FINAL

PHASE IV
QUALITY ASSURANCE PROJECT PLAN ADDENDUM

Remedial Investigation
Former Camp Hero, Montauk, New York

Revision: 0

Prepared for:

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U.S. Army Corps of Engineers
New York District
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and

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January 2021

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ACRONYMS AND ABBREVIATIONS

%	percent
%RSD	percent relative standard deviation
ºC	degrees Celsius
ADR	Automated Data Review
amsl	above mean sea level
AOC	Area of Concern
APP	Accident Prevention Plan
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
bgs	below ground surface
BS	blank spikes
BTV	background threshold value
CAMP	Community Air Monitoring Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulation
CoC	chain of custody
COC	chemical of concern
COPC	chemical of potential concern
CP	Commissioner’s Policy
Cr^{6+}	hexavalent chromium
CSM	conceptual site model
CWM	Chemical Warfare Materiel
DD	Decision Document
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
DO	dissolved oxygen
DoD	Department of Defense
DOT	Department of Transportation
DQI	data quality indicator
DQO	data quality objective
DU	decision unit
EB	equipment blank
ECD	electron capture device
ELCR	excess lifetime cancer risk
ELLE	Eurofins Lancaster Laboratories Environmental, LLC

EM	Engineering Manual or Environmental and Munitions
eQAPP	electronic Quality Assurance Project Plan
ERA	Ecological Risk Assessment
FD	field duplicate
FPS	Fixed-Pulse Radar Surveillance
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
FUDSChem	Formerly Used Defense Sites Chemical Database
GC	gas chromatograph
GC-ECD	gas chromatograph-electron capture detector
GPS	global positioning system
HHRA	Human Health Risk Assessment
HHSE	human health screening evaluation
HI	hazard index
HTRW	Hazardous, Toxic, and Radioactive Waste
ICP	inductively coupled plasma
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigation-derived waste
IEUBK	Integrated Exposure-Uptake Biokinetic
KM	Kaplan Meier
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LICAP	Long Island Commission for Aquifer Protection
LNAPL	light non-aqueous phase liquid
LOD	limit of detection
LOQ	limit of quantitation
µg/dL	micrograms per deciliter
µg/L	micrograms per liter
MCL	maximum contaminant level
MDC	maximum detected concentrations
MDL	method detection limit
MEC	munitions and explosives of concern
mL	milliliters
MP	Motor Pool
MPC	measurement performance criteria

MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
ND	non-detect
NFA	no further action
NRHP	National Register of Historic Places
NTU	nephelometric turbidity unit
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSOPRHP	New York State Office of Parks, Recreation, and Historic Preservation
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PARCCS	precision, accuracy, representativeness, completeness, comparability, and sensitivity
PCB	polychlorinated biphenyl
PDF	portable document format
PID	Photo Ionization Detector
PP	Proposed Plans
ppm	parts per million
PSLs	project screening levels
PVC	poly-vinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RI	Remedial Investigation
RL	reporting limit
RPD	relative percent difference
RSL	regional screening level
SC	specific conductivity
SCDHS	Suffolk County Department of Health Services
SCWA	Suffolk County Water Authority
SEDD	Staged Electronic Data Deliverable
SIM	Selective Ion Monitoring

SOP	standard operating procedure
SS	Site Supervisor
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
STARS	Spill Technology and Remediation Series
STORET	Storage and Retrieval
SVOC	semi-volatile organic compound
TB	trip blank
TBD	to be determined
TCLP	toxicity characteristic leaching procedure
TEF	toxicity equivalence factors
UFP	Uniform Federal Policy
UGA	Upper Glacial Aquifer
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United State Geological Survey
UST	underground storage tank
UU/UE	unlimited use/unrestricted exposure
UXO	unexploded ordnance
VISL	vapor intrusion screening levels
VOC	volatile organic compound

INTRODUCTION

The United States (US) Army Corps of Engineers (USACE) is completing a Remedial Investigation (RI), Proposed Plan (PP), and Decision Document (DD) for the former Camp Hero located in Montauk, Suffolk County, New York. This work is being completed under the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS) for Hazardous, Toxic, and Radioactive Waste (HTRW), Project Number C02NY002403. The project elements are performed under the DERP FUDS program in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process (42 US Code 1980), as amended by the Superfund Amendments and Reauthorization Act of 1986. Following the completion of the RI Report (AECOM-Tidewater JV, 2019a) and PP (AECOM-Tidewater JV, 2019b), public comments were received relative to the potential for historical Camp Hero activities to have impacted deep groundwater (i.e., the Upper Glacial Aquifer [UGA]) that may be used as a drinking water source. The Phase IV RI activities described in this document were designed to address those public concerns.

The USACE has conducted several environmental studies and response actions at the former Camp Hero to date. Extensive field investigations were conducted between 2016 and 2017, as part of the RI, to evaluate whether potential releases related to former military operations may pose a risk to humans or the environment. An RI Report was issued in January 2019, and a PP was issued in September 2019, both of which indicated that no further action (NFA) is required for all media throughout the FUDS. The documents were issued in coordination with support agencies consisting of the New York State (NYS) Department of Environmental Conservation (NYSDEC), NYS Department of Health (NYSDOH), and NYS Office of Parks, Recreation, and Historic Preservation (NYSOPRHP). Both the RI and PP were accepted by the regulatory stakeholders. A public meeting for the PP was hosted by USACE in October 2019 and interested members of the public were invited to comment on the PP during a 45-day Public Comment Period from 1 October 2019 to 15 November 2019. During the public meeting and comment period for the PP, public concerns were raised relative to the potential for impacts from Camp Hero to affect the drinking water aquifer.

Investigation Purpose

The purpose of the Phase IV RI is to determine if chemical constituents attributable to historical Department of Defense (DoD) activities at the Camp Hero FUDS are present in the groundwater of the UGA at unacceptable risk levels for a small set of residential receptors to the southwest of the Camp Hero FUDS. The RI Report concluded that the shallow perched groundwater lenses beneath the areas investigated at Camp Hero, called Decision Units (DUs), were not hydraulically connected to drinking water resources in Suffolk County and that there was limited to no potential for migration of chemical constituents from the shallow perched groundwater to the deeper groundwater in the UGA. Although the shallow perched groundwater lenses beneath Camp Hero were sampled and evaluated as part of the RI, the deep groundwater in the UGA was not characterized due to the presence of confining layers underlying the perched water lenses that impede vertical movement of water and because there was no evidence of vertical or horizontal contaminant migration in soil, sediment, surface water, or groundwater at the identified release areas. However, due to the complex geology of the glacial deposition environment, there is s potential for perched water to leach into the UGA through areas where more permeable subsurface units may exist or the subsurface confining units may be thin. Due to this uncertainty, the USACE decided to conduct sampling of the UGA to address the public's concern about potential impacts from Camp Hero activities to drinking water sources.

Quality Assurance Project Plan Addendum Organization

This Phase IV RI Quality Assurance Project Plan (QAPP) Addendum was developed in accordance with the requirements and elements set forth in the Uniform Federal Policy (UFP) for QAPPs (Intergovernmental Data Quality Task Force [IDQTF], 2005a-c) and USEPA Requirements for Quality Assurance Project Plans (US Environmental Protection Agency [USEPA] 2001). The RI QAPP Addendum is comprehensive to the extent practicable and does not refer to or rely on separate work plans, consistent with the USEPA's intent that the QAPP be the premier planning document for an entire project. Minimizing the existence of separate work plans maintains consistency across project elements and optimizes the administrative effort required to review and revise project documents.

The QAPP worksheets can be grouped based on similar tasks into the following:

Project Management

QAPP Worksheet #1: Title and Approval Page

QAPP Worksheet #3: Distribution List

QAPP Worksheet #5: Project Organizational Chart

QAPP Worksheet #6: Communication Pathways

QAPP Worksheet #9: Project Scoping Session Summary

QAPP Worksheet #16: Project Schedule

Conceptual Site Model and Data Quality Objectives

QAPP Worksheet #10: Conceptual Site Model

QAPP Worksheet #11: Data Quality Objectives/Systematic Planning Process Statements

Sample Locations, Rationale, and Sampling Methods

QAPP Worksheet #14: Summary of Project Tasks

QAPP Worksheet #17: Sampling Design and Rationale

QAPP Worksheet #18: Sampling Locations and Methods

Field Work Quality Control

QAPP Worksheet #20: Field Quality Control Sample Summary

QAPP Worksheet #21: Field Standard Operating Procedures

Chemistry Quality Assurance/ Quality Control

QAPP Worksheet #12: Measurement Performance Criteria

QAPP Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

QAPP Worksheet #19: Sample Containers, Preservation, and Hold Times

QAPP Worksheet #23: Analytical Standard Operating Procedures

QAPP Worksheet #28: Analytical Quality Control and Corrective Actions

QAPP Worksheet #30: Analytical Services Table

Data Review

QAPP Worksheet #34, #35, and #36: Data Verification and Validation (Steps IIa and IIb) Procedures

QAPP Worksheet #37: Data Usability Assessment

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WORKSHEET #1: TITLE AND APPROVAL PAGE

Document Title: Phase IV Remedial Investigation Quality Assurance Project Plan, Camp Hero, Montauk, New York

Document Control Number: To be determined (TBD)

Lead Organization: United States Army Corps of Engineers (USACE), New England District (NAE)

Preparer's Name and Organizational Affiliation: Devon Chicoine, AECOM

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Mark MacEwan, Project Manager, AECOM

Investigative Organization's Project Chemist:

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Devon Chicoine, Project Chemist, AECOM

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Julia Rupp, USACE New England District

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WORKSHEET #3: DISTRIBUTION LIST

The following individuals and their organizations require copies of the approved QAPP Addendum and any subsequent revisions and other site-specific documents.

