20E+03	CRC	7.40E+03	YAWS	INORGANIC	-	-	-	1.10E+10	-	-	-
Dibenz[a,h]anthracene	2.49E-03	1.91E+06	-	1.41E-07	5.76E-06	EPI	7.97E+02	PHYSPROP	9.90E+02	EPA 2001 Fact Sheet	PAH	2.36E-02	6.02E-06	-	1.10E+10	-	-	-
Indeno[1,2,3-cd]pyrene	1.90E-04	1.95E+06	-	3.48E-07	1.42E-05	PHYSPROP	8.09E+02	PHYSPROP	1.08E+03	EPA 2001 Fact Sheet	PAH	2.47E-02	6.37E-06	-	1.10E+10	-	-	-
Iron	-	-	2.50E+01	-	-		3.27E+03	PERRY	9.34E+03	CRC	INORGANIC	-	-	-	1.10E+10	-	-	-
Manganese (Non-diet)	-	-	6.50E+01	-	-		2.37E+03	PHYSPROP	4.33E+03	CRC	INORGANIC	-	-	-	1.10E+10	-	-	-
Thallium (Soluble Salts)	-	-	7.10E+01	-	-		1.73E+03	PHYSPROP	4.65E+03	YAWS	INORGANIC	-	-	-	1.10E+10	-	-	-
Thorium	-	-	1.50E+05	-	-		4.77E+03	CRC	1.77E+04	YAWS	INORGANIC	-	-	-	1.10E+10	-	-	-
Titanium	-	-	1.00E+03	-	-		3.56E+03	CRC	6.40E+03	YAWS	INORGANIC	-	-	-	1.10E+10	-	-	-
Uranium	-	-	4.50E+02	-	-		4.09E+03	CRC	1.37E+04	YAWS	INORGANIC	-	-	-	1.10E+10	-	-	-
Zirconium	-	-	3.00E+03	-	-		4.68E+03	CRC	8.80E+03	YAWS	INORGANIC	-	-	-	1.10E+10	-	-	-

Chemical	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL Child THQ=1 (mg/kg)	Dermal SL Child THQ=1 (mg/kg)	Inhalation SL Child THQ=1 (mg/kg)	Noncarcinogenic SL Child THI=1 (mg/kg)	Ingestion SL Adult THQ=1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	Noncarcinogenic SL Adult THI=1 (mg/kg)	Screening Level (mg/kg)	Present?
Aluminum	-	-	-	-	1.70E+05	-	1.24E+08	1.70E+05	1.81E+06	-	1.24E+08	1.79E+06	1.70E+05 nc max	Yes
Arsenic, Inorganic	1.68E+00	1.19E+01	1.56E+04	1.47E+00	8.50E+01	7.17E+02	3.73E+05	7.60E+01	9.07E+02	4.30E+03	3.73E+05	7.47E+02	1.47E+00 ca	Yes
Benz[a]anthracene	3.33E+00	9.98E+00	1.76E+02	2.46E+00	-	-	-	-	-	-	-	-	2.46E+00 ca	Yes
Benzo[a]pyrene	3.33E-01	9.98E-01	4.03E+04	2.50E-01	5.10E+01	1.65E+02	4.98E+04	3.90E+01	5.44E+02	9.91E+02	4.98E+04	3.49E+02	2.50E-01 ca	Yes
Benzo[b]fluoranthene	3.33E+00	9.98E+00	4.03E+05	2.50E+00	-	-	-	-	-	-	-	-	2.50E+00 ca	Yes
Cobalt	-	-	7.45E+03	7.45E+03	5.10E+01	-	1.49E+05	5.10E+01	5.44E+02	-	1.49E+05	5.42E+02	5.10E+01 nc	Yes
Dibenz[a,h]anthracene	3.33E-01	9.98E-01	4.03E+04	2.50E-01	-	-	-	-	-	-	-	-	2.50E-01 ca	Yes
Indeno[1,2,3-cd]pyrene	3.33E+00	9.98E+00	4.03E+05	2.50E+00	-	-	-	-	-	-	-	-	2.50E+00 ca	Yes
Iron	-	-	-	-	1.19E+05	-	-	1.19E+05	1.27E+06	-	-	1.27E+06	1.19E+05 nc max	Yes
Manganese (Non-diet)	-	-	-	-	4.08E+03	-	1.24E+06	4.07E+03	4.35E+04	-	1.24E+06	4.21E+04	4.07E+03 nc	Yes
Thallium (Soluble Salts)	-	-	-	-	1.70E+00	-	-	1.70E+00	1.81E+01	-	-	1.81E+01	1.70E+00 nc	Yes
Thorium	-	-	-	-	-	-	-	-	-	-	-	-		Yes
Titanium	-	-	-	-	-	-	-	-	-	-	-	-		Yes
Uranium	-	-	-	-	3.40E+01	-	9.96E+05	3.40E+01	3.63E+02	-	9.96E+05	3.63E+02	3.40E+01 nc	Yes
Zirconium	-	-	-	-	1.36E+01	-	-	1.36E+01	1.45E+02	-	-	1.45E+02	1.36E+01 nc	Yes

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Attachment 2
Residual Risk Calculations

RESIDUAL RISK ANALYSIS CALCULATIONS
AOI 8 (FORMERLY HHRA EXPOSURE AREA A5 - AOI 8 SWEEPINGS AREA)
NUCLEAR METALS
CONCORD, MASSACHUSETTS
FILE NO. 131884

Soil Cleanup Levels and Risk-based Values for the Protection of Human Health (mg/kg) [a]						Residual Risk Calculations [c]					
	Cancer (1E-06)	Non-Cancer (HI=1)	Background	Selected Cleanup Level		Excavation Area EPC [b]	Excavation Area ILCR	Excavation Area HQ	Exposure Area EPC [d]	Exposure Area ILCR	Exposure Area HQ
COC											
Benzo(a)anthracene	2.5	3900	0.033	0.34	ILCR	not COPC			not COPC		
Benzo(a)pyrene	0.25	39	0.22	0.22	Background	not COPC			0.0275	1.1E-07	0.00071
Benzo(b)fluoranthene	2.5	3900	0.066	0.34	ILCR	not COPC			not COPC		
Indeno(1,2,3-cd)pyrene	2.5	3900	not detected	0.34	ILCR	not COPC			not COPC		
Polychlorinated biphenyls (PCBs)	0.54	2.6	not applicable	1	Policy	0.21	3.9E-07	0.080	0.30	5.5E-07	0.11
Arsenic	1.5	76	13.7	13.7	Background	6.8	4.5E-06	0.090	6.7	4.5E-06	0.088
Thorium	0.084	NA	7.4	7.4	Background	6.1	7.3E-05		5.9	7.1E-05	
Uranium	2.7	100	1.3	2.7	ILCR	2.0	7.5E-07	0.020	2.4	8.9E-07	0.024
						TOTAL: COCs	**7.8E-05**	**0.19**		**7.7E-05**	**0.23**
						TOTAL: COCs Incremental [e]	**1.1E-06**	**0.10**		**1.5E-06**	**0.14**
COPC											
Dibenz(a,h)anthracene	0.25	3900				not COPC			not COPC		
Aluminum		170000				7893		0.046	8922		0.052
Cobalt	7450	51				3.5	4.7E-10	0.068	3.4	4.5E-10	0.066
Iron		119000				10847		0.091	11245		0.094
Manganese		4070				126		0.031	123		0.030
Thallium		1.7				0.10		0.059411765	0.10		0.061
Titanium						579			543		
Zirconium		13.6				3.0		0.22	2.7		0.20
						TOTAL: COPCs	**4.7E-10**	**0.52**		**4.5E-10**	**0.50**

ABBREVIATIONS AND NOTES:

mg/kg - milligram per kilogram
COC - chemical of concern, as defined in Record of Decision (ROD).
COPC - chemical of potential concern; selected in Part 1 of this Appendix
EPC - exposure point concentration for soil samples that remain (not excavated); lesser of maximum detected concentration and 95% upper concentration limit (Part 3 of this Appendix)
HI - hazard index
HQ - hazard quotient
ILCR - incremental lifetime cancer risk
[a] - Refer to Table 1 of Part 4 of this Appendix.
[b] - The EPCs for PCBs and uranium are the final residual EPCs provided in Table 6.5-2. The EPCs for other COCs and the COPCs are derived in Part 3 of this Appendix as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint. The EPCs will be updated using confirmatory and verification sampling data when the remediation is implemented.
[c] - ILCR calculated as: EPC x 1E-06 / cancer risk-based value; HQ calculated as EPC / non-cancer risk-based value
[d] - The EPCs for PCBs and uranium are the final residual EPCs provided in Table 6.5-2. The EPCs for other COCs and the COPCs are derived in Part 3 of this Appendix as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint and within the exposure area. The EPCs will be updated using confirmatory and verification sampling data when the remediation is implemented.
[e] - Calculated as Total-COC risk minus risks for arsenic and thorium

RESIDUAL RISK ANALYSIS CALCULATIONS
AOI 9 (FORMERLY HHRA EXPOSURE AREA A4 - AOI 14 NORTH)
NUCLEAR METALS
CONCORD, MASSACHUSETTS
FILE NO. 131884

Soil Cleanup Levels and Risk-based Values for the Protection of Human Health (mg/kg) [a]						Residual Risk Calculations [c]					
	Cancer (1E-06)	Non-Cancer (HI=1)	Background	Selected Cleanup Level		Excavation Area			Exposure Area		
						EPC [b]	ILCR	HQ	EPC [d]	ILCR	HQ
COC											
Benzo(a)anthracene	2.5	3900	0.033	0.34	ILCR	not COPC			not COPC		
Benzo(a)pyrene	0.25	39	0.22	0.22	Background	not COPC			not COPC		
Benzo(b)fluoranthene	2.5	3900	0.066	0.34	ILCR	not COPC			not COPC		
Indeno(1,2,3-cd)pyrene	2.5	3900	not detected	0.34	ILCR	not COPC			not COPC		
Polychlorinated biphenyls (PCBs)	0.54	2.6	not applicable	1	Policy	0.39	7.2E-07	0.15	0.44	8.1E-07	0.17
Arsenic	1.5	76	13.7	13.7	Background	5.3	3.5E-06	0.070	5.6	3.8E-06	0.074
Thorium	0.084	NA	7.4	7.4	Background	6.0	7.1E-05		6.2	7.4E-05	
Uranium	2.7	100	1.3	2.7	ILCR	2.0	7.4E-07	0.020	2.12	7.8E-07	0.021
						TOTAL: COCs	**7.6E-05**	**0.24**		**7.9E-05**	**0.26**
						TOTAL: COCs Incremental [e]	**1.5E-06**	**0.17**		**1.6E-06**	**0.19**
COPC											
Dibenz(a,h)anthracene	0.25	3900				not COPC			not COPC		
Aluminum		170000				8681		0.051	9003		0.053
Cobalt	7450	51				3.5	4.7E-10	0.068	3.7	5.0E-10	0.072
Iron		119000				9130		0.077	8951		0.075
Manganese		4070				not COPC			not COPC		
Thallium		1.7				not COPC			not COPC		
Titanium						486			496		
Zirconium		13.6				2.0		0.15	2.1		0.15
						TOTAL: COPCs	**4.7E-10**	**0.34**		**5.0E-10**	**0.35**

ABBREVIATIONS AND NOTES:

mg/kg - milligram per kilogram

COC - chemical of concern, as defined in Record of Decision (ROD).

COPC - chemical of potential concern; selected in Part 1 of this Appendix

EPC - exposure point concentration for soil samples that remain (not excavated); lesser of maximum detected concentration and 95% upper concentration limit (Part 3 of this Appendix)

HI - hazard index

HQ - hazard quotient

ILCR - incremental lifetime cancer risk

[a] - Refer to Table 1 of Part 4 of this Appendix.

[b] - The EPCs for PCBs and uranium are the final residual EPCs provided in Table 6.5-2. The EPCs for other COCs and the COPCs are derived in Part 3 of this Appendix as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint. The EPCs will be updated using confirmatory and verification sampling data when the remediation is implemented.

[c] - ILCR calculated as: EPC x 1E-06 / cancer risk-based value; HQ calculated as EPC / non-cancer risk-based value

[d] - The EPCs for PCBs and uranium are the final residual EPCs provided in Table 6.5-2. The EPCs for other COCs and the COPCs are derived in Part 3 of this Appendix as the lesser of the 95% upper confidence limit and maximum concentration using analytical data for RI and PDI samples that will remain beneath the excavation footprint and within the exposure area. The EPCs will be updated using confirmatory and verification sampling data when the remediation is implemented.

[e] - Calculated as Total-COC risk minus risks for arsenic and thorium

ATTACHMENT C-2

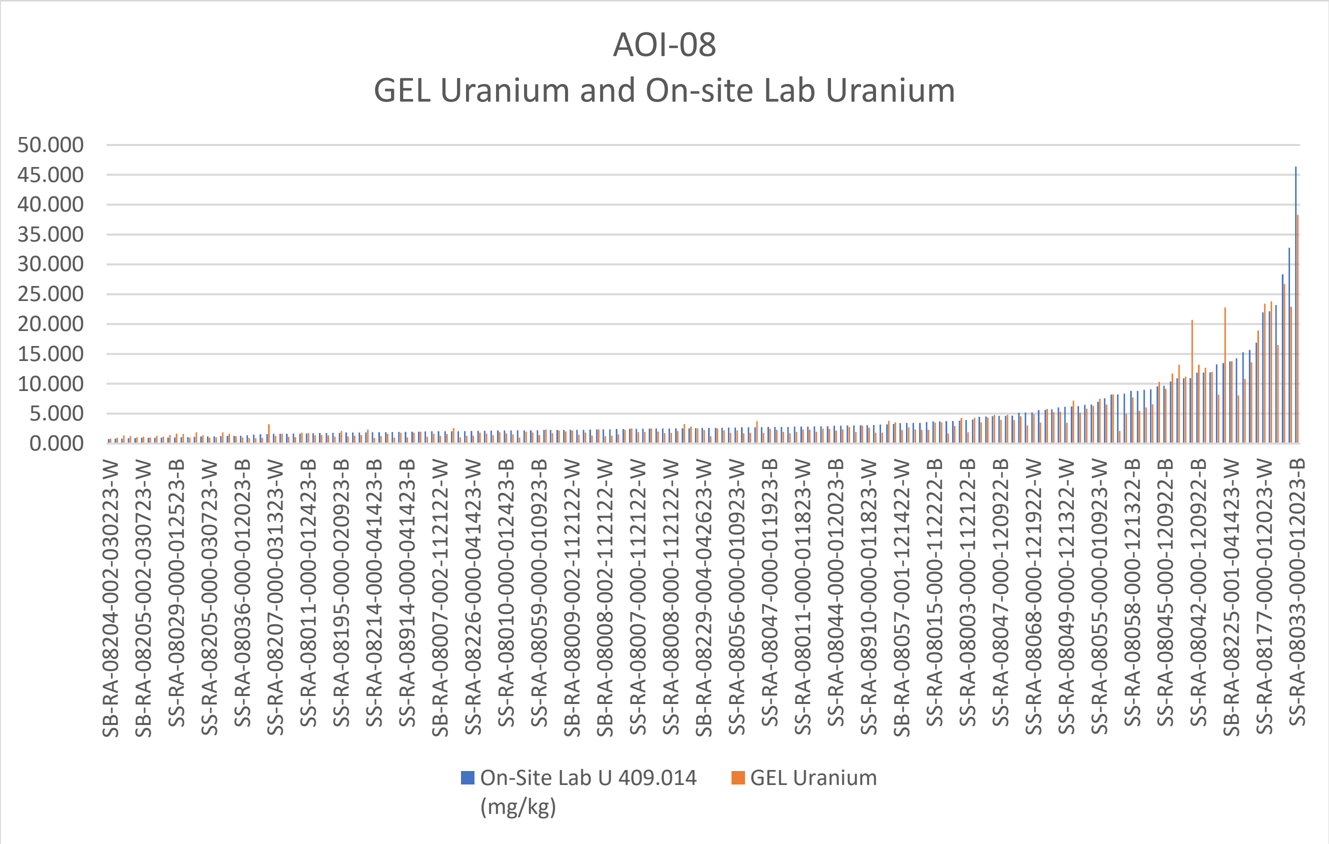
Eavluation of On-Site and Off-Site Laboratory **Data for Uranium**

On-Site Laboratory Data Quality and Correlation to GEL Laboratory Results

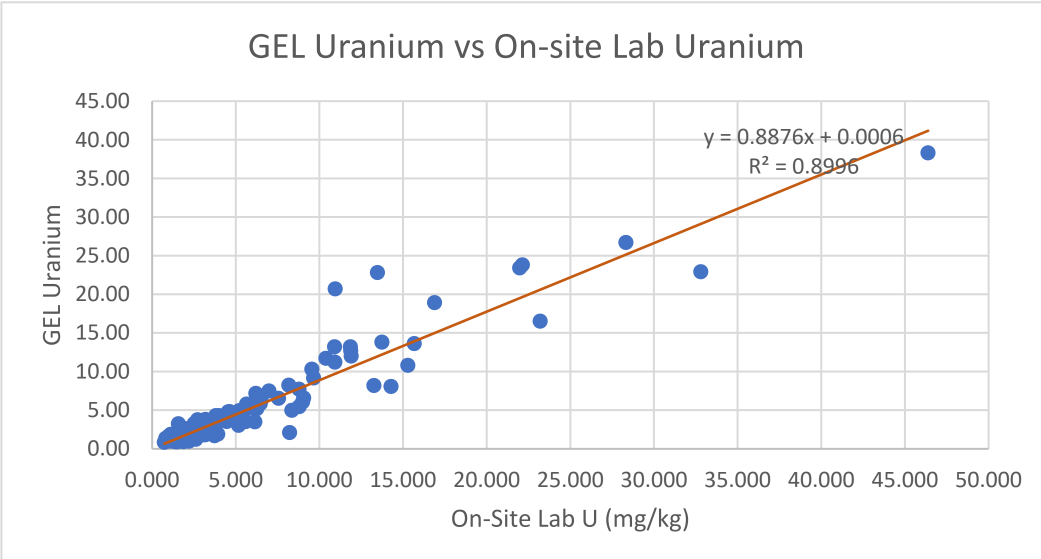
Three hundred twenty-five confirmatory soil samples were analyzed for uranium by both the on-Site laboratory and GEL. The dataset includes samples representative of soil that was excavated and soil that remains in-place. Comparisons of these results are presented in Attachment D. In summary:

- The Pearson Coefficient (r^2) for paired data collected from AOI 8 is 0.9.
- The r^2 for paired data collected from AOI 9 is 0.64.
- Overall, higher uranium concentrations are reported by the on-Site laboratory than by GEL. This can be observed in the bar graphs in Attachment D that compare the on-Site laboratory and GEL analytical results for paired samples. For the range of uranium concentrations that are of greatest interest for evaluating compliance with RALs (2.7 to 8 mg/kg), the ratio of on-Site uranium result to GEL uranium result is 1.28 for AOI 8 and 1.17 for AOI 9 (refer to ratios provided in the tables in Attachment D).
- The observation that the on-Site laboratory reports, on average, reported higher uranium concentrations than GEL improves confidence that using the analytical results from the on-Site laboratory to make decisions concerning compliance with RALs will ensure that the residual EPCs calculated using GEL data will meet the cleanup levels.
- Using the regression from AOI 8, the GEL analytical result can be predicted from the on-Site laboratory data using the following equation: *GEL result = 0.8876 X on-Site result + 0.0006*. The uranium concentrations that are predicted from this equation are, on average, 1.24 times higher than the GEL reported concentrations. For confirmatory soil samples that exhibit uranium concentrations measured with the on-Site laboratory that are near the RAL, application of this equation may be useful for determining if additional excavation is required.
- Additional review of the on-Site uranium results for AOI 9 is required to determine why the correlation with GEL data is not as strong as it is for AOI 8.