QAPP Recipients	Project Role	Affiliation	Telephone Number	Email Address
Julia Rupp, PG	Project Manager/ Technical Lead	USACE-New England District	978-318-8962	Julia.M.Rupp@usace.army.mil
Cynthia Auld	Human Health Risk Assessor	USACE-New England District	978-318-8042	Cynthia.A.Auld@usace.army.mil
Yixian Zhang	Chemist	USACE-New England District	978-318-8730	Yixian.Zhang@usace.army.mil
Dan Groher	Engineer	USACE-New England District	978-318-8404	Daniel.M.Groher@usace.army.mil
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Mike Glinski	Site Safety and Health Officer	AECOM	786-374-8985	Michael.Glinski@aecom.com
John Maier	Quality Assurance Officer	AECOM	703-682-3110	John.Maier@aecom.com

Notes:

AECOM	AECOM Technical Services, Inc.	PMP	Project Management Professional ®
JV	joint venture	USACE	United States Army Corps of Engineers
LNAPL	light non-aqueous phase liquid		
PE	Professional Engineer		
PG	Professional Geologist		

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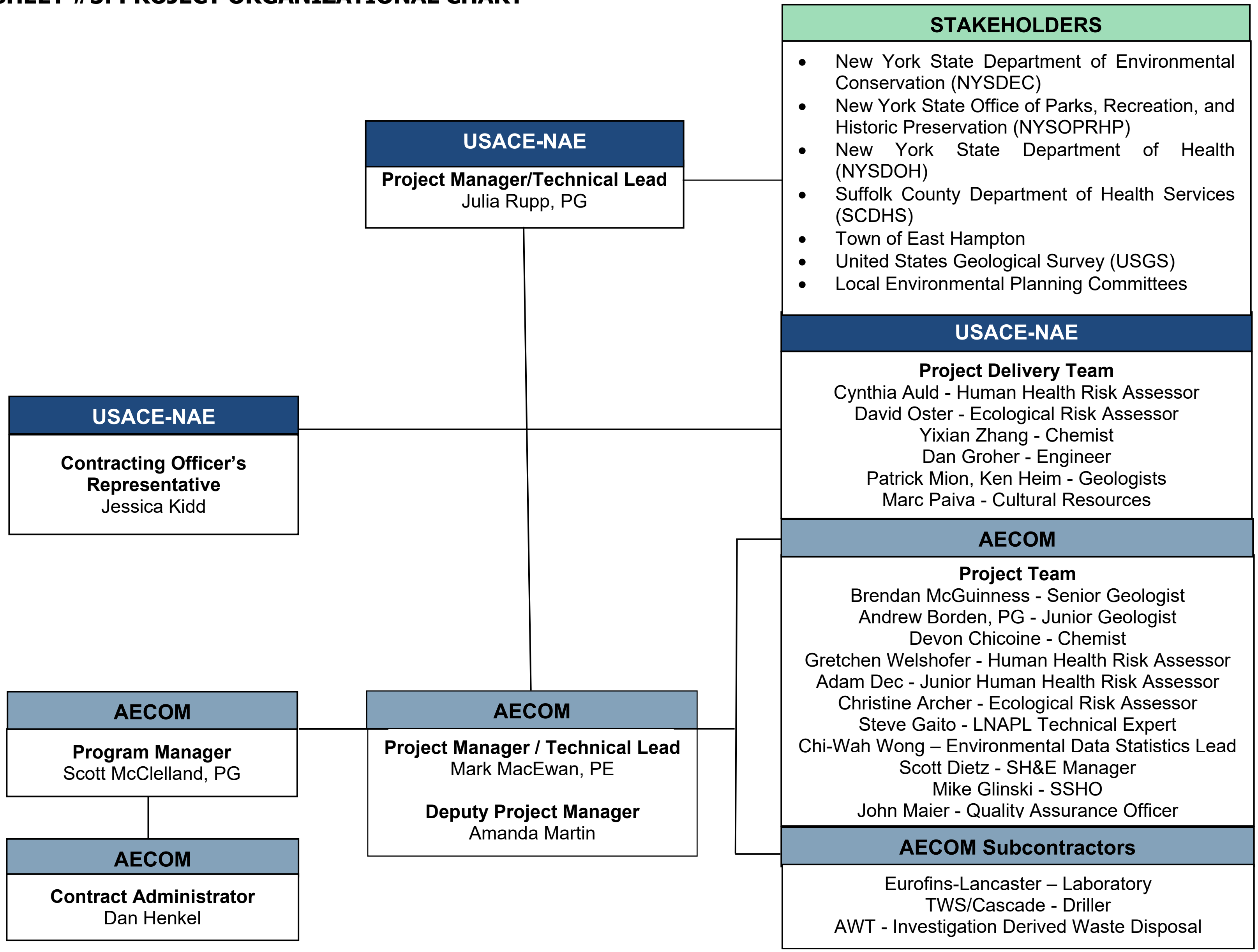
WORKSHEET #5: PROJECT ORGANIZATIONAL CHART



STAKEHOLDERS

- New York State Department of Environmental Conservation (NYSDEC)
- New York State Office of Parks, Recreation, and Historic Preservation (NYSOPRHP)
- New York State Department of Health (NYSDOH)
- Suffolk County Department of Health Services (SCDHS)
- Town of East Hampton
- United States Geological Survey (USGS)
- Local Environmental Planning Committees

USACE-NAE
Project Manager/Technical Lead
Julia Rupp, PG

USACE-NAE
Contracting Officer's Representative
Jessica Kidd

USACE-NAE
Project Delivery Team
Cynthia Auld - Human Health Risk Assessor
David Oster - Ecological Risk Assessor
Yixian Zhang - Chemist
Dan Groher - Engineer
Patrick Mion, Ken Heim - Geologists
Marc Paiva - Cultural Resources

AECOM
Program Manager
Scott McClelland, PG

AECOM
Contract Administrator
Dan Henkel

AECOM
Project Manager / Technical Lead
Mark MacEwan, PE

Deputy Project Manager
Amanda Martin

AECOM
Project Team
Brendan McGuinness - Senior Geologist
Andrew Borden, PG - Junior Geologist
Devon Chicoine - Chemist
Gretchen Welshofer - Human Health Risk Assessor
Adam Dec - Junior Human Health Risk Assessor
Christine Archer - Ecological Risk Assessor
Steve Gaito - LNAPL Technical Expert
Chi-Wah Wong – Environmental Data Statistics Lead
Scott Dietz - SH&E Manager
Mike Glinski - SSHO
John Maier - Quality Assurance Officer

AECOM Subcontractors
Eurofins-Lancaster – Laboratory
TWS/Cascade - Driller
AWT - Investigation Derived Waste Disposal

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WORKSHEET #6: COMMUNICATION PATHWAYS

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Point of Contact with USACE	AECOM Project Manager	Mark MacEwan	703-682-9092	Reporting of project information to the USACE Project Manager through monthly progress reports, e-mail updates, teleconference calls, and meetings.
Manage All Project Phases	AECOM Project Manager AECOM Deputy Project Manager	Mark MacEwan Amanda Martin	703-682-9092 978-905-2486	Primary modes of communication are telephone, e-mail, letter, document submittal; timing dependent on nature of communication and predefined schedules, as applicable and as requested by agencies.
QAPP changes in the field	AECOM Site Supervisor	Mike Glinski	786-374-8985	Notify AECOM Project Manager and Project Chemist of changes to QAPP in the field and rationale for changes. Document changes in field daily progress reports and memoranda to AECOM and USACE Project Managers.
Daily Field Progress Reports	AECOM Site Supervisor	Mike Glinski	786-374-8985	The Site Supervisor will complete daily field progress reports and forward to AECOM and USACE Project Managers on a weekly or as needed basis.
Field Corrective Action	AECOM Project Chemist	Devon Chicoine	703-682-9069	Need for field corrective action will be determined by the Project Chemist and will be communicated to the Site Supervisor and in memoranda to AECOM and USACE Project Managers.
Reporting Laboratory Data Quality Issues	ELLE Project Manager	Stephen Gordon	717-656-2300	All QA/QC issues with project field samples will be reported by the laboratory to the Project Chemist/QA Officer.
Laboratory Analytical Corrective Actions	AECOM Project Chemist ELLE Project Manager	Devon Chicoine Stephen Gordon	703-682-9069 717-656-2300	Need for laboratory corrective actions will be determined by the Project Chemist and/or laboratory Project Manager or QA Manager and will be documented in memoranda to AECOM and USACE Project Managers.
Data Tracking and Management	AECOM Project Chemist	Devon Chicoine	703-682-9069	Project Chemist (or delegated representative) will track data from collection of samples through login at laboratory to delivery by technical report/sample data group and electronic data delivery into database.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Release of Analytical Data	AECOM Project Chemist	Devon Chicoine	703-682-9069	Final analytical data cannot be released until validation is complete and Project Chemist has approved release.
QAPP Amendments	AECOM Project Chemist	Devon Chicoine	703-682-9069	Changes to the QAPP will be approved by the AECOM and USACE Project Managers.
Data Validation Issues	AECOM Data Validator	Devon Chicoine	703-682-9069	The Data Validator will coordinate with the Project Chemist and analytical laboratory to ensure data packages provided by the laboratory are complete. The Data Validator will use ADR in FUDSChem to perform data validation, and will immediately notify the Project Chemist of data that are qualified as being affected by serious data quality deficiencies (X qualifier). Final acceptance or rejection (R qualifier) of the X-qualified data will be decided by the USACE and AECOM project team.
Human Health Risk Assessment	AECOM Human Health Risk Assessor	Gretchen Welsholfer Adam Dec	301-820-3148	The Risk Assessor will coordinate with the Project Chemist, database manager, and statistician to complete risk assessment.
FUDSChem Database Management	AECOM Project Chemist AECOM Database Manager	Devon Chicoine Debbie Masonheimer	703-682-9069 831-920-2949	Data Manager will track data from collection to delivery of report/sample data and create report tables from FUDSChem.

Notes:

AECOM	AECOM Technical Services, Inc.
ADR	Automated Data Review (ADR)
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
FUDSChem	Formerly Used Defense Sites Chemical Database
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
USACE	United States Army Corps of Engineers

WORKSHEET #9: PROJECT SCOPING SESSION SUMMARY

Project Name: Phase IV Remedial Investigation

Site Name: Camp Hero

Projected Date(s) of Sampling: Fall 2020

Site Location: Montauk, New York

Project Manager (Contractor): Mark MacEwan

Dates of Sessions: 26 March 2020, 23 April 2020, 27 May 2020, 11 September 2020, 22 September 2020, 24 September 2020, 8 October 2020, 14 October 2020

Location of Session: Virtual (Phone)

Scoping Session Purpose: Discuss Phase IV RI Sampling Approach

Name	Project Role	Affiliation	Phone Number	E–Mail Address
Gregory Goepfert, PE, PMP	Project Manager (RET)	USACE-New York District	NA	NA
Julia Rupp, PG	Project Manager/ Technical Lead	USACE-New England District	978-318-8962	Julia.M.Rupp@usace.army.mil
Cynthia Auld	Human Health Risk Assessor	USACE-New England District	978-318-8042	Cynthia.A.Auld@usace.army.mil
Yixian Zhang	Chemist	USACE-New England District	978-318-8730	Yixian.Zhang@usace.army.mil
Dan Groher	Engineer	USACE-New England District	978-318-8404	Daniel.M.Groher@usace.army.mil
Patrick Mion	Geologist	USACE-New England District	978-318-8437	Patrick.J.Mion@usace.army.mil
Ken Heim	Geologist	USACE-New England District	978-318-8650	Kenneth.J.Heim@usace.army.mil
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Michael Bailey	Geologist	USACE-EMCX (Omaha)	402-697-2584	Michael.M.Bailey@usace.army.mil
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Amanda Martin	Deputy Project Manager	AECOM	978-905-2486	Amanda.Martin@aecom.com
Brendan McGuinness	Senior Geologist	AECOM	703-682-1564	Brendan.McGuinness@aecom.com
Andrew Borden, PG	Field Geologist	AECOM	978-905-2405	Andrew.Borden@aecom.com
Gretchen Welshofer	Senior Human Health Risk Assessor	AECOM	301-820-3148	Gretchen.Welshofer@aecom.com
Devon Chicoine	Chemist and Data Validator	AECOM	703-682-9069	Devon.Chicoine@aecom.com

Notes:

AECOM	AECOM Technical Services, Inc.
EMCX	Environmental and Munitions Center of Expertise
JV	joint venture
NA	not applicable
PG	Professional Geologist
PE	Professional Engineer
PMP	Project Management Professional ®
RET	retired
RI	Remedial Investigation
USACE	United States Army Corps of Engineers

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Scoping discussions were conducted on 26 March 2020, 23 April 2020, 27 May 2020, 11 September 2020, 22 September 2020, 24 September 2020, 8 October 2020, and 14 October 2020 to discuss the sampling approach for the Phase IV RI. The following bullets summarize the significant topics that were discussed, and the decisions made during the scoping discussions that contributed to the Phase IV RI QAPP Addendum:

Phase IV RI QAPP and Analytical Requirements

- AECOM will prepare a client draft, regulator/stakeholder draft, and final RI QAPP Addendum for the Phase IV field effort at the former Camp Hero. The QAPP Addendum will be prepared in accordance with all applicable NYSDEC, NYSDOH, USEPA, and USACE guidance.
- A FUDS Chemical Database (FUDSChem)-compliant electronic QAPP (eQAPP) will also be prepared, as needed to cover the proposed field work for the Phase IV field investigation. Data will be managed in FUDSChem per the latest FUDSChem Manual and validation will occur via FUDSChem Automated Data Review (ADR) at Level 2a.

Installation of New UGA Permanent Monitoring Wells with Soil and Groundwater Sample Collection

- Four new permanent monitoring wells (two sets of "nested" wells) will be installed via sonic drilling methods to evaluate the potential for impacts from Camp Hero to the UGA at two locations between the former Building 203, where light non-aqueous phase liquid (LNAPL) is present in the perched groundwater lenses, and the potential residential receptors (drinking water wells) along Old Montauk Highway to the southwest of Camp Hero. One complete pilot boring will be conducted at each of the two locations for documenting lithology and collection of geotechnical parameters. Two permanent nested monitoring wells (with different screen elevations) will then be installed at each of the locations.
- Continuous soil cores will be collected for grain size analysis and percent (%) moisture content and to document subsurface lithology. The approximate depth of the continuous cores is 140 feet below ground surface (bgs) and/or up to 50 feet into the UGA. Soil samples will be collected from the continuous cores for % moisture and grain size at a rate of one per 10 feet, up to 13 samples per boring. The field geologist, in consultation with USACE (if present), will determine the exact intervals for grain size sample collection. No quality control (QC) samples will be collected for grain size analysis or % moisture. Grain size analysis or % moisture results will not be entered into the FUDSChem database; however, lab reports for grain size and % moisture in portable document format (PDF) will be uploaded into the FUDSChem Library.

- Two "nested" permanent monitoring wells will be installed and developed at each location. One or two rounds of groundwater samples will be collected from each well, depending on the results of the first round of sampling and the potential subsequent statistical evaluation of data as described in **Worksheet #14, Section 14.3**. Samples will be analyzed for analytes consistent with the previous phases of the RI, with the exception of pesticides and herbicides. Pesticides and herbicide analysis are not warranted based on the non-detect results of the previous phases of the RI. Groundwater samples will be analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and metals (total and dissolved), including mercury and hexavalent chromium. This sampling includes analysis of the NYSDEC Commissioner's Policy (CP)-51 Spill Technology and Remediation Series (STARS) list for fuel oil, in accordance with NYSDEC policy. The specific analytes to be evaluated within each parameter group were previously refined for the Phase III RI field investigation (AECOM-Tidewater JV, 2017). For simplicity, analytical parameter groups warranting further analysis are referred to as VOCs, SVOCs, PCBs, and metals throughout the majority of this RI QAPP Addendum. Refer to **Worksheet #15** for specific details on the parameter groups and specific parameters selected for the Phase IV RI field investigation. Analytical results obtained from the Phase IV RI groundwater sampling will be entered into the FUDSChem database.

- Measures will be taken to protect the UGA from any potential cross-contamination during drilling and well installation. A 3-inch core barrel and a 5-inch diameter override casing will be utilized to core and case the borehole, respectively. A 6-inch or 7-inch override casing will be emplaced into the lower confining till above the UGA to prevent vertical migration of water from the overlying till to the UGA. Additional measures that will be taken to prevent cross-contamination are detailed in **Worksheet #14**, **Section 14.1**.

- Similar to other phases of field work, anomaly avoidance will be conducted by an Unexploded Ordnance (UXO) Technician II in accordance with Engineer's Manual (EM) 385-1-97 during subsurface investigations. Additionally, a botanist will survey areas needing vegetation removal prior to removal activities to flag endangered or rare species. Vegetation removal is anticipated to be minimal due to the location of the proposed borings adjacent to Old Montauk Highway.

- Investigation-derived waste (IDW) will be managed in a manner consistent with the past phases of field investigation. Waste characterization samples will not be submitted to FUDSChem.

Investigation of Existing UGA Supply and Monitoring Wells

- The locations of historical and current UGA supply wells and United State Geological Survey (USGS) UGA monitoring wells in the vicinity of Camp Hero were researched using available online databases including the USGS National Water Information System (USGS, 2019) and

USGS peer reviewed reports (USGS, 1986; Perlmutter and DeLuca, 1963; Cartwright, 2004) (refer to **Worksheet #10** for additional details and sources). Existing historical and current UGA supply wells and monitoring wells in the vicinity of Camp Hero were identified via review from multiple online sources of groundwater quality information; however, the presence and/or condition of each of the wells has not been confirmed. It is unknown which wells, and how many of the wells, are viable for gauging groundwater elevation or collection of groundwater samples.

- Site reconnaissance will be conducted to locate existing UGA wells for gauging. Based on the results of the site reconnaissance, up to 20 existing wells will be gauged. If necessary, USACE will attempt to obtain rights-of-entry for all wells, including any wells not located on the Camp Hero State Park property.
- If existing UGA supply or monitoring wells are determined to be viable for sampling, samples will be collected from up to three wells within the Camp Hero FUDS boundary to determine whether chemicals attributable to a release from historical DoD activities are present or absent in the UGA. The preferred existing wells to be sampled are those located closest to the known subsurface impacts at Camp Hero at the former Building 203. One or two rounds of samples will be collected from the existing on-site wells dependent upon the results of the first round and potential statistical evaluation of data as described in **Worksheet #14, Section 14.3**. Samples from the existing UGA wells will be analyzed for the same list of analytes established for samples from the new UGA wells, as described above.
- Groundwater samples will also be collected from up to eight UGA wells outside the facility boundary to determine local groundwater conditions for potential statistical comparison to groundwater data from wells located on the Camp Hero FUDS. One or two rounds of samples will be collected from the off-site wells in order to calculate background threshold values (BTVs) for constituents that may exist due to naturally-occurring conditions (i.e., heavy metals). The number of rounds of sampling will be determined by the number of data points that are obtained, as a minimum of eight data points are necessary to calculate a BTV that has approximately a 95% confidence level for a non-parametric prediction limit (refer to **Worksheet # 14, Section 14.3** for additional details).
- Existing wells identified for sampling will be redeveloped prior to collection of groundwater samples, except for wells that are actively being used for drinking water purposes, which will not be redeveloped. Groundwater samples will be collected via low-flow methodology or from an existing tap (for wells being actively used for drinking water) for analysis of the sample suite described above.

RI Report Addendum

- An addendum to the RI Report will be prepared to address whether there are impacts from Camp Hero to the UGA that are above acceptable risk.
- Review will include both internal (USACE) and external (Suffolk County Department of Health Services (SCDHS), Suffolk County Water Authority (SCWA), USGS, NYSDEC, and NYSDOH) stakeholders.
- The RI Report Addendum will include a screening level cumulative risk evaluation of groundwater data from the UGA. It is not anticipated that a full risk assessment will be needed to evaluate the groundwater data obtained from the UGA as elevated levels of chemical constituents attributed to Camp Hero activities are not anticipated from this deep aquifer.
- If unacceptable risks are identified, additional investigation beyond what is established in this QAPP Addendum will be considered. Naturally-occurring metals that are not associated with DoD activities at Camp Hero have the potential to be present within the UGA and will be considered as part of the uncertainty assessment included in the cumulative risk evaluation. This will include a comparison to BTVs and/or geochemistry evaluation.

WORKSHEET #10: CONCEPTUAL SITE MODEL

This worksheet presents general background information about the Site, the environmental setting, and the working conceptual site model (CSM) describing the relationship between environmental study areas within Camp Hero and the groundwater of the UGA. The CSM is intended to provide the basis for developing the sampling and analysis program to complete the Phase IV RI.

10.1 Site Description and Current Use

The former Camp Hero was established in early 1942 as a Coastal Defense Installation to defend the approaches to New York. Three self-sufficient weapon batteries and supporting facilities were constructed, which included barracks, mess halls, hospital facilities, a motor repair shop, a recreation facility, sentry boxes, and water supply and sewage facilities. Ammunition stored at Camp Hero included anti-aircraft munitions, high explosive rounds, armor piercing rounds, and various other projectiles. Camp Hero's weaponry was periodically test-fired over water.

Camp Hero was placed on inactive status in 1947 and ultimately declared surplus by the Department of the Army in late 1949. Between 1949 and 1980, portions of the property were transferred to the Department of the Air Force for an aircraft control and warning station or used for firing range and field exercises by the Department of the Army.

In 1974, when some of the on-site military uses were still active, portions of the property were transferred from the DoD to the State of New York. Following the departure of the last military personnel in 1980, the DoD declared the remainder of the property to be surplus federal land. Over the next few years, the property was divided and deeded to the State of New York and the Town of East Hampton, with the final land transfer to the state occurring in 1984.

The former Camp Hero is now used as Camp Hero State Park (**Figure 10-1**), and it is owned by the State of New York and operated under the jurisdiction of the NYSOPRPH. The park consists of 469 acres and is bound by Montauk Highway (Route 27) to the north, the Atlantic Ocean to the south, Montauk Point State Park to the east, and an undeveloped sanctuary area to the west. The landscape includes wooded areas, freshwater wetlands, and seaside bluffs (**Figure 10-2**).

The park contains hiking trails and roadways leading to former military buildings, picnic areas, and recreational areas. Although the Fixed-Pulse Radar Surveillance (FPS)-35 Radar Tower and Antenna ("Radar Tower") was listed under the National Register of Historic Places (NRHP) in 2002, only two facilities on the park are active at this time: a vehicle maintenance shop used by the NYSOPRHP, and an NYS Park Police building utilized as a residence for a park officer. The developed portion of the site is fenced, and the inactive buildings and bunkers have been sealed; however, some portions of these areas may be accessible to trespassers.