AOI-08


AOI-08
GEL Uranium and On-site Lab Uranium
50.000
45.000
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0.000
SB-RA-08204-002-030223-W
SB-RA-08205-002-030723-W
SS-RA-08029-000-012523-B
SS-RA-08205-000-030723-W
SS-RA-08036-000-012023-B
SS-RA-08207-000-031323-W
SS-RA-08011-000-012423-B
SS-RA-08195-000-020923-B
SS-RA-08214-000-041423-B
SS-RA-08914-000-041423-B
SB-RA-08007-002-112122-W
SS-RA-08226-000-041423-W
SS-RA-08010-000-012423-B
SS-RA-08059-000-010923-B
SB-RA-08009-002-112122-W
SB-RA-08008-002-112122-W
SS-RA-08007-000-112122-W
SS-RA-08008-000-112122-W
SB-RA-08229-004-042623-W
SS-RA-08056-000-010923-W
SS-RA-08047-000-011923-B
SS-RA-08011-000-011823-W
SS-RA-08044-000-012023-B
SS-RA-08910-000-011823-W
SB-RA-08057-001-121422-W
SS-RA-08015-000-112222-B
SS-RA-08003-000-112122-B
SS-RA-08047-000-120922-B
SS-RA-08068-000-121922-W
SS-RA-08049-000-121322-W
SS-RA-08055-000-010923-W
SS-RA-08058-000-121322-B
SS-RA-08045-000-120922-B
SS-RA-08042-000-120922-B
SB-RA-08225-001-041423-W
SS-RA-08177-000-012023-W
SS-RA-08033-000-012023-B
On-Site Lab U 409.014 (mg/kg)
GEL Uranium

Slope	Intercept	Correlation Coefficient	Pearson Coefficient (R square)
0.8876	0.000635	0.9484	0.8996



On-site and GEL Uranium Data for AOI 8

Sample Id	Acquisition Time	On-Site Lab U 409.014 (mg/kg)	GEL Uranium	On-site / GEL
SB-RA-08204-002-030223-W	3/6/2023 3:40:34 PM	0.734	0.83	0.89
SB-RA-08205-001-030723-W	3/8/2023 2:42:50 PM	0.807	0.96	0.84
SB-RA-08204-001-030223-W	3/6/2023 3:38:03 PM	0.820	1.34	0.61
SS-RA-08186-000-013123-B	2/1/2023 3:31:57 PM	0.889	1.25	0.71
SS-RA-08037-000-012523-B	1/26/2023 12:25:57 PM	0.904	1.07	0.84
SB-RA-08205-002-030723-W	3/8/2023 2:45:21 PM	0.939	1.14	0.82
SS-RA-08200-000-021623-B	2/17/2023 3:36:44 PM	0.946	0.96	0.98
SB-RA-08204-003-030223-W	3/6/2023 3:43:08 PM	0.955	1.28	0.75
SB-RA-08206-001-030723-W	3/8/2023 2:47:50 PM	0.976	1.14	0.86
SB-RA-08204-000-030223-W	3/6/2023 3:35:33 PM	0.989	1.44	0.69
SS-RA-08029-000-012523-B	1/26/2023 12:30:48 PM	1.010	1.65	0.61
SS-RA-08204-000-030823-B	3/8/2023 2:35:23 PM	1.048	1.60	0.65
SS-RA-08040-000-012523-B	1/26/2023 12:28:23 PM	1.061	1.00	1.06
SS-RA-08066-000-011923-B	1/20/2023 2:04:39 PM	1.115	1.87	0.60
SB-RA-08206-002-030723-W	3/8/2023 2:50:22 PM	1.177	1.37	0.86
SS-RA-08205-000-030723-W	3/8/2023 2:37:54 PM	1.192	0.98	1.22
SS-RA-08936-000-012023-B	1/23/2023 3:24:41 PM	1.199	1.03	1.16
SS-RA-08187-000-013123-B	2/1/2023 3:52:49 PM	1.233	1.86	0.66
SS-RA-08198-000-021623-W	2/17/2023 3:31:52 PM	1.258	1.66	0.76
SS-RA-08900-000-021623-W	2/17/2023 3:39:08 PM	1.274	1.21	1.05
SS-RA-08036-000-012023-B	1/23/2023 2:50:31 PM	1.290	1.04	1.24
SS-RA-08048-000-120922-B	12/14/2022 3:01:27 PM	1.375	0.91	1.51
SB-RA-08209-001-031723-W	3/20/2023 1:47:55 PM	1.479	0.89	1.66
SB-RA-08210-001-031723-W	3/20/2023 2:04:17 PM	1.537	0.92	1.68
SS-RA-08206-000-030723-W	3/8/2023 2:40:23 PM	1.578	3.24	0.49
SS-RA-08207-000-031323-W	3/14/2023 2:19:29 PM	1.614	1.28	1.26
SS-RA-08220-000-041123-B	4/12/2023 3:09:28 PM	1.629	1.66	0.98
SB-RA-08208-002-031323-W	3/14/2023 2:34:20 PM	1.632	1.11	1.47
SB-RA-08210-002-031723-W	3/20/2023 2:06:48 PM	1.636	1.07	1.53
SS-RA-08182-000-012623-W	1/27/2023 3:01:06 PM	1.644	1.81	0.91
SS-RA-08011-000-012423-B	1/25/2023 2:11:49 PM	1.679	1.72	0.98
SB-RA-08229-002-042623-W	4/27/2023 1:59:11 PM	1.717	1.37	1.25
SS-RA-08012-000-011823-W	1/20/2023 9:40:32 AM	1.744	1.43	1.22
SB-RA-08208-003-031323-W	3/14/2023 2:36:48 PM	1.750	1.35	1.30
SS-RA-08227-000-041423-W	4/19/2023 5:33:45 PM	1.768	1.15	1.54
SS-RA-08195-000-020923-B	2/10/2023 3:16:20 PM	1.778	2.09	0.85
SB-RA-08226-001-041423-W	4/19/2023 6:21:51 PM	1.835	1.18	1.56
SB-RA-08207-001-031323-W	3/14/2023 2:21:59 PM	1.842	1.29	1.43
SB-RA-08207-002-031323-W	3/14/2023 2:24:26 PM	1.846	1.40	1.32
SB-RA-08198-001-021623-W	2/17/2023 3:29:26 PM	1.861	2.33	0.80
SS-RA-08214-000-041423-B	4/19/2023 5:54:44 PM	1.876	0.91	2.06
SB-RA-08008-001-112122-W	12/2/2022 11:46:08 AM	1.886	1.24	1.52
SB-RA-08218-002-040523-W	4/7/2023 9:17:22 AM	1.890	1.63	1.16
SS-RA-08054-000-121422-W	12/27/2022 3:27:28 PM	1.907	0.98	1.96
SB-RA-08227-001-041423-W	4/19/2023 6:19:17 PM	1.936	1.78	1.09
SS-RA-08914-000-041423-B	4/19/2023 6:02:04 PM	1.948	1.02	1.91
SB-RA-08009-001-112122-W	12/2/2022 11:54:10 AM	1.960	1.82	1.08

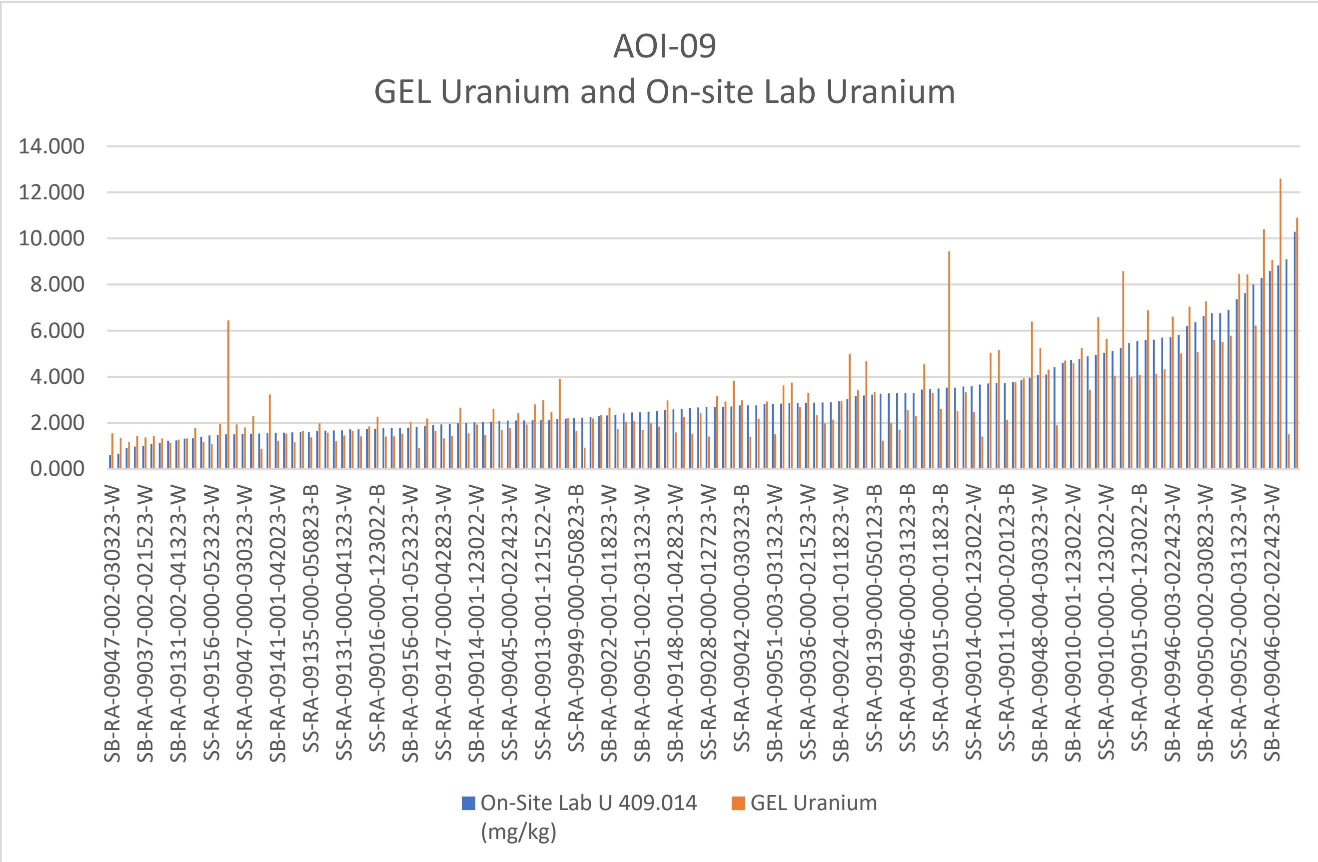
Sample Id	Acquisition Time	On-Site Lab U 409.014 (mg/kg)	GEL Uranium	On-site / GEL
SB-RA-08204-002-030223-W	3/6/2023 3:40:34 PM	0.734	0.83	0.89
SB-RA-08068-001-121922-W	12/28/2022 3:08:30 PM	1.975	1.97	1.00
SS-RA-08210-000-031723-W	3/20/2023 2:01:48 PM	2.014	1.13	1.78
SB-RA-08049-001-121322-W	12/14/2022 3:43:00 PM	2.039	1.63	1.25
SB-RA-08007-002-112122-W	12/2/2022 11:48:50 AM	2.040	1.27	1.61
SS-RA-08067-000-011923-W	1/20/2023 2:07:07 PM	2.046	1.57	1.30
SB-RA-08199-001-021623-W	2/17/2023 3:26:53 PM	2.048	2.59	0.79
SB-RA-08226-003-041423-W	4/19/2023 6:43:59 PM	2.058	1.04	1.98
SB-RA-08208-001-031323-W	3/14/2023 2:31:51 PM	2.066	1.30	1.59
SS-RA-08226-000-041423-W	4/19/2023 5:44:54 PM	2.105	1.30	1.62
SS-RA-08061-000-121322-B	12/14/2022 3:56:30 PM	2.127	1.80	1.18
SB-RA-08229-001-042623-W	4/27/2023 1:50:30 PM	2.135	1.67	1.28
SB-RA-08053-001-121322-W	12/14/2022 4:07:20 PM	2.147	1.37	1.57
SB-RA-08228-002-041423-W	4/19/2023 6:29:14 PM	2.176	1.89	1.15
SS-RA-08010-000-012423-B	1/25/2023 2:00:32 PM	2.182	1.67	1.31
SB-RA-08006-000-112122-B	12/2/2022 11:43:25 AM	2.184	1.50	1.46
SB-RA-08226-002-041423-W	4/19/2023 6:34:08 PM	2.207	0.97	2.27
SB-RA-08900-002-112122-W	12/2/2022 8:26:00 AM	2.211	1.98	1.12
SB-RA-08207-003-031323-W	3/14/2023 2:26:54 PM	2.212	1.84	1.20
SS-RA-08059-000-010923-B	1/10/2023 2:04:26 PM	2.214	1.40	1.58
SS-RA-08032-000-012623-B	1/27/2023 2:58:33 PM	2.254	2.34	0.96
SS-RA-08181-000-012623-W	1/27/2023 3:16:00 PM	2.255	1.72	1.31
SB-RA-08181-001-012623-W	1/27/2023 3:32:08 PM	2.256	2.16	1.04
SS-RA-08193-000-020923-W	2/10/2023 3:11:22 PM	2.268	2.02	1.12
SB-RA-08009-002-112122-W	12/2/2022 11:35:27 AM	2.295	2.15	1.07
SS-RA-08002-000-112122-B	12/2/2022 11:32:43 AM	2.298	1.46	1.57
SB-RA-08228-001-041423-W	4/19/2023 6:46:24 PM	2.299	1.84	1.25
SS-RA-08051-000-121422-W	12/27/2022 3:55:24 PM	2.329	1.33	1.75
SS-RA-08229-000-042623-W	4/27/2023 1:48:06 PM	2.336	2.34	1.00
SB-RA-08008-002-112122-W	12/2/2022 11:51:30 AM	2.364	1.21	1.95
SS-RA-08028-000-011923-B	1/20/2023 1:53:34 PM	2.383	1.29	1.85
SB-RA-08227-003-041423-W	4/19/2023 6:14:23 PM	2.412	1.51	1.60
SS-RA-08041-000-012023-B	1/23/2023 2:52:59 PM	2.413	2.28	1.06
SS-RA-08016-000-112222-B	12/2/2022 7:38:34 AM	2.443	2.51	0.97
SS-RA-08007-000-112122-W	12/2/2022 12:13:56 PM	2.458	1.91	1.29
SS-RA-08053-000-121322-W	12/14/2022 3:51:07 PM	2.469	1.94	1.27
SS-RA-08014-000-011823-W	1/20/2023 9:43:02 AM	2.469	2.51	0.98
SS-RA-08009-000-112122-W	12/2/2022 8:28:39 AM	2.497	2.00	1.25
SS-RA-08004-000-112122-B	12/2/2022 11:40:44 AM	2.504	1.73	1.45
SS-RA-08008-000-112122-W	12/2/2022 12:11:09 PM	2.505	1.79	1.40
SS-RA-08208-000-031323-W	3/14/2023 2:29:24 PM	2.518	2.07	1.22
SS-RA-08954-000-040523-B	4/7/2023 9:32:09 AM	2.527	3.26	0.78
SS-RA-08010-000-011823-W	1/20/2023 9:45:31 AM	2.528	2.83	0.89
SB-RA-08219-001-041123-W	4/12/2023 3:06:58 PM	2.550	2.53	1.01
SB-RA-08229-004-042623-W	4/27/2023 2:04:02 PM	2.609	2.25	1.16
SB-RA-08225-003-041423-W	4/19/2023 5:49:48 PM	2.616	1.22	2.14
SS-RA-08058-000-010923-B	1/10/2023 2:01:59 PM	2.616	2.50	1.05
SB-RA-08194-001-020923-W	2/10/2023 3:01:38 PM	2.643	2.22	1.19