10.2 Topography and Geology

Long Island is in the Atlantic Coastal Plain Physiographic Province of the US. The eastern end of Long Island is divided by a series of connected bays and rivers that create two peninsulas known locally as the North and South Fork. Camp Hero State Park is located on the extreme eastern point of the South Fork. Physiographic features of Long Island are dominated by the Ronkonkoma Moraine. The Ronkonkoma Moraine forms an irregular ridge of coalescing hills traversing Long Island from west to east. The surface features of this moraine are characterized by hills and depressions with steep terrain, thickly wooded areas, and densely vegetated wetlands. Within Camp Hero State Park, the hills rise in elevation to approximately 110 feet above mean sea level (amsl). Along the south shore of the park, steep bluffs rise abruptly from sea level to elevations of 30 to 80 feet amsl above narrow, rock-strewn beaches (USGS, 1986).

Camp Hero is underlain by crystalline bedrock of Pre-Cambrian age upon which rest, in succession, un-consolidated deposits of Cretaceous, Pleistocene, and beach and marsh deposits of recent geologic age. The bedrock consists of gneiss and schist and is estimated to be 1,300 feet below sea level. The Pleistocene deposits of Long Island are end products of the advance and retreat of several glaciers during the Pleistocene Epoch. Because of the complex geologic history of the Pleistocene deposits, a summary of the general character of the glacial deposits and sequence of glacial units is provided below. A summary of the geologic strata names and hydrogeologic units in the Montauk area as presented in USGS, 1986 is provided in **Table 10-1**. Most of the material carried from the glacier was sand and well-rounded gravel that was redeposited as stratified sand and gravel glacial till deposits, which make up the substratum of most of the soil in Suffolk County. Upon further retreat of the ice, most of the till and parts of the outwash and morainic deposits were covered by water or wind-deposited silt, clay, and fine sand to varying depths, resulting in lenses and beds of silt and clay (USGS, 1986).

The upper 200 feet of these glacial deposits at Camp Hero can be broadly divided into an upper unit, consisting of undifferentiated (mixed) till and stratified deposits, and a lower unit of stratified deposits. Within the upper unit, the lower 20 to 40 feet consist of interbedded clay, silt, and thin lenses of fine brown clay (Montauk Till Member) which act as a confining unit above the UGA. The middle portion is compact clayey and gravelly till (Glaciofluvial deposits), occasionally grading laterally into fine-grained stratified sand deposits. Overlying the compact till, is typically moraine and outwash deposits (Ronkonkoma Drift) ranging from 0 to 30 feet thick below the ground surface, composed mostly of lenses of silt, fine to medium sand, and clayey sand (USGS, 1963).

10.3 Hydrology

Surface water features of eastern Long Island include lakes, ponds, streams, and wetland areas. Many of these features occupy depressions referred to as kettle holes formed by retreating glaciers. The major lakes in the area include Fresh Pond, Fort Pond, Big Reed Pond, Little Reed Pond, and Lake Montauk. Oyster Pond is the closest lake, located approximately 2,000 feet northwest of Camp Hero (USGS, 1986).

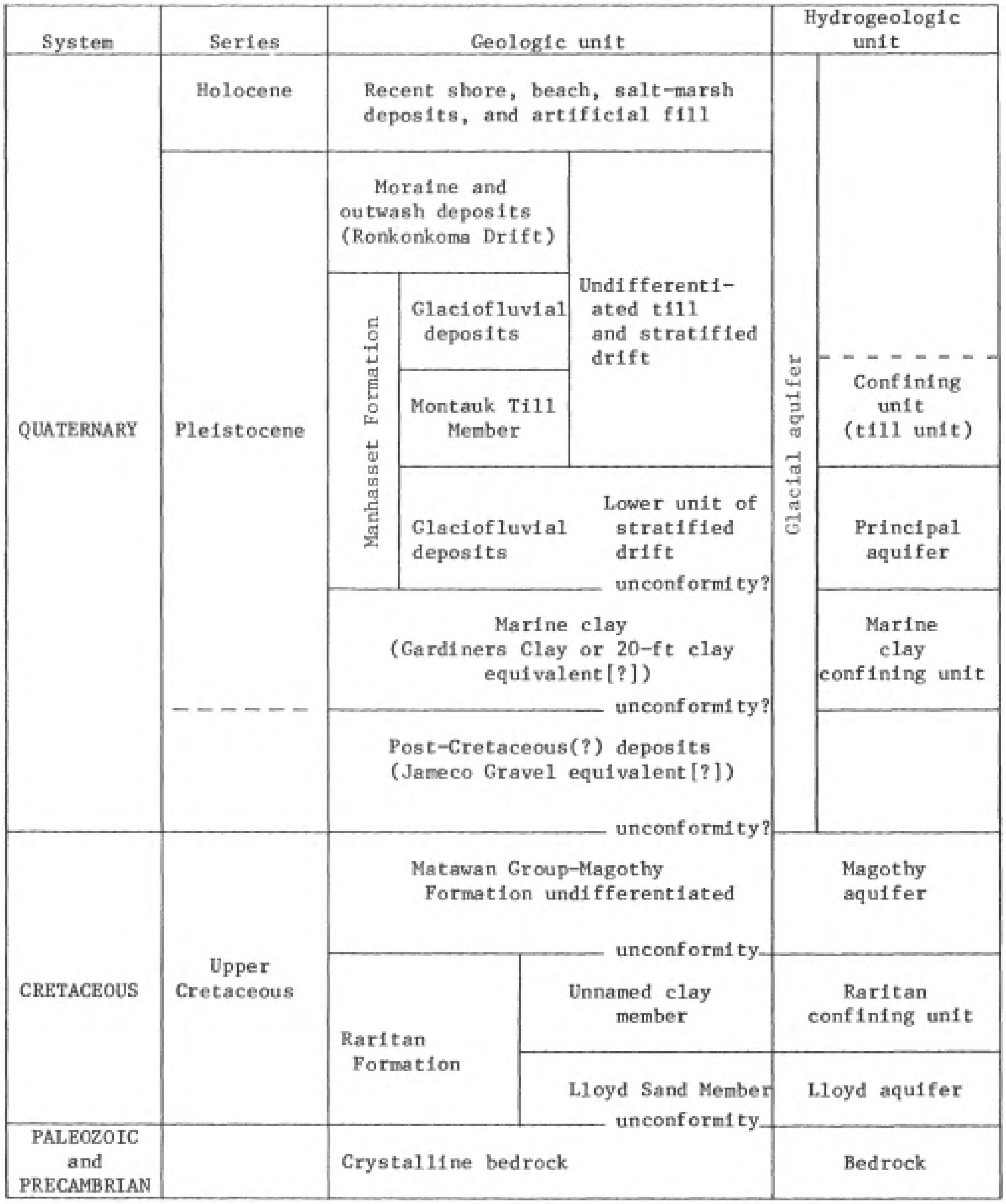
Surface water flow at Camp Hero occurs primarily through three small unnamed streams. Two of the streams flow from the western portion of Camp Hero northwestward to Oyster Pond; the third stream flows north to south across the eastern portion of Camp Hero and discharges to the Atlantic Ocean at the southern park boundary. Under natural conditions, the streams and wetlands at Camp Hero receive freshwater primarily from perched groundwater discharge and, to a lesser extent, precipitation. Some of the wetlands contain water most of the year because they are underlain by deposits of low permeability till, which inhibit infiltration. Although small amounts of water leave these marshes by percolating through the till, most water leaves by evapotranspiration. From April to September, when precipitation is less frequent and evapotranspiration is highest, most drainage features become dry, and very little perched groundwater is available for recharge (USGS, 1986).

10.4 Hydrogeology

The regional aquifer system in Suffolk County consists of a sequence of unconsolidated deposits overlying crystalline bedrock. The hydrogeologic units, in descending order, are as follows: Pleistocene-aged glacial deposits that form: the undifferentiated till and stratified drift that contain perched water; a confining unit consisting of the Montauk Till Member; the UGA, the underlying Gardiners Clay, the Cretaceous-aged deposits that compose the Magothy aquifer, the underlying Raritan Clay, and the Lloyd aquifer. Note that in the Montauk area, the top of the confining unit (Montauk Till Member) is dashed as shown on **Table 10-1**. This dashed line indicates that the thickness of the confining unit above the UGA may vary across the regional aquifer system. Also, the subsurface aquifers below the UGA are saturated with saltwater at Camp Hero.

During the RI at Camp Hero, shallow, perched water lenses were encountered in the shallow subsurface, due to the presence of silty sand lenses interbedded with units and less permeable silt and clay, which impede downward movement of water. The perched water lenses are generally small, discontinuous pockets of water temporarily stored in isolated lenses of permeable material. The thicknesses of the interbedded layers of silty sand, silt, and clay layers encountered in the subsurface during the RI was variable at the DU sites.

Table 10-1: Summary of Geologic Strata and Hydrogeologic Units in the Montauk Area



System	Series	Geologic unit			Hydrogeologic unit	
QUATERNARY	Holocene	Recent shore, beach, salt-marsh deposits, and artificial fill			Glacial aquifer	
	Pleistocene	Moraine and outwash deposits (Ronkonkoma Drift)		Undifferentiated till and stratified drift		
		Manhasset Formation	Glaciofluvial deposits			
			Montauk Till Member			Confining unit (till unit)
			Glaciofluvial deposits	Lower unit of stratified drift unconformity?		Principal aquifer
		Marine clay (Gardiners Clay or 20-ft clay equivalent[?]) unconformity?				Marine clay confining unit
		Post-Cretaceous(?) deposits (Jameco Gravel equivalent[?]) unconformity?				
CRETACEOUS	Upper Cretaceous	Matawan Group-Magothy Formation undifferentiated unconformity			Magothy aquifer	
		Raritan Formation	Unnamed clay member		Raritan confining unit	
			Lloyd Sand Member unconformity		Lloyd aquifer	
PALEOZOIC and PRECAMBRIAN		Crystalline bedrock			Bedrock	

Notes:

The "Principle aquifer" indicated in this diagram is equivalent to the "UGA" terminology utilized in this RI QAPP Addendum.

Table 10-1 is entirely excerpted from USGS, 1986.

The greatest thickness of silt and clay units underlying perched groundwater was documented at DU01. Subsurface silt and clay was encountered at soil boring DU01-S009 from 8.5 feet bgs to the total depth of the borehole at 17 feet bgs and at soil boring DU01-S015 from 8.5 feet bgs to the total depth of the borehole at 29 feet bgs. The result of the geotechnical laboratory analysis of hydraulic conductivity of core samples taken at these borings were equivalent to 0.0001 feet/day to 0.0006 feet/day. The very low hydraulic conductivity results of the clay support the observations that the silt and clay layers represent confining units underlying the perched water-bearing zone at DU01.

In order to further characterize the extent and the thickness of clay and silt confining units at Camp Hero, available subsurface geological logs for supply wells and monitoring wells drilled into the UGA in the vicinity of Camp Hero were reviewed. Well logs were obtained from the NYSDEC, USGS, and various USGS reports (USGS, 1986; Perlmutter and DeLuca, 1963; Cartwright, 2004). Review of these available subsurface logs and cross-sections indicated that layers of clay and silt between 20 to 40 feet in thickness were encountered above the UGA at these locations across the Camp Hero area.

Based on the silt and clay units observed underlying perched water at DU sites during the RI, the low hydraulic conductivity of the silt and clay, the perched water at RI DUs does not appear to directly recharge to the UGA. The subsurface lithology at RI DU sites indicate that shallow perched water primarily discharges to nearby low lying streams and wetlands at Camp Hero. Some of the wetlands contain water most of the year because they are also underlain by deposits of low permeability till. Although much of this water leaves by evapotranspiration, small amounts of water likely leach through the till, to eventually recharge the UGA. The UGA is present in the lower unit of stratified glacial deposits underneath the upper undifferentiated till and stratified glacial deposits and confining unit (Montauk Till). The UGA is bounded laterally and below by saltwater and isolated from the rest of Long Island's groundwater system (USGS, 1986). A General Hydrogeologic Cross-Section is presented as **Figure 10-3**. Groundwater from the UGA is currently obtained for drinking water use via privately owned wells at residences located along Old Montauk Highway to the southwest of Camp Hero State Park. Groundwater is not currently obtained for drinking water use from the UGA at Camp Hero State Park. Groundwater was historically obtained from several UGA supply wells at Camp Hero by the DoD during use of the property from 1942 to 1974. The Madison Hills residential area northwest of Camp Hero historically obtained drinking water from the UGA via community supply wells, but this community and the park officer residence at Camp Hero are now supplied drinking water by Suffolk County Water Authority (SCWA).

The direction of groundwater flow in the UGA beneath Camp Hero is to the north and northwest in the northern portion of Camp Hero and to the south and southwest in the southern portion of Camp Hero. The direction of groundwater flow in the UGA is derived from periodic USGS groundwater monitoring well gauging data and published water table elevation contours from 1997, 2006, 2010, 2013, and 2016. The most recent UGA water table elevations measured in the Camp Hero area during 2016 are shown on **Figure 10-4** (USGS, 2016). Based on the periodic water table elevations, the direction of groundwater flow in the UGA in the known area of subsurface impacts associated with DU01 has been consistently south to southeasterly.

10.5 Summary of Remedial Investigation and Proposed Plan

A RI was completed at Camp Hero to identify and summarize the nature and extent of potential releases and impacts in site media from former military operations, and to subsequently quantify whether unacceptable risks are posed to human health or ecological receptors associated with exposure to constituents from these historical operations. A historical records review conducted in 2015 as part of the RI identified 45 potential Areas of Concern (AOCs) at Camp Hero; two additional AOCs were identified in 2016, for a total of 47 AOCs. These AOCs included former waste disposal and coal storage areas, abandoned drum locations, formerly documented and alleged underground storage tanks (USTs) and aboveground storage tanks (ASTs), a Motor Pool building, and other areas associated with historical DoD operations. Previous investigations at Camp Hero have included UST and AST closures and reports, focused site assessments, and sitewide surveys and reports. Refer to the Final RI Report for Camp Hero (AECOM-Tidewater JV, 2019a) for a detailed discussion of historical investigation reports and the soil, sediment, surface water, and groundwater sampling and evaluations conducted in support of the RI.

The RI Report compiled and evaluated data obtained from approximately 1,300 soil, sediment, surface water, and groundwater samples collected between May 2016 and June 2017 during three phases of field investigation: Phase I, Phase II, and Phase III. The analyses performed varied between AOCs based on the reasons for concern at that AOC, and included VOCs, SVOCs, energetics (munitions), PCBs, and metals. After the first two phases of investigation, the AOCs warranting further evaluation were grouped into 18 geometric DUs for the assessment of soil. Streams in the vicinity of the DUs were grouped into eight stream exposure areas (SEAs) for the assessment of surface water and sediment. The RI data evaluation focused on surface soil and subsurface soil collected from the DUs, surface water and sediment collected from the downgradient SEAs, and groundwater data collected from across the site. The RI Report included a human health risk assessment (HHRA) and an ecological risk assessment (ERA) that evaluated the potential for risks to human and ecological receptors exposed to environmental media associated with the DUs and SEAs at Camp Hero. The RI concluded that there is no unacceptable site-related risk to human health or the environment due to releases regulated under CERCLA.

During the RI, residual LNAPL was identified in the subsurface at the former Building 203 (DU01), where two large USTs and associated contaminated soils were previously removed in 1993. A sample of the LNAPL was submitted for fingerprint analysis and was found to be consistent with weathered diesel/Number 2 fuel oil. Data collected during the RI field investigation delineated the vertical and horizontal extent of LNAPL and indicated the LNAPL is stable and not recoverable, and that natural processes are depleting the LNAPL source mass. Despite the presence of LNAPL, chemicals of concern (COCs) representing human health and ecological risk under CERCLA were not identified in soil, groundwater, surface water, or sediment associated with DU01. Because no COCs presenting risk were identified at DU01 during the risk evaluation, NFA for DU01 is required under the CERCLA program.

Although petroleum is exempt under CERCLA, the USACE is voluntarily working with the NYSDEC to address LNAPL in perched groundwater at the former Building 203 (DU01). A NYSDEC Spill Number (PC-1602757) was opened, and a Technical Memorandum was prepared under the NYSDEC Spills Response Program in accordance with Article Twelve of the NYS Navigation Law. The Technical Memorandum indicated that, based on the 1993 site remediation efforts (over excavation and off-site disposal of soil at the UST locations), LNAPL stability, lack of recoverability, and evidence of active source depletion, NFA is required under the NYSDEC program. The Technical Memorandum was approved by the NYSDEC, and the NYSDEC Spill Number was subsequently closed.

The sitewide groundwater sampling and evaluation in the RI focused on the perched groundwater lenses to assess whether groundwater was being impacted by historical activities associated with the DUs. The 43 monitoring wells installed to support this evaluation had total depths ranging from 15 to 40 feet bgs, and the depth to groundwater in these wells ranged from 6 to 28 feet bgs across the site. As reported in the RI, the shallow perched groundwater at Camp Hero is unsuitable for drinking based on the perched groundwater characteristics and Suffolk County drinking water well standards (AECOM-Tidewater JV, 2019a).

The USACE issued a PP in September 2019, which indicated that NFA is required for all media throughout the FUDS (AECOM-Tidewater JV, 2019b). The PP was issued in coordination with support agencies consisting of the NYSDEC, NYSDOH, and NYSOPRHP. The USACE hosted a public meeting for the PP in October 2019 and invited interested members of the public to comment on the PP during a 45-day Public Comment Period from 1 October 2019 to 15 November 2019. Public concerns were raised relative to the potential for impacts to drinking water from historical activities at Camp Hero. Sampling of the deeper groundwater in the UGA was not conducted as part of the previous RI field efforts. Therefore, sampling of the UGA is being conducted as part of the Phase IV RI to assess the potential for contaminants associated with historical activities to have migrated down to this deeper aquifer and potentially have migrated downgradient of the Camp Hero boundary.

10.6 Summary of Available UGA Water Quality Data

Available analytical data from historical and current UGA supply wells and monitoring wells in the vicinity of Camp Hero were reviewed from multiple sources. These sources included SCWA Water Quality Reports (SCWA, 2016a-b; SCWA, 2017a-b; SCWA, 2018a-b; SCWA, 2019a-b; SCWA, 2020a-b), USGS National Water Information System (USGS, 2019), SCDHS Bureau of Drinking Water supply well testing results, and various USGS peer reviewed reports (USGS, 1986; Perlmutter and DeLuca, 1963; Cartwright, 2004). The Long Island Commission for Aquifer Protection (LICAP) water quality mapping and database known as WaterTraq (LICAP, 2019) and USEPA's Storage and Retrieval (STORET) Water Quality Exchange (USEPA, 2019) were also reviewed for water quality data in the vicinity of Camp Hero. The location of UGA groundwater supply and monitoring wells identified in the Camp Hero area presented on **Figure 10-5**. A summary of information obtained for these UGA supply and monitoring wells in the Camp Hero area is provided in **Table 10-2** and **Table 10-3**.

The water quality analytical data obtained for this review ranges from 1953 to 2016 and contained analyses for water quality parameters, inorganics, metals, VOCs, SVOCs, pesticides, and herbicides. The analytical data was reviewed and compared to USEPA primary and secondary maximum contaminant levels (MCLs). **Table 10-2** summarizes instances where MCLs were exceeded. Most of the groundwater data results shown on **Table 10-2** are raw data results, meaning the groundwater was not treated prior to analysis. **Table 10-3** provides a summary of the data grouped by location.

Review of the water quality analytical data shows that beyond the Camp Hero footprint, such as at the former Madison Hills residential neighborhood supply wells, there were historical exceedances of the primary MCLs for lead and arsenic in raw water samples; however, it is extremely unlikely that these exceedances are associated with former Camp Hero FUDS activities. The exceedance of the MCL for lead was a single occurrence (in 1996) at one well, with later data showing no such exceedance for this metal. The occurrence of arsenic in the UGA of Long Island is believed to be naturally-occurring and associated with erosion of rocks containing arsenic in the glacial till (SCWA, 2020a). As stated in the 2004 USGS arsenic study, "Aquifer zones with arsenic-bearing iron-oxides or sulfide minerals can be a source of arsenic under oxidizing and reducing conditions, respectively." (USGS, 2004). Based on verbal interviews with an SCDHS representative, the SCWA extended public water supply to the Madison Hills residential neighborhood in 2010 to replace UGA supply wells due to arsenic concentrations in exceedance of the MCL.

Iron and manganese were also identified above the secondary MCLs in many raw UGA water quality samples collected in the Camp Hero area and regionally in Suffolk County (SCWA, 2020). Manganese is a common element in rocks, soil, water, plants, and animals. Manganese occurs naturally in water after dissolving from rocks and soil. It may also occur if manganese gets into surface or groundwater after improper waste disposal in landfills or steel production. Iron can be elevated in drinking water in areas where there are naturally-occurring high concentrations of iron in soil and rocks, and where iron salts are used in the water treatment process. Iron (and lead) can also get into drinking water from corrosion of cast iron, steel, and galvanized iron pipes used for water distribution.

SCWA publishes a supplemental annual water quality report documenting the maximum and average concentrations of these metals measured in raw groundwater samples obtained from UGA supply wells in each SCWA water supply district, including the SCWA Camp Hero and Montauk Point water supply district (SCWA, 2016b; SCWA, 2017b; SCWA, 2018b; SCWA, 2019b; SCWA, 2020b). The SCWA Camp Hero and Montauk Point water supply district draws water from eight well fields located west of Camp Hero. The nearest well field is located approximately 3 miles west of Camp Hero. An annual SCWA water quality report provides the results of treated UGA sample analysis for the various water districts (SCWA, 2016a; SCWA, 2017a; SCWA, 2018a; SCWA, 2019a; SCWA, 2020a). The reports document the presence of iron, manganese, and other metals in the UGA within the region. Naturally-occurring metals, which may exceed MCLs or secondary drinking water standards in groundwater samples obtained from the UGA during the Phase IV RI, will be considered during the uncertainty assessment of the Human Health Screening Evaluation (HHSE).