Sample Id	Acquisition Time	On-Site Lab U 409.014 (mg/kg)	GEL Uranium	On-site / GEL
SB-RA-08204-002-030223-W	3/6/2023 3:40:34 PM	0.734	0.83	0.89
SS-RA-08933-000-012623-B	1/27/2023 3:08:34 PM	2.652	1.79	1.48
SS-RA-08056-000-010923-W	1/10/2023 2:06:54 PM	2.659	2.19	1.21
SS-RA-08230-000-042623-B	4/27/2023 2:06:31 PM	2.713	1.70	1.60
SS-RA-08069-000-011923-W	1/20/2023 2:09:33 PM	2.713	1.78	1.52
SB-RA-08054-001-121422-W	12/27/2022 3:19:20 PM	2.724	3.75	0.73
SS-RA-08033-000-012623-B	1/27/2023 3:03:33 PM	2.759	1.77	1.56
SS-RA-08047-000-011923-B	1/20/2023 2:02:10 PM	2.761	2.44	1.13
SB-RA-08067-001-121922-W	12/28/2022 3:11:11 PM	2.763	2.28	1.21
SS-RA-08071-000-011923-B	1/20/2023 2:12:00 PM	2.778	1.93	1.44
SS-RA-08005-000-112122-B	12/2/2022 7:31:03 AM	2.784	1.73	1.61
SB-RA-08007-001-112122-W	12/1/2022 3:10:18 PM	2.816	1.93	1.46
SS-RA-08011-000-011823-W	1/20/2023 9:48:02 AM	2.821	2.35	1.20
SB-RA-08062-001-121422-W	12/27/2022 3:22:02 PM	2.838	2.31	1.23
SB-RA-08229-003-042623-W	4/27/2023 2:01:37 PM	2.844	1.96	1.45
SB-RA-08227-002-041423-W	4/19/2023 6:16:50 PM	2.877	2.47	1.16
SS-RA-08168-000-012623-B	1/27/2023 3:06:04 PM	2.890	2.43	1.19
SS-RA-08044-000-012023-B	1/23/2023 2:57:56 PM	2.959	2.15	1.38
SS-RA-08224-000-041423-B	4/19/2023 5:59:38 PM	2.987	2.38	1.26
SS-RA-08054-000-040523-B	4/7/2023 9:29:39 AM	3.003	2.75	1.09
SS-RA-08062-000-121422-W	12/27/2022 3:52:43 PM	3.019	1.91	1.58
SS-RA-08199-000-021623-W	2/17/2023 3:34:17 PM	3.047	2.97	1.03
SS-RA-08910-000-011823-W	1/20/2023 9:35:31 AM	3.068	2.65	1.16
SB-RA-08051-001-121422-W	12/27/2022 3:16:31 PM	3.092	1.81	1.71
SB-RA-08050-001-121322-W	12/14/2022 3:45:40 PM	3.186	1.81	1.76
SS-RA-08050-000-121322-W	12/27/2022 3:10:59 PM	3.192	3.78	0.84
SS-RA-08021-000-120822-B	12/14/2022 3:04:10 PM	3.268	3.56	0.92
SB-RA-08057-001-121422-W	12/27/2022 3:32:53 PM	3.423	2.25	1.52
SS-RA-08046-000-120922-B	12/14/2022 3:40:18 PM	3.430	2.73	1.26
SS-RA-08030-000-120822-W	12/14/2022 3:12:24 PM	3.431	2.34	1.47
SS-RA-08228-000-041423-W	4/19/2023 5:42:26 PM	3.452	2.28	1.51
SB-RA-08209-002-031723-W	3/20/2023 1:50:26 PM	3.603	2.28	1.58
SS-RA-08015-000-112222-B	12/2/2022 8:42:03 AM	3.710	3.50	1.06
SS-RA-08219-000-041123-W	4/12/2023 3:04:29 PM	3.714	3.54	1.05
SB-RA-08228-003-041423-W	4/19/2023 6:31:42 PM	3.736	1.68	2.22
SS-RA-08012-000-112222-B	12/2/2022 8:23:16 AM	3.776	2.92	1.29
SS-RA-08052-000-121422-W	12/27/2022 4:00:48 PM	3.816	4.28	0.89
SS-RA-08003-000-112122-B	12/2/2022 11:38:03 AM	3.933	1.88	2.09
SS-RA-08066-000-121922-B	12/28/2022 3:13:51 PM	4.009	4.29	0.93
SS-RA-08221-000-041123-B	4/12/2023 3:25:41 PM	4.463	3.52	1.27
SS-RA-08035-000-120822-W	12/14/2022 2:56:00 PM	4.527	4.32	1.05
SB-RA-08209-003-031723-W	3/20/2023 1:52:56 PM	4.555	4.78	0.95
SS-RA-08047-000-120922-B	12/14/2022 3:28:35 PM	4.626	3.96	1.17
SS-RA-08017-000-112222-B	12/2/2022 8:20:39 AM	4.632	4.80	0.96
SB-RA-08225-002-041423-W	4/19/2023 6:26:49 PM	4.660	3.93	1.19
SB-RA-08218-003-040523-W	4/7/2023 9:27:12 AM	5.168	4.56	1.13
SS-RA-08057-000-121422-W	12/27/2022 3:24:45 PM	5.172	3.02	1.71
SS-RA-08068-000-121922-W	12/28/2022 3:00:19 PM	5.211	4.92	1.06

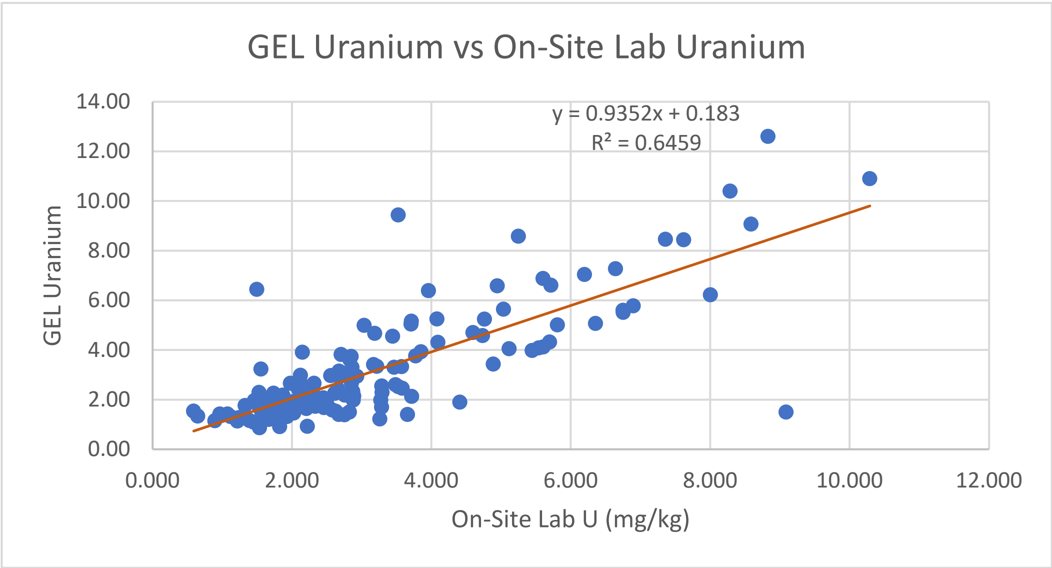
Ratios with on-site data between 2.7 and 8 mg/kg (average 1.28)

Sample Id	Acquisition Time	On-Site Lab U 409.014 (mg/kg)	GEL Uranium	On-site / GEL
SB-RA-08204-002-030223-W	3/6/2023 3:40:34 PM	0.734	0.83	0.89
SB-RA-08052-001-121422-W	12/27/2022 3:30:12 PM	5.590	3.49	1.60
SS-RA-08168-000-012023-B	1/23/2023 3:02:51 PM	5.647	5.77	0.98
SS-RA-08042-000-012023-B	1/23/2023 3:00:23 PM	5.713	5.24	1.09
SS-RA-08001-000-112122-W	12/2/2022 12:03:06 PM	6.041	5.33	1.13
SS-RA-08049-000-121322-W	12/14/2022 3:53:47 PM	6.145	3.48	1.77
SS-RA-08175-000-012023-W	1/23/2023 3:10:13 PM	6.206	7.17	0.87
SS-RA-08043-000-120922-B	12/14/2022 3:25:53 PM	6.266	5.17	1.21
SB-RA-08182-001-012623-W	1/27/2023 3:39:36 PM	6.469	5.84	1.11
SS-RA-08022-000-120822-B	12/14/2022 3:06:54 PM	6.522	6.28	1.04
SS-RA-08055-000-010923-W	1/10/2023 1:59:34 PM	6.987	7.48	0.93
SS-RA-08069-001-121922-W	12/28/2022 3:16:36 PM	7.560	6.53	1.16
SS-RA-08176-000-012023-W	1/23/2023 3:19:51 PM	8.174	8.22	0.99
SS-RA-08203-002-022723-W	3/1/2023 4:14:21 PM	8.221	2.09	3.93
SS-RA-08060-000-121322-B	12/14/2022 4:04:36 PM	8.354	4.98	1.68
SS-RA-08058-000-121322-B	12/14/2022 3:48:23 PM	8.791	7.70	1.14
SS-RA-08059-000-121322-B	12/14/2022 4:10:03 PM	8.793	5.44	1.62
SS-RA-08067-000-121922-W	12/28/2022 3:05:48 PM	8.999	6.05	1.49
SS-RA-08040-000-120922-B	12/14/2022 2:58:42 PM	9.068	6.57	1.38
SS-RA-08018-000-112222-B	12/2/2022 7:36:05 AM	9.554	10.30	0.93
SS-RA-08045-000-120922-B	12/14/2022 3:15:03 PM	9.656	9.16	1.05
SS-RA-08013-000-112222-B	12/2/2022 8:17:56 AM	10.393	11.70	0.89
SS-RA-08014-000-112222-B	12/2/2022 8:36:36 AM	10.909	13.20	0.83
SS-RA-08032-000-012023-B	1/23/2023 2:48:01 PM	10.928	11.20	0.98
SB-RA-08056-001-121422-W	12/27/2022 3:35:34 PM	10.953	20.70	0.53
SS-RA-08042-000-120922-B	12/14/2022 3:17:46 PM	11.858	13.20	0.90
SS-RA-08011-000-112222-B	12/2/2022 7:33:35 AM	11.880	12.70	0.94
SS-RA-08010-000-112222-B	12/2/2022 8:15:11 AM	11.909	12.00	0.99
SS-RA-08173-000-012023-W	1/23/2023 3:05:21 PM	13.261	8.18	1.62
SS-RA-08225-000-041423-W	4/19/2023 5:47:16 PM	13.472	22.80	0.59
SB-RA-08225-001-041423-W	4/19/2023 6:11:56 PM	13.736	13.80	1.00
SS-RA-08069-000-121922-W	12/28/2022 3:03:00 PM	14.282	8.06	1.77
SS-RA-08174-000-012023-W	1/23/2023 3:07:47 PM	15.287	10.80	1.42
SS-RA-08056-000-121422-W	12/27/2022 3:49:58 PM	15.676	13.60	1.15
SS-RA-08044-000-120922-B	12/14/2022 3:37:36 PM	16.890	18.90	0.89
SS-RA-08177-000-012023-W	1/23/2023 3:22:15 PM	21.976	23.40	0.94
SS-RA-08031-000-120822-W	12/14/2022 3:09:40 PM	22.140	23.80	0.93
SB-RA-08055-001-121422-W	12/27/2022 3:58:04 PM	23.200	16.50	1.41
SS-RA-08041-000-120922-B	12/14/2022 2:53:16 PM	28.331	26.70	1.06
SS-RA-08055-000-121422-W	12/27/2022 3:13:46 PM	32.798	22.90	1.43
SS-RA-08033-000-012023-B	1/23/2023 2:55:30 PM	46.383	38.30	1.21

AOI-09


AOI-09
GEL Uranium and On-site Lab Uranium
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
SB-RA-09047-002-030323-W
SB-RA-09037-002-021523-W
SB-RA-09131-002-041323-W
SS-RA-09156-000-052323-W
SS-RA-09047-000-030323-W
SB-RA-09141-001-042023-W
SS-RA-09135-000-050823-B
SS-RA-09131-000-041323-W
SS-RA-09016-000-123022-B
SB-RA-09156-001-052323-W
SS-RA-09147-000-042823-W
SB-RA-09014-001-123022-W
SS-RA-09045-000-022423-W
SS-RA-09013-001-121522-W
SS-RA-09949-000-050823-B
SB-RA-09022-001-011823-W
SB-RA-09051-002-031323-W
SB-RA-09148-001-042823-W
SS-RA-09028-000-012723-W
SS-RA-09042-000-030323-B
SB-RA-09051-003-031323-W
SS-RA-09036-000-021523-W
SB-RA-09024-001-011823-W
SS-RA-09139-000-050123-B
SS-RA-09946-000-031323-B
SS-RA-09015-000-011823-B
SS-RA-09014-000-123022-W
SS-RA-09011-000-020123-B
SB-RA-09048-004-030323-W
SB-RA-09010-001-123022-W
SS-RA-09010-000-123022-W
SS-RA-09015-000-123022-B
SB-RA-09946-003-022423-W
SB-RA-09050-002-030823-W
SS-RA-09052-000-031323-W
SB-RA-09046-002-022423-W
On-Site Lab U 409.014 (mg/kg)
GEL Uranium

Slope	Intercept	Correlation Coefficient	Pearson Coefficient (R square)
0.9352	0.1830	0.8037	0.6459



On-site and GEL Uranium Data for AOI 9

Sample Id	Acquisition Time	On-Site Lab U 409.014 (mg/kg)	GEL Uranium	On-site / GEL
SB-RA-09047-002-030323-W	3/6/2023 3:07:02 PM	0.591	1.54	0.38
SB-RA-09047-003-030323-W	3/6/2023 3:09:31 PM	0.651	1.34	0.49
SB-RA-09145-001-042123-W	4/25/2023 3:04:21 PM	0.896	1.15	0.78
SB-RA-09047-001-030323-W	3/6/2023 3:04:30 PM	0.965	1.42	0.68
SB-RA-09037-002-021523-W	2/16/2023 3:52:47 PM	0.992	1.36	0.73
SB-RA-09045-002-022423-W	3/1/2023 3:32:39 PM	1.076	1.42	0.76
SB-RA-09012-001-121522-W	12/29/2022 3:14:10 PM	1.121	1.32	0.85
SB-RA-09156-003-052323-W	5/24/2023 1:55:04 PM	1.220	1.14	1.07
SB-RA-09131-002-041323-W	4/21/2023 1:36:58 PM	1.238	1.27	0.97
SB-RA-09131-001-041323-W	4/21/2023 1:34:33 PM	1.313	1.32	0.99
SS-RA-09021-000-121622-B	12/29/2022 4:00:20 PM	1.329	1.76	0.76
SS-RA-09027-000-011823-B	1/20/2023 9:03:39 AM	1.394	1.16	1.20
SS-RA-09156-000-052323-W	5/24/2023 1:27:50 PM	1.454	1.09	1.33
SB-RA-09045-001-022423-W	3/1/2023 3:30:15 PM	1.462	1.96	0.75
SS-RA-09046-000-022423-W	3/1/2023 4:07:00 PM	1.498	6.44	0.23
SS-RA-09049-000-030823-B	3/9/2023 12:42:10 PM	1.499	1.93	0.78
SS-RA-09047-000-030323-W	3/6/2023 2:59:36 PM	1.511	1.80	0.84
SB-RA-09141-002-042023-W	4/24/2023 4:10:31 PM	1.529	2.29	0.67
SB-RA-09156-004-052323-W	5/24/2023 1:57:29 PM	1.537	0.868	1.77
SS-RA-09013-000-121522-W	12/29/2022 3:36:01 PM	1.556	3.23	0.48
SB-RA-09141-001-042023-W	4/24/2023 4:08:02 PM	1.562	1.22	1.28
SS-RA-09043-000-030323-B	3/6/2023 2:54:40 PM	1.566	1.53	1.02
SB-RA-09156-005-052323-W	5/24/2023 2:00:01 PM	1.582	1.15	1.38
SS-RA-09921-000-121622-B	12/29/2022 3:57:39 PM	1.599	1.65	0.97
SS-RA-09135-000-050823-B	5/9/2023 3:28:34 PM	1.601	1.37	1.17
SS-RA-09020-000-121522-B	12/29/2022 3:33:20 PM	1.648	1.97	0.84
SB-RA-09155-004-052323-W	5/24/2023 1:37:51 PM	1.657	1.57	1.06
SS-RA-09019-000-123022-B	1/3/2023 3:06:30 PM	1.668	1.20	1.39
SS-RA-09131-000-041323-W	4/21/2023 1:32:07 PM	1.671	1.45	1.15
SS-RA-09017-000-121522-B	12/28/2022 3:53:49 PM	1.715	1.64	1.05
SS-RA-09141-000-042023-W	4/24/2023 4:05:33 PM	1.716	1.41	1.22
SS-RA-09011-000-121522-W	12/29/2022 3:25:03 PM	1.721	1.84	0.94
SS-RA-09016-000-123022-B	1/3/2023 3:01:34 PM	1.737	2.26	0.77
SB-RA-09147-004-042823-W	5/1/2023 3:26:42 PM	1.780	1.40	1.27
SB-RA-09098-001-041223-W	4/19/2023 5:57:12 PM	1.783	1.41	1.26
SS-RA-099132-000-050123-B	5/2/2023 3:32:53 PM	1.786	1.53	1.17
SB-RA-09156-001-052323-W	5/24/2023 1:42:49 PM	1.788	2.03	0.88
SS-RA-09154-000-052323-B	5/24/2023 1:22:54 PM	1.824	0.913	2.00
SB-RA-09156-002-052323-W	5/24/2023 1:45:17 PM	1.870	2.18	0.86
SB-RA-09148-003-042823-W	5/1/2023 3:34:04 PM	1.904	1.64	1.16
SS-RA-09147-000-042823-W	5/1/2023 3:11:46 PM	1.930	1.32	1.46
SB-RA-09155-005-052323-W	5/24/2023 1:40:19 PM	1.956	1.43	1.37
SS-RA-09012-000-121522-W	12/29/2022 3:52:11 PM	1.979	2.66	0.74