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Table 10-2
Upper Glacial Aquifer Well Summary
Camp Hero, Montauk, New York

USGS Well ID	USGS Site ID	Well Nickname	Well Status	Owner	Source of Information	Well Completion Report (Y/N)	Well Depth	Analytical Data (Y/N)	Latitude	Longitude	Location	Sample Period (if available)	Analytical Data Type (if available)	Compounds Exceeded MCLs	Other Notes
S 1202	410415071513101	Lighthouse Well	Active	U.S. Coast Guard	USGS	N	30	N	41°04'15.42"	71°51'29.32"	Montauk Point State Park	Jun. 2015	Water quality parameters, inorganics, metals, VOCs, SVOCs, pesticides, herbicides	---	Data from Lighthouse Reception Center sink
S 3259	415243071522201	---	Inactive	U.S. Air Force	USGS	Y	116	Y	41°03'43"	71°52'20"	Camp Hero	Oct. 1953	Water quality parameters, inorganics, metals	Iron	Former well house
S 3260	---	Former USAF Supply Well	Inactive	U.S. Air Force	USGS[1]	N	---	N	41°03'45"	71°52'32"	Camp Hero	---	---	---	---
S 3599	410412071513001	Lighthouse Well	Active	U.S. Coast Guard	USGS	N	69	N	41°04'13"	71°51'28"	Montauk Point State Park	---	---	---	---
S 79269	---	Montauk Point State Park Managers Residence and Concessions	Active	Long Island State Park	SCDHS, Camp Hero	N	---	Y	41°04'16"	71°51'54"	Montauk Point State Park	Mar. 2019	Water quality parameters, Metals, inorganics, VOCs, SVOCs, pesticides, herbicides	None	---
S 15812	410416071514601	Former Montauk Point State Park Well	Inactive	Long Island State Park	USGS, SCDHS, Camp Hero	Y	95	Y	41°04'16"	71°51'46"	Montauk Point State Park	Sept. 2016, Apr. 1974	Water quality parameters, Metals, inorganics, VOCs, SVOCs, pesticides, herbicides	Iron	---
S 70627	410414071515901	---	Active	USGS	USGS	N	95	N	41°04'14.3"	71°51'57.6"	Camp Hero	---	---	---	---
S 17231S	---	Former USAF Supply Well in Pump House	Inactive	U.S. Air Force	USGS[1]	Y	119	N	41°03'50"	71°52'23"	Camp Hero	---	---	---	---
S 17231D	---	Former USAF Supply Well outside Pump House	Inactive	U.S. Air Force	USGS[1]	N	156	N	41°03'50"	71°52'23"	Camp Hero	---	---	---	---
S 17859	---	Former USAF Supply Well in Pump House	Inactive	U.S. Air Force	USGS[1]	N	---	N	41°03'43"	71°52'20"	Camp Hero	---	---	---	---
S 19494	---	---	Inactive	U.S. Air Force	USGS[1]	N	87	N	41°03'56.83"	71°52'32.49"	Camp Hero	---	---	---	USGS test well
S 19495	---	Former AT&T Building now Park Police Residence Existing Well	Inactive	American Telephone & Telegraph Co.	USGS[1]	N	---	N	41°03'50.77"	71°52'37.47"	Camp Hero	---	---	---	---
S 48579	410316071535501	---	Active		USGS	N	---	N	41°03'17.5"	71°53'52.1"	West of Camp Hero	---	---	---	---
S 58922	410356071544201	USGS Monitoring Well	Active	USGS	USGS	Y	56	N	41°03'55.8	71°54'42.7	West of Camp Hero	---	---	---	---
S 19496	---	Former Barracks Supply Well, USAF Emergency Supply Well	Inactive	U.S. Air Force	USGS[1]	N	140	N	41°03'33.63"	71°52'18.75"	Camp Hero	---	---	---	---
S 21084	---	Former USAF Supply Well in Pump House	Inactive	U.S. Air Force	USGS[1]	N	118	N	41°03'40.47"	71°52'44.11"	Camp Hero	---	---	---	---
---	---	Old Montauk Hwy Residential Well	Active	Private	SCDHS	N	---	Y[2]	NA[4]	---	Old Montauk Hwy East	2010, 2015	Water quality parameters, inorganics, metals, VOCs, pesticides, herbicides[3]	Coliforms	Private residential well location; replacement well recently installed in 2019
---	---	Old Montauk Hwy Residential Well	Active	Private	SCDHS	N	---	Y2	---	---	Old Montauk Hwy East	2010-2019	Inorganics, metals, VOCs, SVOCs, pesticides, herbicides	Iron, Manganese, Coliforms	Samples taken from taps from outside, kitchen, and bathroom. Kitchen and bathroom samples have softener and GAC-ion exchange.
S 76304	410406071523001	Well #1	Inactive	SCWA/Town of East Hampton	USGS, SCDHS	Y	141	Y	41°04'07"	71°52'35"	Madison Hills	Oct. 1984 - Jul. 2002	Water quality parameters, inorganics, metals, VOCs, pesticides, herbicides	Arsenic, Iron, Manganese	---

Table 10-2
Upper Glacial Aquifer Well Summary
Camp Hero, Montauk, New York

USGS Well ID	USGS Site ID	Well Nickname	Well Status	Owner	Source of Information	Well Completion Report (Y/N)	Well Depth	Analytical Data (Y/N)	Latitude	Longitude	Location	Sample Period (if available)	Analytical Data Type (if available)	Compounds Exceeded MCLs	Other Notes
S 76305	410406071523101	Well #3	Inactive	SCWA/Town of East Hampton	USGS, SCDHS	Y	125	Y	41°04'07"	71°52'35"	Madison Hills	Oct. 1984 - Jul. 2002	Water quality parameters, inorganics, metals, VOCs, pesticides, herbicides	Arsenic, Lead, Iron, Manganese	---
S 121808	---	Well #2	Inactive	SCWA/Town of East Hampton	SCDHS	Y	132	Y	41°04'06.5"	71°52'35"	Madison Hills	Feb. 2005, Sep. 2009, Feb. 2010	Metals, inorganics, VOCs, SVOCs, pesticides, herbicides	Arsenic, Iron, Manganese	---
S 121811	---	Well #3A	Inactive	SCWA/Town of East Hampton	SCDHS	Y	132	Y	41°04'06.5"	71°52'35"	Madison Hills	Sep. 2009, Feb. 2010	Metals, inorganics, VOCs, SVOCs, pesticides, herbicides	Iron, Manganese	
---	---	Motor Pool Supply Well	Active	Camp Hero	SCDHS	N	---	Y	41°04'00.5"	71°52'09"	Camp Hero	Aug. 2015, Sep. 2016	Metals, inorganics, VOCs, SVOCs	None	3 compartment sink

Notes:

[1] Perlmutter, N.M., and DeLuca, F.A., 1963, *Availability of fresh ground water Montauk Point area Suffolk County Long Island, New York* : U.S. Geological Survey Water-Supply Paper 1613-B, 39 p.

[2,3] Analytical results exceeding MCLs provided by SCDHS; full analytical results not provided by SCDHS due to privacy concerns. Standard drinking water analyses assumed.

[4] Location not available due to privacy concerns.

Notes Continued:

ID - identifier
N - no
SCWA - Suffolk County Water Authority
SCDHS - Suffolk County Department of Health Services
SVOC - semi-volatile organic compound
TBD - to be determined
U.S. - United States
UGA - Upper Glacial Aquifer
USGS - United States Geological Survey
VOC - volatile organic compound
Y - yes

Table 10-3
Upper Glacial Aquifer Groundwater Analyses
Camp Hero, Montauk, New York

Location	USGS Well ID	Sample Dates	Analytical Data Type	Exceedances	Source of Data
Camp Hero	**S 3259**	October 1953	Water quality parameters, inorganics, metals	Iron (16 mg/L)	USGS
	Well for Motor Pool	August 2015	Water quality parameters, metals, inorganics, VOCs, pesticides, herbicides	None	SCDHS
		September 2016	Water quality parameters, metals, inorganics, VOCs, SVOCs, pesticides, herbicides	None	SCDHS
Madison Hills Drive Well Field	**S 76304**	October 1984 (3 dates)	Water quality parameters, inorganics, metals, VOCs	Iron (0.34 to 0.47 mg/L) Manganese (0.53 to 0.58 mg/L)	SCDHS
		October 1989	Water quality parameters, inorganics, metals	Iron (0.98 mg/L) Manganese (0.8 mg/L)	SCDHS
		April 1990	Water quality parameters, inorganics, metals, VOCs	Iron (0.97 mg/L) Manganese (0.88 mg/L)	SCDHS
		October 1990	Water quality parameters, inorganics, metals, VOCs	Iron (1.2 mg/L) Manganese (0.84 mg/L)	SCDHS
		January 1991	Water quality parameter, inorganics, metals, VOCs	Iron (1.94 mg/L) Manganese (0.95 mg/L)	SCDHS
		October 1991	Water quality parameters, inorganics, metals, VOCs	Iron (3.2 mg/L) Manganese (0.84 mg/L)	SCDHS
		November 1992	Water quality parameters, inorganics, metals, VOCs, pesticides	Iron (2.7 mg/L) Manganese (0.75 mg/L)	SCDHS
		July 1994	Water quality parameters, inorganics, metals, VOCs, pesticides	Iron (4.6 mg/L) Manganese (0.89 mg/L)	SCDHS
		October 1994 (1 date)	Water quality parameters, inorganics, metals	Arsenic (10 µg/L) Iron (2.5 and 4.7 mg/L) Manganese (0.83 and 0.57 mg/L)	SCDHS
		November 1995	Pesticides	None	SCDHS
		April 1996	Water quality parameters, inorganics, metals, VOCs, pesticides	Iron (1.34 mg/L) Manganese (0.98 mg/L)	SCDHS
		June 1998	Water quality parameters, inorganics, metals, VOCs, SVOCs, pesticides, herbicides	Iron (6 mg/L) Manganese (0.616 mg/L)	SCDHS
		June 1999	Arsenic	None	USGS [1]
		August 2000	Arsenic	None	USGS [1]
		December 2000	Arsenic	None	USGS [1]
		April 2002	Arsenic	Arsenic (10.2 µg/L)	USGS [1]
		July 2002	Water quality parameters, inorganics, metals	Arsenic (11 µg/L) Iron (2.24 mg/L) Manganese (1.4 mg/L)	USGS
	S 76305	October 1984 (3 dates)	Water quality parameters, inorganics, metals, VOCs	Iron (1.91 to 2.03 mg/L) Manganese (0.52 to 0.58 mg/L)	SCDHS
		February 1985	Water quality parameters, inorganics, metals, VOCs	Iron (2.18 mg/L) Manganese (0.59 mg/L)	SCDHS
		March 1985	Water quality parameters, inorganics, metals, VOCs	Iron (2.51 mg/L) Manganese (0.55 mg/L)	SCDHS
		July 1985	Water quality parameters, inorganics, metals, VOCs	Iron (3.9 mg/L) Manganese (0.72 mg/L)	SCDHS
		October 1989	Water quality parameters, inorganics, metals	Iron (5.3 mg/L) Manganese (0.58 mg/L)	SCDHS
		April 1990	Water quality parameters, inorganics, metals, VOCs	Iron (6.2 mg/L) Manganese (0.79 mg/L)	SCDHS
		October 1990	Water quality parameters, inorganics, metals, VOCs	Iron (5.7 mg/L) Manganese (0.68 mg/L)	SCDHS
		January 1991	Water quality parameters, inorganics, metals, VOCs	Iron (4.29 mg/L) Manganese (0.66 mg/L)	SCDHS
		October 1991	Water quality parameters, inorganics, metals, VOCs	Iron (5.1 mg/L) Manganese (0.73 mg/L)	SCDHS