On-site and GEL Uranium Data for AOI 9

Sample Id	Acquisition Time	On-Site Lab U 409.014 (mg/kg)	GEL Uranium	On-site / GEL
SB-RA-09147-002-042823-W	5/1/2023 3:21:46 PM	1.998	1.54	1.30
SB-RA-09014-001-123022-W	1/3/2023 2:56:38 PM	2.011	1.92	1.05
SS-RA-09149-000-050823-B	5/9/2023 3:30:58 PM	2.026	1.46	1.39
SB-RA-09048-003-030323-W	3/6/2023 3:30:37 PM	2.051	2.59	0.79
SB-RA-09131-003-041323-W	4/21/2023 1:39:30 PM	2.073	1.69	1.23
SS-RA-09045-000-022423-W	3/1/2023 4:04:33 PM	2.095	1.76	1.19
SS-RA-09051-000-031323-W	3/14/2023 2:51:39 PM	2.095	2.42	0.87
SB-RA-09044-002-022423-W	3/1/2023 3:27:50 PM	2.101	1.92	1.09
SS-RA-09042-000-022423-B	3/1/2023 3:47:21 PM	2.113	2.80	0.75
SS-RA-09013-001-121522-W	12/29/2022 3:54:56 PM	2.124	2.98	0.71
SS-RA-09132-000-050123-B	5/2/2023 3:25:33 PM	2.130	2.47	0.86
SS-RA-09046-000-031623-B	3/20/2023 2:14:17 PM	2.151	3.91	0.55
SS-RA-09022-000-011823-W	1/20/2023 9:01:09 AM	2.177	2.20	0.99
SS-RA-09949-000-050823-B	5/9/2023 3:33:23 PM	2.209	1.64	1.35
SB-RA-09147-003-042823-W	5/1/2023 3:24:16 PM	2.222	0.92	2.41
SS-RA-09922-000-011823-W	1/20/2023 9:10:59 AM	2.244	2.19	1.02
SS-RA-09044-003-022423-W	3/1/2023 4:02:06 PM	2.293	2.34	0.98
SB-RA-09022-001-011823-W	1/20/2023 9:18:25 AM	2.317	2.66	0.87
SB-RA-09044-001-022423-W	3/1/2023 3:25:24 PM	2.337	1.73	1.35
SB-RA-09051-001-031323-W	3/14/2023 2:54:10 PM	2.409	2.03	1.19
SS-RA-09148-000-042823-W	5/1/2023 3:14:17 PM	2.452	2.07	1.18
SB-RA-09051-002-031323-W	3/14/2023 2:56:41 PM	2.461	1.68	1.47
SB-RA-09155-003-052323-W	5/24/2023 1:35:19 PM	2.482	1.97	1.26
SB-RA-09148-004-042823-W	5/1/2023 3:43:50 PM	2.503	1.83	1.37
SS-RA-09032-000-022423-W	3/1/2023 3:44:54 PM	2.556	2.97	0.86
SB-RA-09148-001-042823-W	5/1/2023 3:29:11 PM	2.581	1.58	1.63
SB-RA-09155-001-052323-W	5/24/2023 1:30:18 PM	2.613	2.25	1.16
SB-RA-09148-002-042823-W	5/1/2023 3:31:37 PM	2.631	1.53	1.72
SB-RA-09026-001-011823-W	1/20/2023 9:30:33 AM	2.662	2.42	1.10
SS-RA-09028-000-012723-W	1/30/2023 3:40:16 PM	2.674	1.40	1.91
SS-RA-09019-000-121522-B	12/29/2022 3:30:35 PM	2.677	3.15	0.85
SS-RA-09026-000-011823-W	1/20/2023 9:06:05 AM	2.684	2.92	0.92
SS-RA-09048-000-030323-W	3/6/2023 2:57:07 PM	2.707	3.82	0.71
SS-RA-09042-000-030323-B	3/6/2023 2:52:10 PM	2.754	2.98	0.92
SB-RA-09147-001-042823-W	5/1/2023 3:19:19 PM	2.754	1.39	1.98
SS-RA-09015-000-012723-B	1/30/2023 3:37:45 PM	2.759	2.18	1.27
SS-RA-09942-000-030323-B	3/6/2023 3:02:01 PM	2.804	2.92	0.96
SB-RA-09051-003-031323-W	3/14/2023 2:59:10 PM	2.826	1.50	1.88
SB-RA-09037-001-021523-W	2/16/2023 3:50:22 PM	2.829	3.62	0.78
SS-RA-09043-000-022423-B	3/1/2023 3:49:51 PM	2.850	3.74	0.76
SS-RA-09098-000-041223-W	4/19/2023 5:52:17 PM	2.855	2.68	1.07
SS-RA-09036-000-021523-W	2/16/2023 3:40:29 PM	2.861	3.30	0.87
SS-RA-09034-000-020923-W	2/10/2023 3:30:45 PM	2.873	2.33	1.23

Ratios with on-site data between 2.7 and 8 mg/kg (average 1.17)

On-site and GEL Uranium Data for AOI 9

Sample Id	Acquisition Time	On-Site Lab U 409.014 (mg/kg)	GEL Uranium	On-site / GEL
SB-RA-09155-002-052323-W	5/24/2023 1:32:49 PM	2.881	1.98	1.46
SS-RA-09046-000-031323-B	3/14/2023 2:39:17 PM	2.887	2.14	1.35
SB-RA-09024-001-011823-W	1/20/2023 9:33:02 AM	2.931	2.94	1.00
SB-RA-09011-001-121522-W	12/29/2022 3:22:17 PM	3.038	4.99	0.61
SS-RA-09015-000-121522-B	12/29/2022 3:16:53 PM	3.172	3.41	0.93
SS-RA-09018-000-121522-B	12/29/2022 3:49:27 PM	3.188	4.67	0.68
SS-RA-09139-000-050123-B	5/2/2023 3:30:26 PM	3.219	3.34	0.96
SB-RA-09031-001-020123-W	2/2/2023 2:20:34 PM	3.261	1.22	2.67
SS-RA-09018-000-123022-B	1/3/2023 3:30:59 PM	3.275	1.98	1.65
SB-RA-09028-001-012723-W	1/30/2023 3:47:42 PM	3.286	1.70	1.93
SS-RA-09946-000-031323-B	3/14/2023 2:41:48 PM	3.289	2.55	1.29
SS-RA-09044-000-022423-W	3/1/2023 3:52:22 PM	3.293	2.29	1.44
SS-RA-09014-000-121522-W	12/29/2022 3:43:59 PM	3.445	4.55	0.76
SS-RA-09024-000-011823-W	1/20/2023 9:20:54 AM	3.467	3.30	1.05
SS-RA-09015-000-011823-B	1/20/2023 8:58:41 AM	3.488	2.60	1.34
SS-RA-09016-000-121522-B	12/29/2022 3:46:46 PM	3.526	9.44	0.37
SS-RA-09013-000-123022-W	1/3/2023 3:13:52 PM	3.528	2.52	1.40
SB-RA-09025-001-011823-W	1/20/2023 9:38:02 AM	3.573	3.33	1.07
SS-RA-09014-000-123022-W	1/3/2023 3:28:29 PM	3.583	2.46	1.46
SS-RA-09145-000-042123-W	4/25/2023 3:01:55 PM	3.659	1.40	2.61
SB-RA-09014-001-121522-W	12/29/2022 3:27:49 PM	3.709	5.04	0.74
SB-RA-09048-001-030323-W	3/6/2023 3:18:19 PM	3.714	5.16	0.72
SS-RA-09011-000-020123-B	2/2/2023 2:13:16 PM	3.718	2.13	1.75
SS-RA-09001-000-123022-W	1/3/2023 3:23:35 PM	3.776	3.76	1.00
SS-RA-09025-000-011823-W	1/20/2023 9:13:30 AM	3.851	3.93	0.98
SB-RA-09048-002-030323-W	3/6/2023 3:20:51 PM	3.959	6.39	0.62
SB-RA-09048-004-030323-W	3/6/2023 3:33:06 PM	4.082	5.25	0.78
SS-RA-09023-000-011823-W	1/20/2023 9:08:31 AM	4.094	4.31	0.95
SS-RA-09155-000-052323-W	5/24/2023 1:25:22 PM	4.409	1.9	2.32
SB-RA-09001-001-123022-W	1/3/2023 2:59:07 PM	4.598	4.70	0.98
SB-RA-09010-001-123022-W	1/3/2023 3:26:03 PM	4.735	4.58	1.03
SB-RA-09052-001-031323-W	3/14/2023 3:04:08 PM	4.763	5.24	0.91
SS-RA-09031-000-020123-W	2/2/2023 2:15:43 PM	4.889	3.43	1.43
SB-RA-09053-002-031623-W	3/20/2023 2:09:20 PM	4.946	6.58	0.75
SS-RA-09010-000-123022-W	1/3/2023 3:08:58 PM	5.037	5.64	0.89
SS-RA-09032-000-020123-W	2/2/2023 2:18:07 PM	5.116	4.05	1.26
SS-RA-09050-000-030823-W	3/9/2023 12:44:44 PM	5.250	8.58	0.61
SS-RA-09012-000-123022-W	1/3/2023 3:48:26 PM	5.447	3.98	1.37
SS-RA-09015-000-123022-B	1/3/2023 3:04:02 PM	5.540	4.08	1.36
SB-RA-09046-003-022423-W	3/1/2023 3:40:00 PM	5.602	6.88	0.81
SB-RA-09036-002-021523-W	2/16/2023 3:47:53 PM	5.606	4.12	1.36
SB-RA-09032-001-020123-W	2/2/2023 2:22:59 PM	5.698	4.32	1.32
SB-RA-09946-003-022423-W	3/1/2023 3:42:27 PM	5.717	6.61	0.86

On-site and GEL Uranium Data for AOI 9

Sample Id	Acquisition Time	On-Site Lab U 409.014 (mg/kg)	GEL Uranium	On-site / GEL
SB-RA-09023-001-011823-W	1/20/2023 9:16:00 AM	5.809	5.01	1.16
SB-RA-09046-001-022423-W	3/1/2023 3:35:05 PM	6.197	7.04	0.88
SB-RA-09011-001-123022-W	1/3/2023 3:35:47 PM	6.357	5.07	1.25
SB-RA-09050-002-030823-W	3/9/2023 12:33:17 PM	6.643	7.27	0.91
SS-RA-09033-000-020923-W	2/10/2023 3:21:11 PM	6.751	5.60	1.21
SB-RA-09012-001-123022-W	1/3/2023 3:33:25 PM	6.753	5.51	1.23
SS-RA-09011-000-123022-W	1/3/2023 2:54:12 PM	6.897	5.78	1.19
SS-RA-09052-000-031323-W	3/14/2023 3:01:39 PM	7.359	8.46	0.87
SB-RA-09036-001-021523-W	2/16/2023 3:45:27 PM	7.621	8.44	0.90
SB-RA-09013-001-123022-W	1/3/2023 3:11:27 PM	8.003	6.22	1.29
SB-RA-09050-001-030823-W	3/9/2023 12:30:49 PM	8.287	10.40	0.80
SB-RA-09046-002-022423-W	3/1/2023 3:37:32 PM	8.587	9.07	0.95
SB-RA-09034-001-020923-W	2/10/2023 3:06:33 PM	8.831	12.60	0.70
SB-RA-09053-003-031623-W	3/20/2023 2:11:49 PM	9.089	1.50	6.06
SB-RA-09052-002-031323-W	3/14/2023 3:06:38 PM	10.290	10.90	0.94

ATTACHMENT C-3
Supporting Information for Courtyard **RALs**

Courtyard Area - Soil Remaining with RALs for bottom verifiation samples

subfacility_code	sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type	Uranium_RAL_3.5	D_Uranium_RAL_3.5
AOI 11	MW-S07	SBMWS07001-11/4/2004	11/04/2004	1	3	N	3.8	1
AOI 11	MW-S07	SBMWS07008-11/4/2004	11/04/2004	8	10	N	1.4	1
AOI 11	MW-S16	SBMWS16001-11/22/2004	11/22/2004	1	3	N	6.5	1
AOI 11	MW-S16	SBMWS16008-11/22/2004	11/22/2004	8	10	N	2.2	1
AOI 11	SB-RI-11001	SBRI11001000-11/10/2004	11/10/2004	0	4	N	1.6	1
AOI 11	SB-RI-11001	SBRI11001004-11/10/2004	11/10/2004	4	8	N	1.2	1
AOI 11	SB-RI-11002	SBRI11002001-11/5/2004	11/05/2004	1	5	N	9.4	1
AOI 11	SB-RI-11002	SBRI11002004-11/5/2004	11/05/2004	4	8	N	5.8	1
AOI 11	SB-RI-11009	SBRI11009000-11/10/2004	11/10/2004	0	4	N	1.7	1
AOI 11	SB-RI-11009	SBRI11009004-11/10/2004	11/10/2004	4	8	N	1.2	1
AOI 11	SB-RI-11010	SBRI11010000-11/10/2004	11/10/2004	0	4	N	2.6	1
AOI 11	SB-RI-11010	SBRI11010004-11/10/2004	11/10/2004	4	8	N	1.7	1
AOI 11	SB-RI-11011	SBRI11011000-11/9/2004	11/09/2004	0	4	N	3.4	1
AOI 11	SB-RI-11011	SBRI11011004-11/9/2004	11/09/2004	4	8	N	1.9	1
AOI 11	SB-RI-11013	SBRI11013000-11/10/2004	11/10/2004	0	4	N	1.4	1
AOI 11	SB-RI-11014	SBRI11014000-11/10/2004	11/10/2004	0	4	N	3.3	1
AOI 11	SB-RI-11015	SBRI11015000-11/10/2004	11/10/2004	0	4	N	3.9	1
AOI 11	SB-RI-11017	SBRI11017002-10/28/2005	10/28/2005	2	4	N	7.9	1
AOI 11	SB-RI-11017	SBRI11017008-10/28/2005	10/28/2005	8	10	N	0.9	1
AOI 11	SB-RI-11018	SBRI11018008-10/27/2005	10/27/2005	8	10	N	1.2	1
AOI 11	SB-RI-11019	SBRI11019008-10/27/2005	10/27/2005	8	10	N	1.6	1
AOI 11	SB-RI-11021	SBRI11021002-10/26/2005	10/26/2005	2	4	N	1.9	1
AOI 11	SB-RI-11023	SBRI11023002-10/28/2005	10/28/2005	2	4	N	1.1	1
AOI 11	SB-RI-11023	SBRI11023008-10/28/2005	10/28/2005	8	10	N	2.5	1
AOI 11	SB-RI-11024	SBRI11024008-10/28/2005	10/28/2005	8	10	N	1.5	1
AOI 11	SB-RI-11025	SBRI11025002-10/27/2005	10/27/2005	2	4	N	1.5	1
AOI 11	SB-RI-11025	SBRI11025008-10/27/2005	10/27/2005	8	10	N	1.5	1
AOI 11	SB-RI-11027	SBRI11027008-7/31/2007	07/31/2007	8	10	N	1.3	1
AOI 11	SB-RI-11029	SBRI11029000-8/1/2007	08/01/2007	0	2	N	2.4	1
AOI 11	SB-RI-11029	SBRI11029008-8/1/2007	08/01/2007	8	10	N	3.8	1
AOI 15	SB-PD-15002	SB-PD-15002-002-120720	12/07/2020	2	4	N	1.61	1
AOI 15	SB-PD-15004	SB-PD-15004-006-120720	12/07/2020	6	8	N	1.57	1

Courtyard Area - Soil Remaining with RALs for bottom verifiation samples

subfacility_code	sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type	Uranium_RAL_3.5	D_Uranium_RAL_3.5
AOI 15	SB-PD-15005	SB-PD-15005-002-120720-DUP	12/07/2020	2	4	FD	1.85	1
AOI 15	SB-PD-15008	SB-PD-15008-002-040221	04/02/2021	2	4	N	2.64	1
AOI 15	SB-PD-15010	SB-PD-15010-004-040221	04/02/2021	4	6	N	1.76	1
AOI 15	SS-RI-15019	SSRI15019002-11/17/2004	11/17/2004	2	3	N		
AOI 15	SS-RI-15021	SSRI15021002-11/17/2004	11/17/2004	2	3	N		
AOI 15	SS-RI-15022	SSRI15022002-11/17/2004	11/17/2004	2	3	N		
AOI 01	SB-RI-01020	SBRI01020008-11/17/2004	11/17/2004	8	12	N	1.7	1
AOI 11	SB-RI-11012	SBRI11012008-11/5/2004	11/05/2004	8	12	N	1.4	1
Bottom Sample1	Bottom Sample1						3.5	1
Bottom Sample2	Bottom Sample2						3.5	1
Bottom Sample3	Bottom Sample3						3.5	1
Bottom Sample4	Bottom Sample4						3.5	1
Bottom Sample5	Bottom Sample5						3.5	1
Bottom Sample6	Bottom Sample6						3.5	1
Bottom Sample7	Bottom Sample7						3.5	1
Bottom Sample8	Bottom Sample8						3.5	1
Bottom Sample9	Bottom Sample9						3.5	1
Bottom Sample10	Bottom Sample10						3.5	1
Bottom Sample11	Bottom Sample11						3.5	1
Bottom Sample12	Bottom Sample12						3.5	1
Bottom Sample13	Bottom Sample13						3.5	1
Bottom Sample14	Bottom Sample14						3.5	1
Bottom Sample15	Bottom Sample15						3.5	1
Bottom Sample16	Bottom Sample16						3.5	1
Bottom Sample17	Bottom Sample17						3.5	1
Bottom Sample18	Bottom Sample18						3.5	1
Bottom Sample19	Bottom Sample19						3.5	1
Bottom Sample20	Bottom Sample20						3.5	1
Bottom Sample21	Bottom Sample21						3.5	1
Bottom Sample22	Bottom Sample22						3.5	1
Bottom Sample23	Bottom Sample23						3.5	1
Bottom Sample24	Bottom Sample24						3.5	1

Courtyard Area - Soil Remaining with RALs for bottom verifiation samples

subfacility_code	sys_loc_code	sys_sample_code	sample_date	start_depth	end_depth	sample_type	Uranium_RAL_3.5	D_Uranium_RAL_3.5
Bottom Sample25	Bottom Sample25						3.5	1
Bottom Sample26	Bottom Sample26						3.5	1
Bottom Sample27	Bottom Sample27						3.5	1
Bottom Sample28	Bottom Sample28						3.5	1
Bottom Sample29	Bottom Sample29						3.5	1
Bottom Sample30	Bottom Sample30						3.5	1
Bottom Sample31	Bottom Sample31						3.5	1
Bottom Sample32	Bottom Sample32						3.5	1
Bottom Sample33	Bottom Sample33						3.5	1
Bottom Sample34	Bottom Sample34						3.5	1
Bottom Sample35	Bottom Sample35						3.5	1
Bottom Sample36	Bottom Sample36						3.5	1
Bottom Sample37	Bottom Sample37						3.5	1
Bottom Sample38	Bottom Sample38						3.5	1
Bottom Sample39	Bottom Sample39						3.5	1
Bottom Sample40	Bottom Sample40						3.5	1
Bottom Sample41	Bottom Sample41						3.5	1
Bottom Sample42	Bottom Sample42						3.5	1
Bottom Sample43	Bottom Sample43						3.5	1
Bottom Sample44	Bottom Sample44						3.5	1
Bottom Sample45	Bottom Sample45						3.5	1
Bottom Sample46	Bottom Sample46						3.5	1
Bottom Sample47	Bottom Sample47						3.5	1
Bottom Sample48	Bottom Sample48						3.5	1
Bottom Sample49	Bottom Sample49						3.5	1
Bottom Sample50	Bottom Sample50						3.5	1

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.2 7/28/2023 10:51:30 AM
From File	ProUCLInput.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Uranium_RAL_3.5

General Statistics

Total Number of Observations	87	Number of Distinct Observations	27
		Number of Missing Observations	3
Minimum	0.9	Mean	3.099
Maximum	9.4	Median	3.5
SD	1.338	Std. Error of Mean	0.143
Coefficient of Variation	0.432	Skewness	1.597

Normal GOF Test

Shapiro Wilk Test Statistic	0.746	**Shapiro Wilk GOF Test**
1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.302	**Lilliefors GOF Test**
1% Lilliefors Critical Value	0.11	Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.338	95% Adjusted-CLT UCL (Chen-1995)	3.361
		95% Modified-t UCL (Johnson-1978)	3.342

Gamma GOF Test

A-D Test Statistic	8.717	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.323	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0961	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.647	k star (bias corrected MLE)	5.46
Theta hat (MLE)	0.549	Theta star (bias corrected MLE)	0.568
nu hat (MLE)	982.5	nu star (bias corrected)	950
MLE Mean (bias corrected)	3.099	MLE Sd (bias corrected)	1.326
		Approximate Chi Square Value (0.05)	879.4
Adjusted Level of Significance	0.0472	Adjusted Chi Square Value	878.3

Assuming Gamma Distribution

95% Approximate Gamma UCL	3.348	95% Adjusted Gamma UCL	3.352

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.809	**Shapiro Wilk Lognormal GOF Test**
10% Shapiro Wilk P Value	2.220E-16	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.339	**Lilliefors Lognormal GOF Test**
10% Lilliefors Critical Value	0.0871	Data Not Lognormal at 10% Significance Level

Data Not Lognormal at 10% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.105	Mean of logged Data	1.04
Maximum of Logged Data	2.241	SD of logged Data	0.444

Assuming Lognormal Distribution

95% H-UCL	3.405	90% Chebyshev (MVUE) UCL	3.583
95% Chebyshev (MVUE) UCL	3.793	97.5% Chebyshev (MVUE) UCL	4.085
99% Chebyshev (MVUE) UCL	4.659		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution

Nonparametric Distribution Free UCLs

95% CLT UCL	3.335	95% BCA Bootstrap UCL	3.361
95% Standard Bootstrap UCL	3.338	95% Bootstrap-t UCL	3.374
95% Hall's Bootstrap UCL	3.411	95% Percentile Bootstrap UCL	3.338
90% Chebyshev(Mean, Sd) UCL	3.529	95% Chebyshev(Mean, Sd) UCL	3.724
97.5% Chebyshev(Mean, Sd) UCL	3.995	99% Chebyshev(Mean, Sd) UCL	4.526

Suggested UCL to Use

95% Student's-t UCL	3.338

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL
Recommendations are based upon data size, data distribution, and skewness using results from simulation studies
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician

ATTACHMENT C-4
Supporting Information for Landfill RALs

Landifll Area - Soil Remaining with RALs for bottom verifiation samples

Iter#	Location Name	Sample Name	Sample Date	Sample Depth (bgs)	Uranium	D_Uranium
Iter29_2	SB-PD-03003	SB-PD-03003-006-111920	11/19/2020	6 - 8 (ft)	0.95	1
Iter29_2	SB-PD-03003	SB-PD-03003-008-111920	11/19/2020	8 - 10 (ft)	1.98	1
Iter29_2	SB-PD-03004	SB-PD-03004-006-111920	11/19/2020	6 - 8 (ft)	1.3	1
Iter29_2	SB-PD-03004	SB-PD-03004-008-111920	11/19/2020	8 - 10 (ft)	1.5	1
Iter29_2	SB-PD-03005	SB-PD-03005-006-111920	11/19/2020	6 - 8 (ft)	1.02	1
Iter29_2	SB-PD-03005	SB-PD-03005-008-111920	11/19/2020	8 - 10 (ft)	1.4	1
Iter29_2	SB-PD-03006	SB-PD-03006-008-111920	11/19/2020	8 - 10 (ft)	1.27	1
Iter29_2	SB-PD-03008	SB-PD-03008-006-112020	11/20/2020	6 - 8 (ft)	1.33	1
Iter29_2	SB-PD-03008	SB-PD-03008-006-112020-D	11/20/2020	6 - 8 (ft)	1.07	1
Iter29_2	SB-PD-03008	SB-PD-03008-008-112020	11/20/2020	8 - 10 (ft)	1.49	1
Iter29_2	SB-PD-03010	SB-PD-03010-006-112020	11/20/2020	6 - 8 (ft)	0.868	1
Iter29_2	SB-PD-03010	SB-PD-03010-008-112020	11/20/2020	8 - 10 (ft)	0.799	1
Iter29_2	SB-RI-03003	SBRI03003006-5/4/2005	05/04/2005	6 - 8 (ft)	1.5	1
Iter29_2	SB-RI-03004	SBRI03004004-5/4/2005	05/04/2005	4 - 6 (ft)	2	1
Iter29_2	SB-RI-03005	SBRI03005008-5/4/2005	05/04/2005	8 - 10 (ft)	1.8	1
Iter29_2	SB-RI-03006	SBRI03006008-5/3/2005	05/03/2005	8 - 10 (ft)	1	1
Iter29_2	SB-RI-03007	SBRI03007008-5/3/2005	05/03/2005	8 - 10 (ft)	1.8	1
Iter29_2	SB-RI-03008	SBRI03008004-5/3/2005	05/03/2005	4 - 6 (ft)	1.4	1
Iter29_2	SB-RI-03008	SBRI03008008-5/3/2005	05/03/2005	8 - 10 (ft)	1.7	1
Iter29_2	SB-RI-03009	SBRI03009004-5/2/2005	05/02/2005	4 - 6 (ft)	2.4	1
Iter29_2	SB-RI-03010	SBRI03010008R-11/2/2005	11/02/2005	8 - 12 (ft)	0.78	1
Iter29_2	SB-RI-03012	SBRI03012004-5/2/2005	05/02/2005	4 - 6 (ft)	1.2	1
Iter29_2	SB-RI-03014	SBRI03014004-5/3/2005	05/03/2005	4 - 6 (ft)	2	1
Iter29_2	SB-RI-03015	SBRI03015004-5/3/2005	05/03/2005	4 - 6 (ft)	1.5	1
Iter29_2	SB-RI-03016	SBRI03016004-5/3/2005	05/03/2005	4 - 6 (ft)	1.7	1
Iter29_2	SB-RI-03017	SBRI03017000-10/21/2005	10/21/2005	0.5 - 2 (ft)	2.2	1
Iter29_2	SB-RI-03017	SBRI03017008-10/21/2005	10/21/2005	8 - 10 (ft)	2	1
Iter29_2	SB-RI-03018	SBRI03018008-10/21/2005	10/21/2005	8 - 9 (ft)	1.1	1
Iter29_2	SB-RI-03020	SBRI03020008-11/2/2005	11/02/2005	8 - 12 (ft)	1.6	1
Iter29_2	SB-RI-03021	SBRI03021008-11/2/2005	11/02/2005	8 - 12 (ft)	1.2	1
Iter29_2	SB-RI-03022	SBRI03022008-11/2/2005	11/02/2005	8 - 12 (ft)	1.1	1
Iter29_2	SB-RI-03023	SBRI03023008-11/3/2005	11/03/2005	8 - 12 (ft)	0.74	1
Iter29_2	SB-RI-03024	SBRI03024008-11/3/2005	11/03/2005	8 - 12 (ft)	1.3	1
Iter29_2	TP-RI-03011	TPRI03011004-12/2/2004	12/02/2004	4 - 5 (ft)	2.6	1
Iter29_2	TP-RI-03012	TPRI03012004-12/2/2004	12/02/2004	4 - 5 (ft)	1.5	1
Iter29_2	TP-RI-03014	TPRI03014004-12/2/2004	12/02/2004	4 - 5 (ft)	2.5	1
Iter29_2	TP-RI-03015	TPRI03015004-12/1/2004	12/01/2004	4 - 5 (ft)	1.6	1
Iter29_2	TP-RI-03016	TPRI03016004-12/2/2004	12/02/2004	4 - 5 (ft)	2.1	1
Iter29_2	TP-RI-03017	TPRI03017004-12/1/2004	12/01/2004	4 - 5 (ft)	2	1
Iter29_2	TP-RI-03018	TPRI03018004-12/1/2004	12/01/2004	4 - 5 (ft)	1.6	1
Iter29_2	TP-RI-03019	TPRI03019000-12/1/2004	12/01/2004	0 - 1 (ft)	2.6	1
Iter29_2	TP-RI-03019	TPRI03019004-12/1/2004	12/01/2004	4 - 5 (ft)	1.9	1
Iter29_2	TP-RI-03020	TPRI03020000-12/1/2004	12/01/2004	0 - 1 (ft)	1.5	1
Iter29_2	TP-RI-03020	TPRI03020004-12/1/2004	12/01/2004	4 - 5 (ft)	1	1
Iter29_2	SB-RI-01012	SBRI01012001-10/25/2004	10/25/2004	1 - 1.5 (ft)	1.3	1
Iter29_2	SB-RI-01012	SBRI01012008-10/25/2004	10/25/2004	8 - 10 (ft)	1.3	1
Iter29_2	Bottom Sample_1				4.5	1
Iter29_2	Bottom Sample_2				4.5	1
Iter29_2	Bottom Sample_3				4.5	1
Iter29_2	Bottom Sample_4				4.5	1

Landifll Area - Soil Remaining with RALs for bottom verifiation samples

Iter#	Location Name	Sample Name	Sample Date	Sample Depth (bgs)	Uranium	D_Uranium
Iter29_2	Bottom Sample_5				4.5	1
Iter29_2	Bottom Sample_6				4.5	1
Iter29_2	Bottom Sample_7				4.5	1
Iter29_2	Bottom Sample_8				4.5	1
Iter29_2	Bottom Sample_9				4.5	1
Iter29_2	Bottom Sample_10				4.5	1
Iter29_2	Bottom Sample_11				4.5	1
Iter29_2	Bottom Sample_12				4.5	1
Iter29_2	Bottom Sample_13				4.5	1
Iter29_2	Bottom Sample_14				4.5	1
Iter29_2	Bottom Sample_15				4.5	1
Iter29_2	Bottom Sample_16				4.5	1
Iter29_2	Bottom Sample_17				4.5	1
Iter29_2	Bottom Sample_18				4.5	1
Iter29_2	Bottom Sample_19				4.5	1
Iter29_2	Bottom Sample_20				4.5	1
Iter29_2	Bottom Sample_21				4.5	1
Iter29_2	Bottom Sample_22				4.5	1
Iter29_2	Bottom Sample_23				4.5	1
Iter29_2	Bottom Sample_24				4.5	1
Iter29_2	Bottom Sample_25				4.5	1
Iter29_2	Bottom Sample_26				4.5	1
Iter29_2	Bottom Sample_27				4.5	1
Iter29_2	Bottom Sample_28				4.5	1
Iter29_2	Bottom Sample_29				4.5	1

	A–F	F	G–K	L
1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 7/20/2023 7:46:58 AM		
5	From File	ProUCLInput.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
84				
85	Uranium (iter29_2)			
86				
87	**General Statistics**			
88	Total Number of Observations	75	Number of Distinct Observations	28
89			Number of Missing Observations	0
90	Minimum	0.74	Mean	2.68
91	Maximum	4.5	Median	2
92	SD	1.504	Std. Error of Mean	0.174
93	Coefficient of Variation	0.561	Skewness	0.29
94				
95	**Normal GOF Test**			
96	Shapiro Wilk Test Statistic	0.755	**Shapiro Wilk GOF Test**	
97	1% Shapiro Wilk P Value	0	Data Not Normal at 1% Significance Level	
98	Lilliefors Test Statistic	0.274	**Lilliefors GOF Test**	
99	1% Lilliefors Critical Value	0.118	Data Not Normal at 1% Significance Level	
100	**Data Not Normal at 1% Significance Level**			
101				
102	**Assuming Normal Distribution**			
103	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
104	95% Student's-t UCL	2.969	95% Adjusted-CLT UCL (Chen-1995)	2.972
105			95% Modified-t UCL (Johnson-1978)	2.97
106				
107	**Gamma GOF Test**			
108	A-D Test Statistic	5.296	**Anderson-Darling Gamma GOF Test**	
109	5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level	
110	K-S Test Statistic	0.266	**Kolmogorov-Smirnov Gamma GOF Test**	
111	5% K-S Critical Value	0.104	Data Not Gamma Distributed at 5% Significance Level	
112	**Data Not Gamma Distributed at 5% Significance Level**			
113				
114	**Gamma Statistics**			
115	k hat (MLE)	3.043	k star (bias corrected MLE)	2.93
116	Theta hat (MLE)	0.881	Theta star (bias corrected MLE)	0.915
117	nu hat (MLE)	456.5	nu star (bias corrected)	439.5
118	MLE Mean (bias corrected)	2.68	MLE Sd (bias corrected)	1.566
119			Approximate Chi Square Value (0.05)	391.9
120	Adjusted Level of Significance	0.0468	Adjusted Chi Square Value	391.1
121				
122	**Assuming Gamma Distribution**			
123	95% Approximate Gamma UCL	3.005	95% Adjusted Gamma UCL	3.012
124				
125	**Lognormal GOF Test**			
126	Shapiro Wilk Test Statistic	0.833	**Shapiro Wilk Lognormal GOF Test**	
127	10% Shapiro Wilk P Value	1.143E-11	Data Not Lognormal at 10% Significance Level	
128	Lilliefors Test Statistic	0.259	**Lilliefors Lognormal GOF Test**	
129	10% Lilliefors Critical Value	0.0936	Data Not Lognormal at 10% Significance Level	
130	**Data Not Lognormal at 10% Significance Level**			
131				
132	**Lognormal Statistics**			
133	Minimum of Logged Data	-0.301	Mean of logged Data	0.813
134	Maximum of Logged Data	1.504	SD of logged Data	0.608
135				
136	**Assuming Lognormal Distribution**			
137	95% H-UCL	3.106	90% Chebyshev (MVUE) UCL	3.317
138	95% Chebyshev (MVUE) UCL	3.594	97.5% Chebyshev (MVUE) UCL	3.98
139	99% Chebyshev (MVUE) UCL	4.738		
140				
141	**Nonparametric Distribution Free UCL Statistics**			
142	**Data do not follow a Discernible Distribution**			
143				
144	**Nonparametric Distribution Free UCLs**			
145	95% CLT UCL	2.966	95% BCA Bootstrap UCL	2.965
146	95% Standard Bootstrap UCL	2.969	95% Bootstrap-t UCL	2.974
147	95% Hall's Bootstrap UCL	2.966	95% Percentile Bootstrap UCL	2.971
148	90% Chebyshev(Mean, Sd) UCL	3.201	95% Chebyshev(Mean, Sd) UCL	3.437
149	97.5% Chebyshev(Mean, Sd) UCL	3.764	99% Chebyshev(Mean, Sd) UCL	4.407
150				
151	**Suggested UCL to Use**			
152	95% Student's-t UCL	2.969		
153				
154	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL			
155	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies			
156	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician			
157				