Table 10-3
Upper Glacial Aquifer Groundwater Analyses
Camp Hero, Montauk, New York

Location	USGS Well ID	Sample Dates	Analytical Data Type	Exceedances	Source of Data
Madison Hills Drive Well Field (*continued*)	**S 76305 (*continued*)**	November 1992	Water quality parameters, inorganics, metals, VOCs, pesticides	Iron (4.34 mg/L) Manganese (0.59 mg/L)	SCDHS
	S 76305 *(continued)*	July 1994	Pesticides	None	SCDHS
		April 1996	Water quality parameters, inorganics, metals, VOCs, pesticides	Lead (15.9 µg/L) Iron (3.9 mg/L) Manganese (0.72 mg/L)	SCDHS
		June 1998	Water quality parameters, inorganics, metals, VOCs, SVOCs, pesticides, herbicides	Arsenic (10.1 µg/L) Iron (1.29 mg/L)	SCDHS
		June 1999	Arsenic	None	USGS[1]
		December 2000	Arsenic	None	USGS[1]
		February 2002	Arsenic	None	USGS[1]
		July 2002	Water quality parameters, inorganics, metals	Iron (4.7 mg/L) Manganese (0.585 mg/L)	USGS
	S 121808	February 2005	Water quality parameters, metals, inorganics, VOCs, SVOCs, pesticides, herbicides	Arsenic (12 µg/L) Manganese (0.640 mg/L)	SCDHS
		September 2009	Water quality parameters, metals, inorganics, VOCs, SVOCs, pesticides, herbicides	Arsenic (14 µg/L) Iron (0.8 mg/L) Manganese (0.922 mg/L)	SCDHS
		February 2010	Water quality parameters, metals, inorganics, VOCs, SVOCs, pesticides, herbicides	Arsenic (13 µg/L) Iron (0.7 mg/L) Manganese (0.987 mg/L)	SCDHS
	S 121811	September 2009	Water quality parameters, metals, inorganics, VOCs, SVOCs, pesticides, herbicides	Iron (3.7 mg/L) Manganese (0.566 mg/L)	SCDHS
		February 2010	Water quality parameters, metals, inorganics, VOCs, pesticides, herbicides	Iron (4.6 mg/L) Manganese (0.641 mg/L)	SCDHS
Montauk Lighthouse	**S 1202**	June 2015	Water quality parameters, inorganics, metals, VOCs, SVOCs, pesticides, herbicides	None	SCDHS
Montauk Point State Park	**S 79269**	March 2019	Water quality parameters, inorganics, metals, VOCs, SVOCs, pesticides, herbicides	None	SCDHS
	S 15812	April 1974	Water quality parameters, inorganics, metals	Iron (0.32 mg/L)	USGS
Old Montauk Highway East	**---**	April 2010	Inorganics, metals, VOCs, SVOCs, pesticides, herbicides,	None	SCDHS
		March 2015	Inorganics, metals, VOCs, SVOCs, pesticides, herbicides,	Iron (0.34 mg/L)	SCDHS
		April 2015	Inorganics, metals, VOCs, SVOCs, pesticides, herbicides,	Iron (4.60 mg/L) Manganese (391.0 mg/L)	SCDHS
		June 2019	Inorganics, metals, VOCs, SVOCs, pesticides, herbicides,	None	SCDHS
		July 2019	Inorganics, metals, VOCs, SVOCs, pesticides, herbicides,	None	SCDHS

Table 10-3
Upper Glacial Aquifer Groundwater Analyses
Camp Hero, Montauk, New York

Location	USGS Well ID	Sample Dates	Analytical Data Type	Exceedances	Source of Data

Notes:

[1] Cartwright, R.A., 2004, *Occurrence of Arsenic in Ground Water of Suffolk County, New York, 1997-2002* : USGS Water-Resources Investigations Report 03-4315, 11 p.

μg/L - micrograms per liter
ID - identifier
mg/L - milligrams per liter
SCDHS - Suffolk County Department of Health Services
SVOC - semi-volatile organic compound
USGS - United States Geological Survey
VOC - volatile organic compound

Maximum Contaminant Levels
Arsenic - 10 μg/L
Lead - 15 μg/L (Action Level)

Drinking Water Secondary Standards
Manganese - .05 mg/L
Iron - 0.3 mg/L

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10.7 Potential Human Health Exposure Pathways and Receptors

The following subsections describe the potential human health exposure pathways and receptors to be considered for Camp Hero. Refer to **Figure 10-6** for a graphical presentation of the potential current and future human health risk pathways for the UGA groundwater that will be evaluated.

Information provided by the NYSOPRHP in 2017 was used to identify current and potential future land uses that were evaluated in the HHRA included in the Final RI Report (AECOM-Tidewater JV, 2019a). An on-site hypothetical residential scenario was evaluated as a conservative measure even though no plans for future residential use of the area or shallow perched groundwater were identified. The drinking water exposure pathway, however unlikely, was assessed for potential unlimited use/unrestricted exposure (UU/UE). Additionally, a potability evaluation of the shallow perched groundwater was conducted as part of the RI (AECOM-Tidewater JV, 2019a). The evaluation determined that shallow groundwater was not suitable as a potable water source; however, the deeper groundwater of the UGA was not evaluated in the 2019 HHRA.

A HHSE will be conducted with the data obtained during the Phase IV RI to determine if any unacceptable risks exist for on- and off-site residential scenarios. As noted above, an on-site future residential scenario is hypothetical and used to assess potential UU/UE for informational purposes only. However, current and future off-site residents use private wells to access the lower productive aquifer. Because impacts from Camp Hero are not anticipated in the UGA, a full HHRA is not scoped for this phase of work.

The human health screening levels used to evaluate the deeper groundwater will be protective of USEPA default residential exposure parameters taken from USEPA resources including the Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors (USEPA, 2014), Exposure Factors Handbook (USEPA, 2011), and Risk Assessment Guidance for Superfund Parts E and F (USEPA, 2004; USEPA, 2009).

Potential Future On-Site Resident

There are no plans for future residential use at the Camp Hero Park (per NYSOPRHP). However, on-site residential exposure to groundwater in the UGA will be evaluated in the HHSE as a conservative measure of a potential future site use, however unlikely.

The HHSE will evaluate a potential future on-site adult and child residential scenario for the following pathways:

- Exposure to deeper groundwater through ingestion of drinking water and dermal contact and inhalation during showering or bathing; and

- Exposure to indoor air via volatilization from the subsurface (i.e., vapor intrusion) if volatile chemicals of potential concern (COPCs) are identified in the UGA groundwater.

Potential Current and Future Off-Site Resident

- If groundwater flow confirms downgradient pathways in the direction of off-site residents, then the HHSE will evaluate the off-site use of the deeper groundwater by nearby residents assuming the same groundwater exposure pathways that will be evaluated for the on-site adult and child residential scenario.

10.8 Conceptual Site Model

This section briefly summarizes the CSM, which provides the basis and framework for developing the sampling and analysis plan. For simplicity, analytical parameter groups warranting further analysis are referred to in this worksheet as VOCs, SVOCs, PCBs, and metals. The specific analytes to be evaluated within each parameter group were previously refined for the Phase III RI field investigation (AECOM-Tidewater JV, 2017). Refer to **Worksheet #15** for specific details on the parameter groups and specific parameters selected for this Phase IV RI field investigation. Refer to **Worksheet #17** and specifically **Figure 17-1** for the sampling design associated with the Phase IV RI field investigation.

The RI evaluation characterized the nature and extent of contamination in soil, sediment, surface water, and shallow perched groundwater lenses associated with historical releases within the DUs. Potential sources of releases included spills, USTs, ASTs, and other DoD operations. Relative to potential releases to groundwater, leaching is the primary transport mechanism for chemicals migrating from the source areas in soil into the underlying groundwater. The deeper groundwater in the UGA has not previously been sampled as part of the Camp Hero RI; this Phase IV RI will confirm that elevated chemical constituents associated with DUs have not migrated downgradient through the shallow perched groundwater lenses and into the deeper groundwater of the UGA towards the receptors located to the southwest of Camp Hero.

In particular, LNAPL is present in the perched groundwater of DU01 due to a release of fuel oil and the historical use of former Building 203 as an electrical power generating plant (refer to **Section 10.5** of **Worksheet #10** for additional information). Elevated chemical constituents associated with DU01 and other DUs include VOCs, SVOCs, PCBs, and metals. The very low hydraulic conductivity results presented in the RI Report (AECOM-Tidewater JV, 2019a) suggest the presence of clay layers representing confining units within and underlying the perched water bearing zone. Perched groundwater lenses in other DUs are also expected to be confined above the UGA, owing to lenses and beds of silt and clay, which retard downward movement of water.

As discussed in **Section 10.4** and shown on **Table 10-1**, subsurface geological logs for supply wells and monitoring wells drilled into the UGA in the vicinity of Camp Hero indicated that confining layers of clay and silt between 20 to 40 feet in thickness were encountered above the UGA across the Camp Hero area.

On-site groundwater within the UGA is not currently being used as a potable source, and the deep groundwater in the UGA does not discharge to local surface waterbodies that may be used by aquatic and semi-aquatic ecological receptors (e.g., fish, birds). However, off-site residents use private wells to access the lower productive aquifer (i.e., the UGA). The HHSE will determine if unacceptable risks exist in UGA groundwater to the on-site hypothetical resident (UU/UE evaluation) or for current and future off-site residents due to historical Camp Hero activities. Exposure pathways are not expected to be complete between ecological receptors and deep groundwater within the UGA, so an evaluation of potential impacts to ecological receptors will not be included as part of the Phase IV data evaluation.