ATTACHMENT C-5
Supporting Information for Cooling Pond RALs

Cooling Pond - Soil Remaining with RALs for bottom verifiation samples

Location Name	Sample Name	Sample Date	Sample Type	Sample Depth (bgs)	Top Depth	Bottom Depth	U_RAL_60ft_3.5	D_U_RAL_60ft_3.5
SB-RI-02007	SBRI02007008-10/17/2005	10/17/2005	Primary	8 - 10 (ft)	8	10	2.5	1
SB-PD-02017	SB-PD-02017-001-042921	04/29/2021	Primary	1 - 2 (ft)	1	2	4.12	1
SB-PD-02038	SB-PD-02038-001-042921-DUP	04/29/2021	Duplicate	1 - 2 (ft)	1	2	4.27	1
SB-RI-04003	SBRI04003008-10/17/2005	10/17/2005	Primary	8 - 10 (ft)	8	10	1.5	1
SB-RI-02003	SBRI02003008-10/18/2005	10/18/2005	Primary	8 - 10 (ft)	8	10	3.8	1
SB-PD-02009	SB-PD-02009-004-112420	11/24/2020	Primary	4 - 6 (ft)	4	6	1.15	1
SB-PD-04039	SB-PD-04039-002-120220	12/02/2020	Primary	2 - 4 (ft)	2	4	3.67	1
SB-RI-02008	SBRI02008008-10/17/2005	10/17/2005	Primary	8 - 10 (ft)	8	10	2.	1
SB-RI-04001	SBRI04001008-10/17/2005	10/17/2005	Primary	8 - 10 (ft)	8	10	1.9	1
SB-PD-04036	SB-PD-04036-002-120120	12/01/2020	Primary	2 - 4 (ft)	2	4	4.53	1
SB-PD-02037	SB-PD-02037-001-042921	04/29/2021	Primary	1 - 2 (ft)	1	2	1.88	1
SB-PD-02007	SB-PD-02007-001-112420	44159		1 - 2 (ft)			3.07	1
SB-PD-02036	SB-PD-02036-001-042921	04/29/2021	Primary	1 - 2 (ft)	1	2	2.74	1
SB-PD-04026	SB-PD-04026-002-112420	11/24/2020	Primary	2 - 4 (ft)	2	4	1.8	1
TS-RI-02S03	TSRI02S03002-12/14/2004	12/14/2004	Primary	2 - 6 (ft)	2	6	2.3	1
SB-PD-02007	SB-PD-02007-002-112420	44159		2 - 4 (ft)			0.95	1
SB-RI-04002	SBRI04002008-10/17/2005	10/17/2005	Primary	8 - 10 (ft)	8	10	1.8	1
TS-RI-02S01	TSRI02S01002-12/14/2004	12/14/2004	Primary	2 - 6 (ft)	2	6	1.4	1
SB-RI-01022	SBRI01022008-11/11/2004	11/11/2004	Primary	8 - 12 (ft)	8	12	3.4	1
SB-PD-02009	SB-PD-02009-006-112420	11/24/2020	Primary	6 - 8 (ft)	6	8	1.13	1
SB-PD-02039	SB-PD-02039-001-042921	04/29/2021	Primary	1 - 2 (ft)	1	2	1.45	1
SS-RI-04004	SSRI04004001-10/25/2004	10/25/2004	Primary	1 - 1.5 (ft)	1	1.5	1.7	1
SS-RI-04012	SSRI04012001-10/22/2004	10/22/2004	Primary	1 - 1.5 (ft)	1	1.5	2.7	1
SB-RI-01014	SBRI01014001-11/8/2004	11/08/2004	Primary	1 - 3 (ft)	1	3	2.2	1
SB-RI-01014	SBRI01014008-11/9/2004	11/09/2004	Primary	8 - 10 (ft)	8	10	2.3	1
SB-RI-01022	SBRI01022001-11/11/2004	11/11/2004	Primary	1 - 3 (ft)	1	3	5.9	1
BottomSample1							3.5	1
BottomSample2							3.5	1
BottomSample3							3.5	1
BottomSample4							3.5	1
BottomSample5							3.5	1
BottomSample6							3.5	1
BottomSample7							3.5	1
BottomSample8							3.5	1
BottomSample9							3.5	1
BottomSample10							3.5	1
BottomSample11							3.5	1
BottomSample12							3.5	1
BottomSample13							3.5	1
BottomSample14							3.5	1
BottomSample15							3.5	1
BottomSample16							3.5	1

Cooling Pond - Soil Remaining with RALs for bottom verifiation samples

Location Name	Sample Name	Sample Date	Sample Type	Sample Depth (bgs)	Top Depth	Bottom Depth	U_RAL_60ft_3.5	D_U_RAL_60ft_3.5
BottomSample17							3.5	1
BottomSample18							3.5	1
BottomSample19							3.5	1
BottomSample20							3.5	1
BottomSample21							3.5	1
BottomSample22							3.5	1
BottomSample23							3.5	1
BottomSample24							3.5	1
BottomSample25							3.5	1
BottomSample26							3.5	1
BottomSample27							3.5	1
BottomSample28							3.5	1
BottomSample29							3.5	1
BottomSample30							3.5	1

	A-E	F	G-K	L
1	UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.2 8/3/2023 10:02:40 AM		
5	From File	ProUCLInput.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
84				
85	U_RAL_60ft_3.5			
86				
87	**General Statistics**			
88	Total Number of Observations	56	Number of Distinct Observations	25
89			Number of Missing Observations	0
90	Minimum	0.95	Mean	3.056
91	Maximum	5.9	Median	3.5
92	SD	0.959	Std. Error of Mean	0.128
93	Coefficient of Variation	0.314	Skewness	-0.341
94				
95	**Normal GOF Test**			
96	Shapiro Wilk Test Statistic	0.842	**Shapiro Wilk GOF Test**	
97	1% Shapiro Wilk P Value	7.6794E-8	Data Not Normal at 1% Significance Level	
98	Lilliefors Test Statistic	0.321	**Lilliefors GOF Test**	
99	1% Lilliefors Critical Value	0.136	Data Not Normal at 1% Significance Level	
100	**Data Not Normal at 1% Significance Level**			
101				
102	**Assuming Normal Distribution**			
103	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
104	95% Student's-t UCL	3.271	95% Adjusted-CLT UCL (Chen-1995)	3.261
105			95% Modified-t UCL (Johnson-1978)	3.27
106				
107	**Gamma GOF Test**			
108	A-D Test Statistic	5.496	**Anderson-Darling Gamma GOF Test**	
109	5% A-D Critical Value	0.752	Data Not Gamma Distributed at 5% Significance Level	
110	K-S Test Statistic	0.339	**Kolmogorov-Smirnov Gamma GOF Test**	
111	5% K-S Critical Value	0.119	Data Not Gamma Distributed at 5% Significance Level	
112	**Data Not Gamma Distributed at 5% Significance Level**			
113				
114	**Gamma Statistics**			
115	k hat (MLE)	8.207	k star (bias corrected MLE)	7.78
116	Theta hat (MLE)	0.372	Theta star (bias corrected MLE)	0.393
117	nu hat (MLE)	919.2	nu star (bias corrected)	871.3
118	MLE Mean (bias corrected)	3.056	MLE Sd (bias corrected)	1.096
119			Approximate Chi Square Value (0.05)	803.8
120	Adjusted Level of Significance	0.0457	Adjusted Chi Square Value	802.1
121				
122	**Assuming Gamma Distribution**			
123	95% Approximate Gamma UCL	3.313	95% Adjusted Gamma UCL	3.32
124				
125	**Lognormal GOF Test**			
126	Shapiro Wilk Test Statistic	0.795	**Shapiro Wilk Lognormal GOF Test**	
127	10% Shapiro Wilk P Value	4.088E-10	Data Not Lognormal at 10% Significance Level	

	A	B	C	D	E	F	G	H	I	J	K	L
128	Lilliefors Test Statistic					0.34	Lilliefors Lognormal GOF Test					
129	10% Lilliefors Critical Value					0.108	Data Not Lognormal at 10% Significance Level					
130	Data Not Lognormal at 10% Significance Level											
131												
132	Lognormal Statistics											
133	Minimum of Logged Data					-0.0513	Mean of logged Data					1.055
134	Maximum of Logged Data					1.775	SD of logged Data					0.383
135												
136	Assuming Lognormal Distribution											
137	95% H-UCL					3.391	90% Chebyshev (MVUE) UCL					3.576
138	95% Chebyshev (MVUE) UCL					3.797	97.5% Chebyshev (MVUE) UCL					4.105
139	99% Chebyshev (MVUE) UCL					4.709						
140												
141	Nonparametric Distribution Free UCL Statistics											
142	Data do not follow a Discernible Distribution											
143												
144	Nonparametric Distribution Free UCLs											
145	95% CLT UCL					3.267	95% BCA Bootstrap UCL					3.274
146	95% Standard Bootstrap UCL					3.268	95% Bootstrap-t UCL					3.265
147	95% Hall's Bootstrap UCL					3.268	95% Percentile Bootstrap UCL					3.27
148	90% Chebyshev(Mean, Sd) UCL					3.441	95% Chebyshev(Mean, Sd) UCL					3.615
149	97.5% Chebyshev(Mean, Sd) UCL					3.857	99% Chebyshev(Mean, Sd) UCL					4.332
150												
151	Suggested UCL to Use											
152	95% Student's-t UCL					3.271						
153												
154	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
155	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.											
156	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
157												
158	Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be											
159	reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.											
160												

APPENDIX D

Transportation and Off-Site Disposal Plan

TRANSPORTATION & OFF-SITE DISPOSAL PLAN

NUCLEAR METALS, INC. SUPERFUND SITE
REMEDIAL DESIGN/REMEDIAL ACTION
CONCORD, MASSACHUSETTS

Prepared by:

US ecology

A Republic Services Company

Prepared for:

General Contractor:

de maximis, inc.

200 Day Hill Road, Suite 200
Windsor, CT 06095

Original - October 21, 2021
Revision 1 – September 26, 2022
Revision 2 – December 14, 2022
Revision 3 – May 24, 2023

Table of Contents

Section 1: Introduction

On October 17, 2019, the United States Environmental Protection Agency (USEPA) lodged a Consent Decree (CD) with the United States District Court for the District of Massachusetts in connection with Civil Action No. 1-19-cv-12097-RGS. The CD was entered by the Court on December 6, 2019. The CD and its accompanying Statement of Work (SOW) describe the Remedial Design/Remedial Action (RD/RA) activities to be performed for the Nuclear Metals, Inc. (NMI) Superfund Site in Concord, Massachusetts (the NMI Site or Site). The RD/RA activities are to be undertaken by the Settling Defendants (SDs) to the CD, with funding contributions from the Settling Federal Agencies (SFAs).

The SDs have retained de maximis, inc. (*de maximis*) to serve as the Project Coordinator and Supervising Contractor (as defined in the CD), and General Contractor (GC) for the performance of all Work required by the CD. *de maximis* will execute sub-contracts with consultants, contractors, laboratories and waste transporters and disposal facilities, as necessary, to implement the Work. As the GC, *de maximis* personnel will act as the Site Project Manager and Construction Manager(s).

de maximis has retained US Ecology- A Republic Services Company (US Ecology) for the transportation and off-site disposal of approximately 130,000 tons of soil, sediment and debris from the Site.

1.1 Purpose and Scope

As the selected Transportation and Disposal contractor, US Ecology has prepared this *Transportation and Off-Site Disposal Plan* (T&D Plan) pursuant to and in accordance with the requirements set forth in the SOW Section 6.7(g) to ensure compliance with SOW Section 4.4 which outlines requirements for Off-Site Shipments. The requirements of Section 6.7(g) are designed to provide a minimal standard of content in this T&D Plan which includes:

- Proposed routes for off-site shipment of waste material
- Identification of communities affected by shipment of clean fill transported on-site and waste material transported off-site; and
- Description of plans to minimize impacts on affected communities.

This T&D Plan has been developed to satisfy these requirements and to provide supplemental information detailing the project team and their responsibilities and includes a Spill Contingency Plan provided in Appendix C. The T&D Plan has been developed to detail proposed transportation and disposal means and methods, including routes and personnel required to transport trucks and filled gondola railcars (waste containers) from the Nuclear Metals, Inc. (NMI) Site in Concord, MA to the designated US Ecology disposal facility, (US Ecology Michigan Disposal (USEM) in Belleville, MI) and the return of emptied gondola railcars to the MHF Transload site in Worcester, MA for loading.

Section 2: Responsibilities

The following sections outline the roles and responsibilities of the US Ecology staff regarding shipping and disposal of materials originating from the Site. Additional information regarding responsibilities and authority of organizations and key personnel for the project can be found in section 3.3 of the Remedial Design Work Plan (RDWP) (*de maximis, inc.,* September 2020). A copy of the NMI Project Team Organizational Chart is included as Appendix A and a US Ecology Organizational Chart is included as Appendix B.

2.1 US Ecology Onsite Waste Coordinator

The US Ecology Onsite Waste Coordinator is responsible for the following:

- Serving as a central US Ecology point-of-contact (POC) with de maximis, inc. (*de maximis)* staff and contractors at the project Site.
- Reviewing of all shipment data intended for use on shipment documentation.
- Reviewing all bills of ladings or shipping manifests and required associated shipping documents that accompany outgoing shipments of waste from the NMI Site to USEM.
- Providing the US Ecology Rail Program Manager all necessary documents required for the waybilling of loaded railcars.
- Communication with US Ecology Technical Staff on all waste acceptance and Department of Transportation issues.
- Serving as the POC with Director of Rail Development, Manager Rail Equipment and Operations, and shipping container vendors on all NMI Site transportation issues.
- Coordinating with the Rail Program Manager in Michigan for all railcars to be returned for re-loading of waste from the NMI Site.
- Confirming all required markings, if required are labeled and placarded in compliance with all federal, state, and local rules and regulations; and ensuring that all original shipping documents are forwarded to the appropriate parties.

2.2 Republic Director of Rail Development

Republic’s Director of Rail Development is responsible for the following:

- Approving and ensuring all transporters and transportation-related subcontractors comply with SOW Section 4.4 and the facilities and subcontractors comply with Section 121(d)(3) of CERCLA, 42 U.S.C § 9621(d)(3), and 40 CFR § 300.440.
- Preparing all transportation related plans.

2.3 Republic Manager Rail Equipment and Operations

Republic’s Manager Rail Equipment and Operations is responsible for the following:

- Supplying all rail transportation required for the project
- Waybill and tracking of all loaded rail movements

- Reviewing and approving all rail related transportation charges and invoices.

2.4 US Ecology Rail Logistics Coordinator

US Ecology's Rail Logistics Coordinator is responsible for the following:

- Supporting the Manager Rail Equipment and Operations with waybilling and tracking of rail movements.
- Coordinating with the Onsite Waste Coordinator, Manager Rail Equipment and Operations and US Ecology MA Field Services Group, as necessary to support project activities and scheduling.

2.5 US Ecology Michigan's Logistics Manager

US Ecology Michigan's Logistics Manager is responsible for the following:

- Arranging back-end dray (a truck designed to specifically transport heavy loads) transportation for all waste containers received at US Ecology's Rail Transfer Facility (RTF) located in Romulus, MI.
- Empty return of waste containers (railcars) back to the MHF Transload site.
- Reviewing and approving all back-end dray related transportation charges and invoices.

2.6 US Ecology's Landfill Site Manager

US Ecology's Landfill Site Manager is responsible for the following:

- Arranging for off-load and disposal of material from waste containers received at USEM in Belleville, MI.
- Releasing of empty waste containers from the subtitle C landfill site.

In addition, Decontamination Decommissioning & Environmental Services, LLC (DDES) will provide radiation protection plan support, including surveying and documenting radiological conditions on all waste material containers entering and leaving the Site

2.7 US Ecology's Field Service Group

US Ecology's Field Service Group will be responsible for coordinating and loading all waste containers for shipment off-site.

In addition, Decontamination Decommissioning & Environmental Services, LLC (DDES) will provide radiation protection plan support, including surveying and documenting radiological conditions on all waste material containers entering and leaving the Site.

Section 3: Transportation Program

The current outlook of site progress indicates that select shipments from the NMI Site are anticipated to begin as early as the 2021 calendar year and will likely continue through the 2026, or later, construction season. Throughout the shipping duration, it is anticipated that nearly all remedial waste shipments will be completed via a combination of truck and rail transportation. Shipments are anticipated to include predominantly impacted soils with the inclusion of miscellaneous debris both identified and produced throughout the Remedial Design/Remedial Action. The following sections outline the anticipated waste containers, their methods of transfer, as well as the vendors of this equipment.

3.1 Waste Containers or Conveyances

The anticipated waste at the NMI Site will be predominantly soils, sediments, concrete debris, and other debris generated throughout remedial actions. Waste will be loaded into trucks (dump trailers), lined with a 4 mil slip liner to ease the transfer between truck and rail during the dumping operation. Each dump trailer will be loaded between thirty-three (33) and thirty-five (35) net tons.

Upon arrival at the MHF Transload site, each dump trailer will dump directly into gondola railcars for shipment via rail to the USEM rail facility in Romulus, MI. The gondola railcars will have a volume capacity of 101 cubic yards (~2700 cubic feet) with a maximum gross weight capacity of 286,000 pounds. Railcar gondolas will be lined with bulk railcar liners prior to being loaded. The railcar liners will be properly closed and secured prior to shipment.

3.2 Transportation Methods

Shipments of waste from the NMI site to USEM will be accomplished using both truck and rail transportation. All truck shipments originating from NMI will be shipped either via road directly to the WDI facility or to the MHF Transload site in Worcester, MA, approximately 38 miles from the Site. The soil will be transferred to gondolas via direct dump through a chute, prior to being shipped via rail cars by US Ecology, to the US Ecology's RTF in Romulus, MI; and then transported by truck to the landfill for disposal. All shipments originating from NMI will be off-loaded in Romulus, MI, under cover, using excavators and the waste materials will be placed into trucks provided by S&C transport for delivery to the landfill in Belleville, MI. Material being transported via truck directly to WDI, will unload directly into the WDI landfill. All transportation routes are discussed in Section 4.

3.3 Railcar Shipment Dispatch – Empty / Loaded Cars

US Ecology's on-site Waste Coordinator will coordinate with *de maximis* and the Manager Rail Equipment and Operations to schedule empty railcars for delivery to the MHF Transload site based on orders for rail cars from *de maximis*, via e-mail 30 days in advance. Loaded railcars will be directed to be pulled for transportation to USEM by the Manager Rail Equipment and Operations. Rail service availability is expected to be Monday through Friday.

3.4 Transporters

The following is a list of transporters that are proposed to be used by US Ecology on the NMI Project. All transporters, if not already part of US Ecology, will be subcontracted to US Ecology over the course of the Project.

3.4.1 Goulet Trucking

Goulet trucking will be providing the dump trailer transportation from the NMI site to the MHF transload in Worcester, MA.

3.4.2 Providence and Worcester Railroad (PWRR)

The Providence and Worcester Railroad will be providing the first leg of rail transportation from the MHF Transload site. PWRR will interchange with the CSX Railroad (CSXT) in Worcester for further transport.

The primary contact for scheduling at the MHF Transload site located in Worcester, MA, will be Rebecca Hans, Transload Project Manager. Ms. Hans' mobile number is 724-766-2543. Her email address is becky_hans@mhfservices.com.

3.4.2 CSX Transportation (CSXT)

CSXT will be providing RR service for the project from the PWRR interchange point. Loaded railcars will be interchanged in Worcester, MA and be delivered directly to the US Ecology Romulus RTF in Romulus, MI. Empty railcars returning to the MHF Transload site will be delivered to the PWRR in Worcester, MA.

3.4.3 S&C Transport

S&C Transport or US Ecology will provide back-end dray trucking services from the US Ecology Romulus RTF to the USEM Landfill in Belleville, MI.

Mr. Jim Vigrass – the US Ecology Romulus RTF Manager will make trucking arrangements for the back-end transportation of materials offloaded from the received railcars. Mr. Vigrass's primary office number is 734-727-5526 and his alternate contact number (mobile) is 734-576-0161, with an email address of jim.vigrass@usecology.com.

Mr. Mike McInnis is the primary contact for S&C transport. Mr. McInnis can be reached at 734-576-0384, with an email address of mike.mcinnis@sctransport.org.

3.4.4 US Ecology

The US Ecology Field Services group located in Wrentham, MA will provide over-road transportation from the NMI Site to the MHF Transload site in Worcester, MA utilizing Goulet trucking. US Ecology will also provide over-road transportation directly to WDI

The primary contact based out of Wrentham, MA, is Mr. Richard Blake. Mr. Blake can be reached on his mobile phone at 339-327-7309, with an email address of rich.blake@usecology.com.

The primary contact for transportation to USEM via truck (without rail) is Joe Weiseman. Mr. Weiseman is located in Boise, Idaho and can be reached at 845 551-7602 or joe.weismann@usecology.com.

The alternate contact based out of Wrentham, MA, is Ms. Kristine Sahagian. Ms. Sahagian can be reached on her mobile phone at 508-803-1218, with an email address of kristine.sahagian@usecology.com.

Section 4: Transportation Routes

The following RR and trucking routes will be utilized for shipments from the NMI site to the designated disposal facility. Railcar Tracking Reports will be provided for all railcar shipments daily to parties specified by *de maximis.*

4.1 Shipments from NMI to PWRR in Worcester, MA

4.1.1 Front End Trucking – Concord, MA to Worcester, MA (Primary Route)

1. Turn Left from NMI onto Rte. 62 West
2. Rte. 62 West to Rte. 117 West
3. Rte. 117 West to Rte. 495 South
4. Rte. 495 South to exit 65B I-290 West
5. I-290 West to exit 17 Kelley Square
6. Merge onto MA-122A North
7. Second exit onto Madison Street
8. Turn left onto Southbridge Street
9. Arrive at Railyard on Southbridge Street in Worcester, MA

4.2 Shipments from PWRR to USEM

4.2.1 PWRR to CSXT Direct Rail Routing to Romulus, MI

1. PWRR to CSXT interchange in Worcester, MA
2. Worcester, MA to Selkirk, NY
3. Selkirk, NY to Willard, OH
4. Willard, OH to Romulus, MI via Detroit, MI

4.2.2 Back End Dray Trucking – Romulus, MI to Belleville, MI (Primary Route)

1. Van Born Road to Merriman Road
2. Merriman Road to I-94
3. I-94 Exit 187 to Rawsonville Road
4. Rawsonville Road to North I-94 Service Drive

4.2.3 Back End Dray Trucking – Romulus, MI to Belleville, MI (Alternate Route)

1. Van Born Road to Wayne Road
2. Wayne Road to I-94
3. I-94 Exit 187 to Rawsonville Road
4. Rawsonville Road to North I-94 Service Drive

4.3 Shipments from NMI to PWRR in Worcester, MA

4.3.1 Front End Trucking – Concord, MA to Worcester, MA (Primary Route)

1. Turn Left from NMI onto Rte. 62 West
2. Rte. 62 West to Rte. 117 West
3. Rte. 117 West to Rte. 495 South
4. Rte. 495 South to exit 65B I-290 West
5. I-290 West to exit 17 Kelley Square
6. Merge onto MA-122A North
7. Second exit onto Madison Street
8. Turn left onto Southbridge Street
9. Arrive at Railyard on Southbridge Street in Worcester, MA

4.4 Direct Shipments from Concord, MA to US Ecology, Wayne Disposal, Belleville, Michigan

1. Turn Left from NMI onto Rte. 62 West
2. Rte. 62 West to Rte. 117 West
3. Rte. 117 West to Rte. 495 South
4. Rte. 495 South to I-90 West
5. I-90 West to I-280 North (Ohio)
6. I-280 to I-75 North (From Ohio into Michigan)
7. I-75 North to I-275 West
8. I-275 West to I-94, Exit 187 to Rawsonville Road
9. Rawsonville Road to North I-94 Service Drive

Note: alternative routes may be developed during the project if conditions warrant them, such as avoiding road construction projects and congestion from new traffic patterns. In the event that a new traffic route is developed the project contact list (Appendix D) will be notified.

Section 5: Schedule and Operations

5.1 Shipping Schedule

The NMI Project shipments will be made Monday through Friday during normal business hours (7:00 AM and 5:00 PM). MHF's available service times require the last loads to be received prior to 4:30 PM during the week to not interfere with truck-to-rail transfer operations. US Ecology shall work with the project Site and the MHF Transload Facility to schedule railcar moves on a monthly, weekly and daily basis.

Preliminary project schedule calls for a consistent average of 1,000 tons per week for 2.4 years. To accommodate the proposed schedule, it is anticipated that a railcar fleet of 50 to 60 railcars will be required to support the project needs.

The following railcar cycle times are expected:

- Transit time to Michigan - 9 to 11 days
- Railcar off Load - 3 to 5 days
- Transit time back to NMI Site - 9 to 11 day

The following road transport cycle times are expected:

- Travel time to USEM in Belleville, Michigan – 13 hours
- Travel time back to NMI Site – 13 hours

5.2 Community Disturbance

5.2.1 Communities Affected by Shipment of Waste Material

US Ecology will notify the police and fire departments in these communities two weeks prior to any waste shipment.

- Bolton, Massachusetts
- Stow, Massachusetts
- Acton, Massachusetts
- Concord, Massachusetts
- Maynard, Massachusetts
- Worcester, Massachusetts
- Belleville, Michigan
- Romulus, Michigan

5.2.3 Plans to Minimize Impacts on Affected Communities

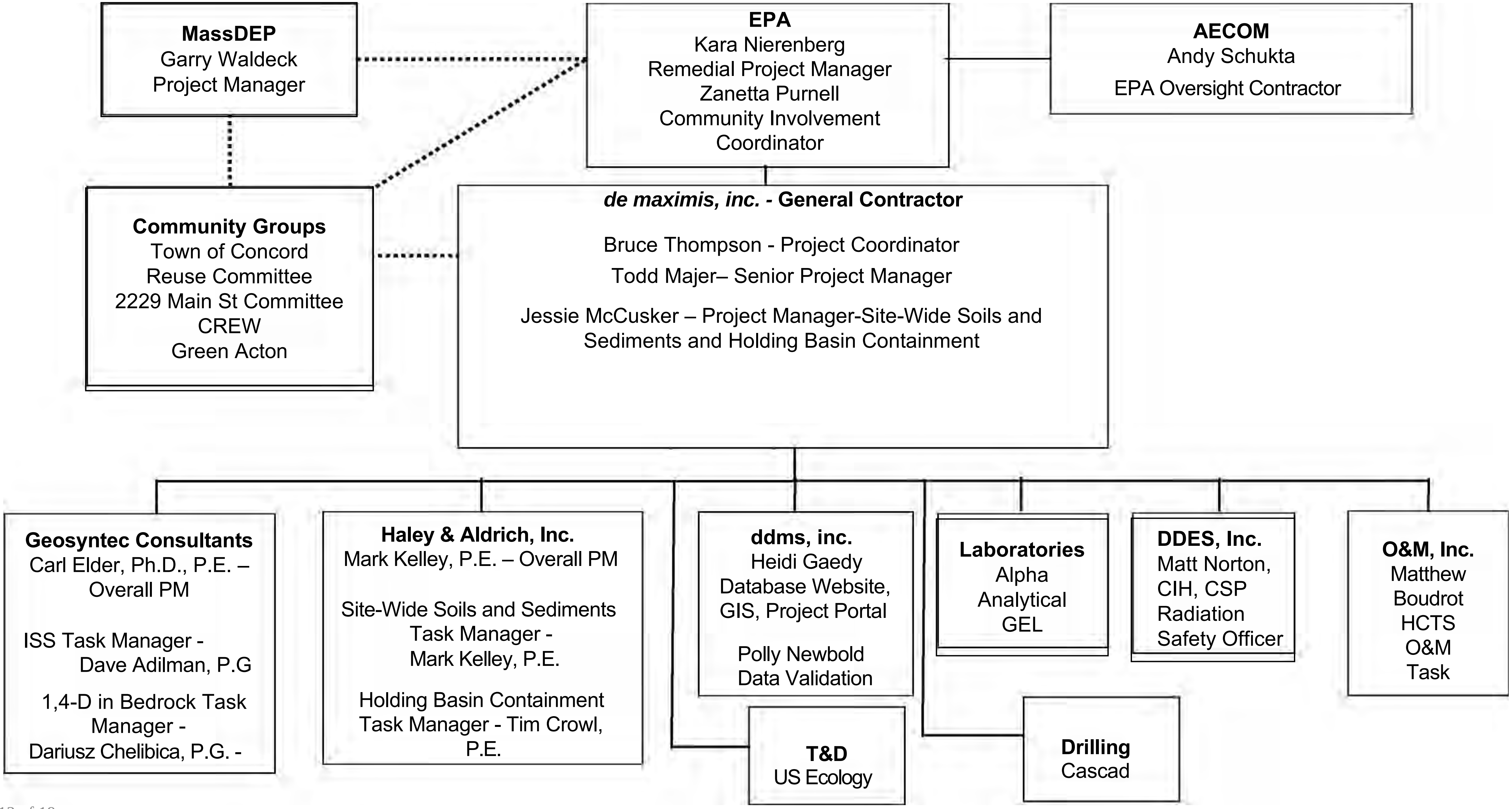
- The established truck routes will be on state/interstate roads to avoid traffic in neighborhoods.

- It is anticipated that a maximum of 10 to15 trucks will used per day, during normal business hours (Monday – Friday, 7:00 AM and 5:00 PM).
- Noise abatement procedures will always be followed by transporters servicing the Site. All drivers will be informed to keep noise to a minimum while dropping or picking up waste containers. The use of air horns and compression braking (i.e., 'jake brakes') are prohibited on and around the Site at all times.

Appendix A

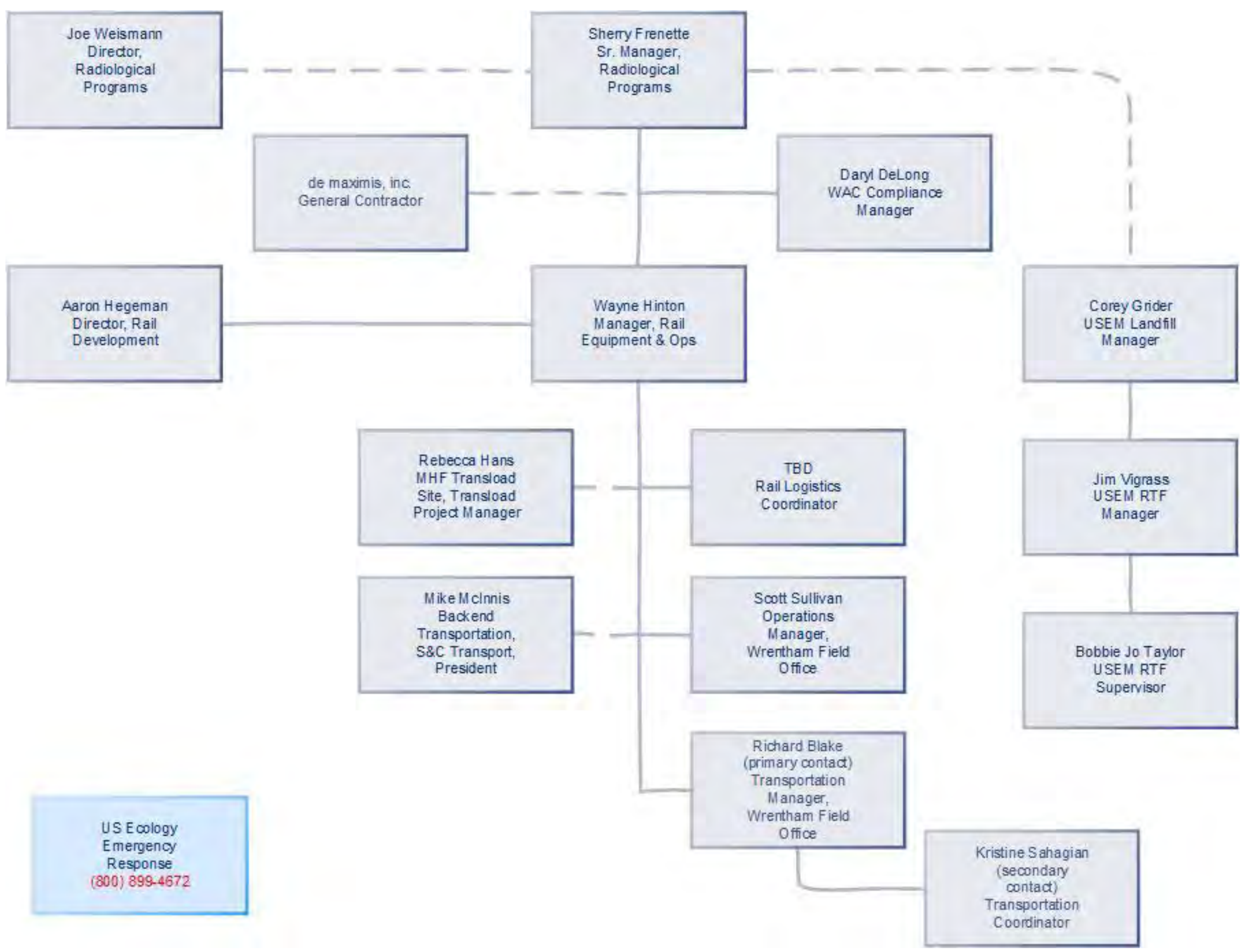
NMI Organization Chart

APPENDIX A – NMI Organizational Chart



APPENDIX B

US Ecology, Inc. Org Chart for NMI Project



APPENDIX C

SPILL CONTINGENCY PLAN

SCOPE

The purpose of this Spill Contingency Plan is to describe possible off-normal conditions that may occur during transportation of waste via truck (front and back-end dray) and rail from the NMI Site in Concord, MA, to the US Ecology Michigan (USEM) disposal facility located in Belleville, MI and back to the NMI Site. This Plan also discusses expected causal factors and appropriate response actions that will be undertaken by RR transportation contractor and/or US Ecology (or its agents/designees). This plan may be amended as necessary to satisfy changes to project scope, and regulatory or disposal site requirements.

This plan addresses the following Contingency Areas:

1. Railcar or train derailment occurs enroute to designated disposal facility or back to MHF.
2. Spill of truck contents during front to MHF or back-end dray to USEM.
3. Spill of truck contents during direct transportation to USEM.

CONTINGENCY AREAS

The following areas have been identified as requiring contingency plan analysis and corrective actions in the event they occur during waste shipments originating from the Site:

Contingency Area 1: Railcar or train derailment occurs enroute to disposal facility or back to MHF.

Likely Cause(s)**:** Catastrophic rail component failure(s), Acts of God.

Immediate Response and Corrective Action(s)**:**

1. In the event of a spill enroute to US Ecology or back to MHF, US Ecology's emergency response center will be contacted (800-899-4672) by the servicing railroad's first responder within 24 hours. US Ecology will then notify *de maximis. de maximis* will be responsible for notifying the USEPA project manager. Please note that in some cases the railroad's first responder may also contact the generator of the waste listed on the shipping documents.
2. The railroad's HAZMAT first responder will isolate the affected railcar(s) to a secluded track, if available, or isolate the initial spill area if the railcar cannot be moved.
3. US Ecology is responsible for logging information from the first responder and will dispatch an emergency response contractor to the scene to take over from the CSXT railroad. US

Ecology will remain in contact with de maximis during the duration of the spill and resulting clean up action. US Ecology, or our designee, will report the spill to the various entities. Reporting will be determined after the team assesses the actual volume of the spill. Remediation will be performed by US Ecology's emergency response contractor and all other necessary subcontractors (e.g., radiological services). All affected areas will typically be over-excavated with the contents placed in a secondary container (e.g., roll-offs, supersack bags, etc.) and loaded onto a truck or replacement railcar for final disposal. This material will be on an additional manifest referencing the original manifest.

4. US Ecology will provide a written report documenting results of the initial site assessment and any required clean-up efforts, including written notes and a photo diary compiled by their emergency response contractor. A copy of this response report will be provided to de maximis.

Discussion: US Ecology will coordinate response to any reported spill from the Site. Representatives from US Ecology and/or our agents may be present at the spill location to ensure all impacted areas are appropriately cleaned up.

Contingency Area 2- **Spill of truck contents during front to MHF or back-end dray transport to USEM.**

Likely Cause(s)**:** Truck accident and loss of gate containment.

Immediate Response and Corrective Action(s)**:**

1. In the event of a spill enroute to the rail facility in Worcester, MA or to USEM from the Romulus transload facility or back to the NMI Site, US Ecology will be contacted by the truck driver or first responder. US Ecology will report the spill to all required parties. US Ecology will then notify Bruce Thompson of *de maximis* immediately. *de maximis* will be responsible for notifying the USEPA and MADEP project managers. Please note that in some cases the first responder may also contact the generator of the waste listed on the shipping documents.

2. The HAZMAT first responder will isolate the affected container, if available, or isolate the initial spill area if the truck cannot be moved.

3. US Ecology is responsible for logging information from the first responder and will dispatch an emergency response contractor to the scene as required. US Ecology or its designated representative will make follow-up reports to designated agencies. Reporting will be determined after the team assesses the actual volume spilled.

4. Remediation of a spill in Massachusetts or Michigan will be performed by US Ecology's emergency response contractor. All affected areas will typically be over-excavated with the contents placed in a secondary container (e.g., drums, bags, etc.) and loaded into a

replacement truck or container for final disposal. This material will be on an additional manifest referencing the original manifest.

5. US Ecology will coordinate response to any reported spill from the Site. Representatives from US Ecology and/or its contractors may be present at the spill location to ensure all impacted areas are appropriately cleaned up. US Ecology will provide a written report documenting the results of the initial site assessment and any required clean-up efforts, including written notes and a photo diary compiled by their emergency response contractor. A copy of this response report will be provided to *de maximis*.

REFERENCE - Emergency Response Guidebook, U.S. Department of Transportation.

Contingency Area 3- Spill of truck contents during direct transport to USEM.

Likely Cause(s)**:** Truck accident.

Immediate Response and Corrective Action(s)**:**

1. In the event of a spill enroute to the USEM, US Ecology will be contacted by the truck driver or first responder. US Ecology will report the spill to all required parties. US Ecology will then notify Bruce Thompson of *de maximis* immediately. *de maximis* will be responsible for notifying the USEPA and MADEP project managers. Please note that in some cases the first responder may also contact the generator of the waste listed on the shipping documents.

2. The HAZMAT first responder will isolate the affected container, if available, or isolate the initial spill area if the truck cannot be moved.

3. US Ecology is responsible for logging information from the first responder and will dispatch an emergency response contractor to the scene as required. US Ecology or its designated representative will make follow-up reports to designated agencies. Reporting will be determined after the team assesses the actual volume spilled.

4. Remediation of a spill will be performed by US Ecology's emergency response contractor. All affected areas will typically be over-excavated with the contents placed in a secondary container (e.g., drums, bags, etc.) and loaded into a replacement truck or container for final disposal. This material will be on an additional manifest referencing the original manifest.

5. US Ecology will coordinate response to any reported spill from the Site. Representatives from US Ecology and/or its contractors may be present at the spill location to ensure all impacted areas are appropriately cleaned up. US Ecology will provide a written report

documenting the results of the initial site assessment and any required clean-up efforts, including written notes and a photo diary compiled by their emergency response contractor. A copy of this response report will be provided to *de maximis*.

REFERENCE - Emergency Response Guidebook, U.S. Department of Transportation.

APPENDIX D

NMI Project Transportation Contact List

Name	Company	Role/Responsibility	Contact Number(s)	Email
Bruce Thompson	de maximis, inc.	NMI Project Coordinator	860-662-0526	Brucet@demaximis.com
Jessie McCusker	de maximis, inc.	NMI Project Manager	860-833-4112	Jessie@demaximis.com
Todd Majer	de maximis, inc.	NMI Project Manager	978-875-0635	tmajer@demaximis.com
Aaron Hegeman	Republic Services	Director of Rail Development	(m) 480-205-9632 (o) 480-718-0474	AHegeman@republicservices.com
Wayne Hinton	US Ecology	Manager Rail Equipment and Operations	(m) 508-954-1545 (o) 508-803-1224	wayne.hinton@usecology.com
Sherry Frenette	US Ecology	Sr. Manager- Rad Programs	(m) 702-912-7925	sherry.frenette@usecology.com
Daryl DeLong	US Ecology	On-Site Waste Coordinator	(m) 415-308-7027	daryl.delong@usecology.com
Richard Blake	US Ecology Wrentham Field Office	Transportation Manager Primary Contact	(m) 339-327-7309	rich.blake@usecology.com
Kristine Sahagian	US Ecology Wrentham Field Office	Transportation Coordinator Secondary Contact	(m) 508-803-1218	kristine.sahagian@usecology.com

Scott Sullivan	US Ecology Wrentham Field Office	Operations Manager	(m) 774-210-9311	scott.sullivan@usecology.com
John Yuscko	Goulet Trucking	Transportation Manager	(m) 413-687-7278	john.yuscko@goulettrucking.com
Rebecca Hans	MHF Transload Site	Transload Project Manager	(m) 724-766-2543	becky_hans@mhfservices.com
Jim Vigrass	US Ecology	USE MI RTF Manager	(m) 734-576-0161 (o) 734-727-5526	jim.vigrass@usecology.com
Corey Grider	US Ecology	USE MI Landfill Manager	734-699-6213	corey.grider@usecology.com
Mike McInnis	President - S&C Transport	Back End Transportation	734-576-0384	mike.mcinnis@sctransport.org
Global Response Operations Center (GROC)	US Ecology	Emergency Response	800-899-4672	groc@usecology.com

Appendix E

NMI Project Transportation Emergency Call List

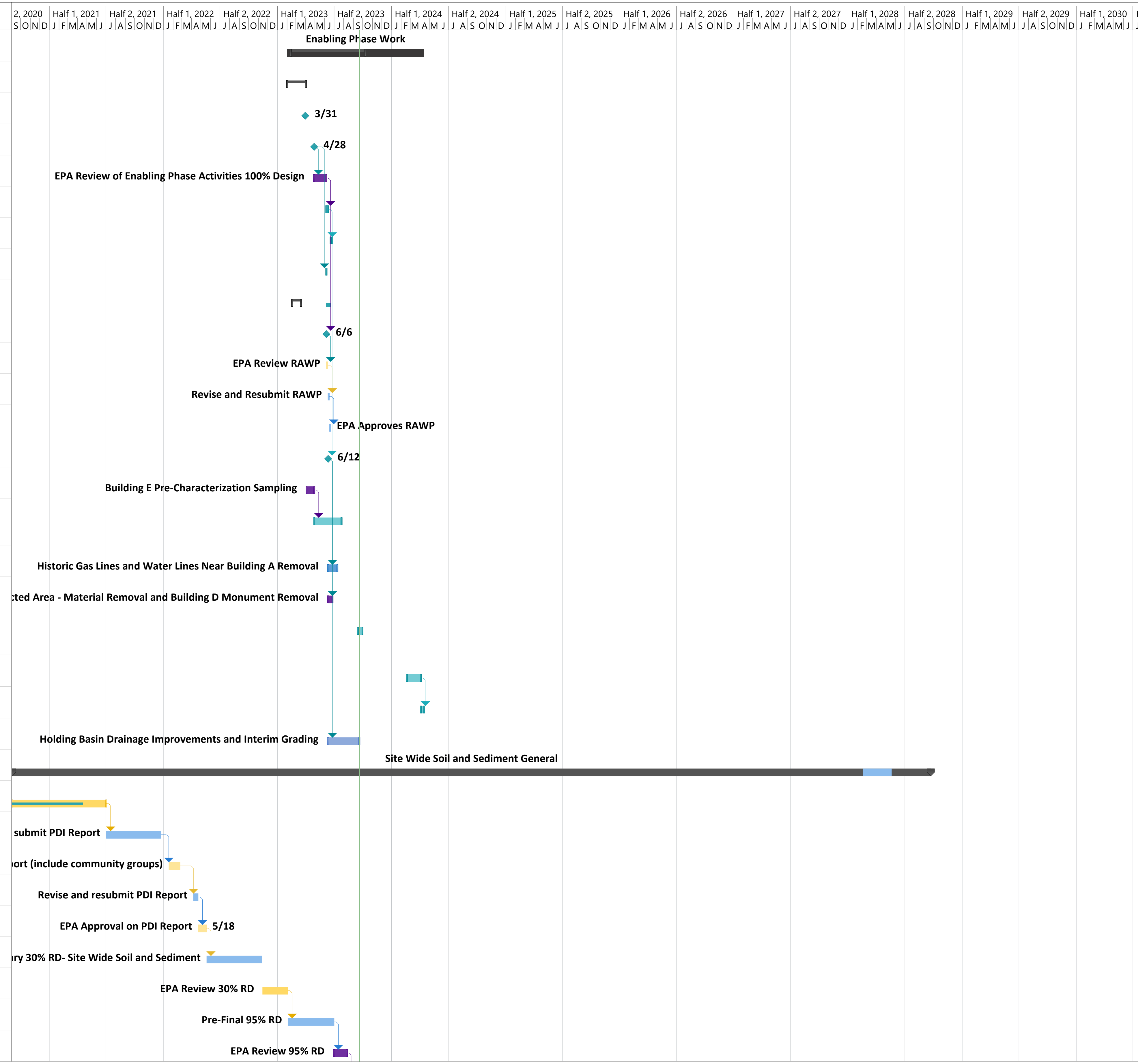
Order of Notification	Name	Company	Role/ Responsibility	Contact Number	Email
1	Global Response Operations Center (GROC)	US Ecology	Emergency Response	800-899-4672	groc@usecology.com
2	Wayne Hinton	US Ecology	Manager, Rail Equipment & Ops	508-954-1545	wayne.hinton@usecology.com
3	Todd Majer	de maximis, inc.	NMI Project Manager	978-875-0635	tmajer@demaximis.com
4	Jessie McCusker	de maximis, inc.	NMI Project Manager	860-833-4112	Jessie@demaximis.com

Note: The GROC is staffed 24/7/365 with ER Coordinators. US Ecology has approximately 16 – 18 personnel managing ER calls through the GROC.

APPENDIX E

Schedule

ID	Task Name	Start	Finish
48	**Enabling Phase Work**	**Mon 2/13/23**	**Sun 10/8/23**
49	**Enabling Phase Submit 100% Design Completion and Submission to EPA**	**Wed 2/1/23**	**Sat 4/1/23**
50	Enabling Phase Activities Pre Construction Conference	Fri 3/31/23	Fri 3/31/23
51	Submit 100% Design	Fri 4/28/23	Fri 4/28/23
52	EPA Review of Enabling Phase Activities 100% Design	Fri 4/28/23	Mon 6/5/23
53	Revise and resubmit Enabling Phase Activities 100% Design	Tue 6/6/23	Sat 6/10/23
54	EPA Approval of Enabling Phase Activities 100% Design	Tue 6/20/23	Sat 6/24/23
55	Award RA Contract	Tue 6/6/23	Tue 6/6/23
56	**Enabling Phase Activities RAWP completion and EPA Approval**	**Fri 2/17/23**	**Thu 3/16/23**
57	RAWP	Tue 6/6/23	Tue 6/6/23
58	EPA Review RAWP	Tue 6/6/23	Sat 6/10/23
59	Revise and Resubmit RAWP	Sun 6/11/23	Thu 6/15/23
60	EPA Approves RAWP	Fri 6/16/23	Tue 6/20/23
61	Pre-construction conference	Mon 6/12/23	Mon 6/12/23
62	Building E Pre-Characterization Sampling	Tue 4/4/23	Fri 4/28/23
63	Building A Pre-Characterization Sampling	Sat 4/29/23	Mon 7/24/23
64	Historic Gas Lines and Water Lines Near Building A Removal	Mon 6/12/23	Tue 7/11/23
65	Courtyard Restricted Area - Material Removal and Building D Monument Removal	Mon 6/12/23	Sun 6/25/23
66	Southern Cooling Pond Excavation and Grading	Fri 9/15/23	Fri 9/29/23
67	Buildings B, C, and D Pre-Characterization Sampling	Mon 2/19/24	Wed 4/3/24
68	Outside Building Pre-Characterization Sampling	Thu 4/4/24	Sat 4/13/24
69	Holding Basin Drainage Improvements and Interim Grading	Mon 6/12/23	Tue 9/19/23
70	**Site Wide Soil and Sediment General**	**Fri 9/4/20**	**Thu 9/21/28**
71	Implement PDIs	Fri 9/4/20	Thu 7/1/21
72	Prepare and submit PDI Report	Fri 7/2/21	Thu 12/23/21
73	EPA Review PDI Report (include community groups)	Tue 1/18/22	Tue 2/22/22
74	Revise and resubmit PDI Report	Thu 4/7/22	Thu 4/21/22
75	EPA Approval on PDI Report	Fri 4/22/22	Wed 5/18/22
76	Preliminary 30% RD- Site Wide Soil and Sediment	Thu 5/19/22	Fri 11/11/22
77	EPA Review 30% RD	Mon 11/14/22	Thu 2/2/23
78	Pre-Final 95% RD	Fri 2/3/23	Fri 6/30/23
79	EPA Review 95% RD	Sat 7/1/23	Thu 8/10/23



ID		Task Name	Start	Finish
80		Final 100% RD	Fri 8/11/23	Wed 9/6/23
81		EPA Review 100% RD (include Community Groups)	Thu 9/7/23	Tue 9/12/23
82		Revise and resubmit Phase 1 - 100% RD	Wed 9/13/23	Tue 9/26/23
83		EPA Approval and notice to Proceed with Phase 1 - RA	Fri 9/29/23	Fri 9/29/23
84		Revise and resubmit Phase 2 - 100% RD	Sat 9/30/23	Sat 3/22/25
85		EPA Approval and notice to Proceed with Phase 2 - RA	Sun 3/23/25	Sat 4/5/25
86		**Award Phase 1 RA Contract**	**Wed 7/26/23**	**Fri 11/17/23**
103		Phase 1 Remedial Action Work Plan	Sat 9/30/23	Thu 12/28/23
104		EPA Review Phase 1 RAWP	Fri 12/29/23	Sat 1/27/24
105		Revise and Resubmit Phase 1 RAWP	Sun 1/28/24	Sat 2/10/24
106		EPA Approves Phase 1 RAWP	Sun 2/11/24	Sat 2/17/24
107		Phase 1 Pre-construction conference	Fri 3/15/24	Fri 3/15/24
108		Start of Phase 1 Construction	Fri 3/15/24	Fri 3/15/24
109		**Site Wide Soils and Sediments Construction**	**Fri 3/15/24**	**Thu 9/21/28**
110		**Courtyard Area Construction (Phase 1)**	**Fri 3/15/24**	**Fri 5/24/24**
111		Courtyard Support of Excavation (SOE) Installation and Utility Excavation	Fri 3/15/24	Thu 4/11/24
112		Remaining Courtyard Soil Excavation	Wed 3/27/24	Thu 4/25/24
113		Courtyard Confirmatory Sampling for Demonstration of Compliance	Fri 4/26/24	Thu 5/9/24
114		Courtyard Additional Excavations	Fri 5/10/24	Fri 5/24/24
115		Landfill Area Construction (Phase 1)	Tue 4/6/27	Sun 7/4/27
116		Bog Sediment Remediation (Phase 1)	Mon 7/5/27	Sat 10/2/27
117		Cooling Pond Construction (Phase 1)	Sat 3/27/27	Sat 7/24/27
118		Building E Slab remediation (Phase 2)	Sun 7/25/27	Thu 10/21/27
119		Buildings B through D Slab Remediation (Phase 2)	Fri 10/22/27	Wed 1/19/28
120		Paved area around Buildings Construction (Phase 2)	Thu 1/20/28	Fri 2/18/28
121		Site-Restoration / Demobilization	Sat 2/19/28	Thu 5/18/28
122		Inspection of completed remedy	Sat 6/17/28	Sat 6/17/28
123		RA Report	Tue 8/1/28	Tue 8/1/28
124		EPA Review RA Report	Wed 8/2/28	Thu 8/31/28
125		Revise and Resubmit RA Report	Fri 9/1/28	Thu 9/14/28
126		EPA Determination of RA Completion	Fri 9/15/28	Thu 9/21/28
127		**Post Restoration Monitoring**	**Fri 9/22/28**	**Thu 9/22/33**