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WORKSHEET #11: DATA QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

The Phase IV RI is designed to complete the RI phase of the CERCLA process, as well as provide data to support risk-based decisions. In general, the Phase IV RI will refine the CSM to evaluate the if chemical constituents attributable to historical DoD activities at the Camp Hero FUDS are present in the groundwater within the UGA. Data quality objectives (DQOs) are developed in this worksheet based on the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA QA/G4, EPA/240/B-6/001) and are presented below (USEPA, 2006).

11.1 Problem Statement

Following the completion of the RI Report (AECOM-Tidewater JV, 2019a) and PP (AECOM-Tidewater JV, 2019b), concerns were raised during the Public Comment Period relative to the potential impacts to drinking water due to historical activities at Camp Hero. Although the shallow perched groundwater at Camp Hero was sampled and evaluated as part of the RI, deep groundwater in the UGA was not evaluated as part of the RI. Limited sampling is warranted to evaluate groundwater conditions in the UGA.

11.2 Study Goals

The study goals for the Phase IV RI were designed to determine if chemical constituents attributable to historical DoD activities at the Camp Hero FUDS are present in the groundwater of the UGA at unacceptable risk levels for a small set of residential receptors to the southwest of the Camp Hero FUDS. The specific goals are outlined below. For simplicity, analytical parameter groups warranting further analysis are referred to as VOCs, SVOCs, PCBs, and metals in this worksheet. Refer to **Worksheet #15** for specific details on the parameter groups and specific parameters selected for the Phase IV RI field investigation.

- **Goal 1** – Complete a well reconnaissance and synoptic gauging event of up to 20 existing wells screened within the UGA in the vicinity of Camp Hero. The groundwater gauging data will be used to refine the understanding of the groundwater flow direction in the UGA.

- **Goal 2** – Complete deep boreholes with continuous soil sampling to document the lithology and hydrogeologic units at two locations between known subsurface impacts associated with DU01 and potential receptors (drinking water wells) along Old Montauk Highway to the southwest of Camp Hero. Analyze soil samples for geotechnical parameters (grain size and % moisture) to support understanding of lithologic units. Based on the lithology of the borings, determine the depth of the UGA and select well screen intervals for two permanent nested monitoring wells at each location.

- **Goal 3** – Determine if historical DoD activities at Camp Hero have impacted UGA groundwater between known subsurface impacts associated with DU01 and potential receptors (drinking water wells) along Old Montauk Highway to the southwest of Camp Hero. Collect groundwater samples from four new permanent monitoring wells installed in the boreholes described in Goal 2 above and up to three existing UGA wells within the Camp Hero FUDS boundary to determine whether VOCs, SVOCs, PCBs, and metals attributable to Camp Hero FUDS activities are present or absent in the UGA. Compare the data to human health screening levels to determine if the potential for unacceptable risk levels exist, as well as complete a statistical comparison of data to local groundwater conditions in order to evaluate levels of naturally-occurring constituents (i.e., heavy metals).

- **Goal 4** – Collect groundwater samples from up to eight existing UGA wells in close proximity of Camp Hero that could reasonably be considered representative of local UGA groundwater conditions, with analysis of similar constituents provided in Goal 3 above. Use statistical methods (including, but not limited to, BTVs, geochemical evaluations, or hypothesis testing) to compare on-site groundwater data to local groundwater conditions.

To achieve these goals and ensure that appropriate data quality is obtained, project screening levels (PSLs) were identified based on applicable human health screening levels. Quantitation limits for analytical data must be at or below the PSLs in order to be of sufficient quality for evaluating chemical concentrations relative to human health screening levels. Refer to **Worksheet #15** for the specific PSLs and associated sources.

11.3 Information Inputs

Information inputs used to develop this QAPP Addendum consist of prior study reports, available analytical data, available site-specific data representing local groundwater conditions in the vicinity of Camp Hero, preliminary screening criteria, consideration of potential human health exposure pathways and receptors, and consideration of potential data needs to support the Feasibility Study (FS). Refer to **Worksheet #10** and the RI Report (AECOM-Tidewater JV, 2019a) for discussion of prior investigations and reports. Additional information inputs that will be generated from the Phase IV RI field investigation described in this QAPP Addendum will include the following items:

- Field observations and measurements, including geologic logs, ambient air (Photo Ionization Detector [PID]) measurements, water quality parameters, global positioning system (GPS) coordinates, and survey data (Goals 1, 2, 3 and 4).

- Water level gauging results from up to 20 existing monitoring wells (Goal 1).

- Soil samples collected from within two deep borings (up to 13 samples per boring for grain size and % moisture) (Goal 2).
- Groundwater samples from the four new UGA monitoring wells and up to three additional UGA wells within the Camp Hero FUDS boundary (analyzed for VOCs, SVOCs, PCBs, and metals) (Goal 3).
- Groundwater samples from up to eight existing permanent UGA monitoring wells located off-site in close proximity to Camp Hero (analyzed for VOCs, SVOCs, PCBs, and metals) (Goal 4).

11.4 Study Area Boundaries

Camp Hero State Park is located on the eastern tip of the south fork of Long Island, NY, approximately 5 miles east of the Village of Montauk (**Figure 10-1**). The park consists of 469 acres and is bound by Montauk Highway (Route 27) to the north, the Atlantic Ocean to the south, Montauk Point State Park to the east, and Camp Hero State Park's undeveloped sanctuary area to the west. General spatial and temporal boundaries are described below.

Spatial Boundaries

Up to 20 existing monitoring or supply wells in the vicinity of Camp Hero will be gauged. Additionally, up to three existing wells within the Camp Hero FUDS boundary and up to eight existing wells outside of the Camp Hero FUDS boundary will be sampled. The locations of the known historical wells are provided in **Figure 10-5**. Not all existing UGA wells are located on the Camp Hero State Park property, and these wells may no longer exist or potentially cannot be located. USACE will attempt to obtain rights-of-entry for as many targeted wells as possible in advance of the well reconnaissance and gauging event. Additionally, four new on-site permanent monitoring wells will be installed into the UGA at two locations. The new monitoring wells, which are shown on **Figure 17-1,** are located between the known subsurface impacts at DU01 and the potential receptors with private wells in the UGA along Old Montauk Highway. Anticipated groundwater flow in the UGA between DU01 and the private residences along Old Montauk Highway is in the south to southwest direction. The new monitoring wells are anticipated to be installed to approximately 140 feet bgs. The exact depth of the wells may be adjusted in the field if evidence of saltwater intrusion is encountered during the completion of the initial borings, such as encountering the marine clay geology that exists below the UGA.

Temporal Boundaries

The temporal boundaries for this study will be the Phase IV RI field investigation, anticipated to be completed in October through January 2021.

11.5 Analytical Approach

The analytical approach for the planned Phase IV RI field investigation includes specific "if… then…" statements to expand upon the study goals established earlier in this worksheet. These decision statements will guide the sampling design and will be continually referenced by the team in evaluating the results of the investigation and proceeding with risk-based decisions.

Well Reconnaissance and Gauging Event

Goal 1

- Site reconnaissance will be conducted to locate existing UGA wells for gauging. **Figure 10-5** identifies the historical UGA wells in the vicinity of Camp Hero that will be the subject of site reconnaissance. Prior to the reconnaissance effort, USACE will attempt to obtain rights-of-entry for as many historical wells as possible.

- Up to 20 existing wells will be gauged synoptically to characterize UGA groundwater elevations and flow in the vicinity of Camp Hero.

- If some wells cannot be located, if unanticipated areas of limited accessibility are encountered, or if some wellheads cannot be accessed with available hand tools, then these wells will not be gauged.

Soil Boring / Well Installation and Groundwater Sampling Event

Goal 2

- Sonic drilling techniques will be used to complete two borings into the UGA to approximately 140 feet bgs.

- Soil samples will be collected from within each boring to determine subsurface lithology. The AECOM field geologist, in consultation with USACE (if present), will determine the exact intervals for grain size and % moisture sample collection. It is anticipated that up to 13 samples per boring will be collected and submitted for analysis (approximately one sample per 10 feet).

Goal 3

- Four new permanent UGA wells will be installed in the two borings referenced above. The 2-inch diameter nested wells will be installed with a ten foot of screen placed at two elevations within each borehole: 0 to 10 feet into the UGA, which corresponds to the construction of older private water wells along Old Montauk Highway; and 40 to 50 feet into the UGA, which is consistent with current Suffolk County private water well regulations that require drinking water wells to be installed a minimum of 40 feet below the water table (SCDHS, 1985). These screen depths equate to total anticipated well depths of approximately 100 and 140 feet bgs, respectively, dependent upon the depth at which the UGA is encountered at each borehole. The exact depth of the wells may be adjusted in the field if evidence of saltwater intrusion is encountered during the completion of the initial borings, such as encountering the marine clay geology that exists below the UGA.

- Up to three UGA wells located within the Camp Hero FUDS boundary as shown on **Figure 10-5** will be redeveloped. The wells will be selected for sampling based on condition of the well, the depth of the well, and location of the well. The wells will be in good condition with no down well blockages. The depth of the well must be deep enough to obtain a representative sample from the UGA. Additional details on the preferred wells to be sampled are provided in **Worksheet #17** and the well development and sampling procedures are outlined in **Worksheet #14**.
- Up to seven groundwater samples will be analyzed for VOCs, SVOCs, PCBs, and metals (dissolved and total; including mercury and hexavalent chromium [Cr^{6+}]). Refer to **Worksheet #15** for details on the parameter groups and specific analytes.
- One or two rounds of samples will be collected from the on-site wells dependent upon the results of the first round and potential statistical evaluation of data as described in **Worksheet #14, Section 14.3**.
- Analytical data will be compared to human health screening levels to determine if unacceptable risk levels exists as well as completion of a statistical comparison of data to local groundwater conditions in order to evaluate levels of naturally-occurring constituents (i.e., heavy metals).

Goal 4

- Up to eight wells not located on Camp Hero FUDS but in close proximity to Camp Hero will be selected for sampling based on the results of the reconnaissance and well gauging event described under Goal 1. Groundwater contours from the well gauging will inform the selection of potential wells to be sampled.
- The wells will be selected for sampling based on condition of the well, the depth of the well, and location of the well. The wells selected will be in good condition with no down well blockages. The depth of the well must be deep enough to obtain a representative sample from the UGA. Additional details on the preferred wells to be sampled are provided in **Worksheet #17** and the well development and sampling procedures are outlined in **Worksheet #14**.

- Wells that are selected will be developed prior to sampling unless they are active water supply wells with a tap located prior to any treatment systems. Following well stabilization, a groundwater sample will be collected from each of the newly developed UGA wells. Each groundwater sample will be analyzed for VOCs, SVOCs, PCBs, and metals (dissolved and total; including mercury and Cr^{6+}). Refer to **Worksheet #15** for details on the parameter groups and specific analytes.

- One or two rounds of samples will be collected from the existing off-site wells dependent upon the results of the first round and potential statistical evaluation of data as described in **Worksheet #14, Section 14.3**.

- The off-site analytical data obtained will be used to calculate BTVs and evaluate local groundwater conditions to provide as a comparison to the Camp Hero FUDS data described in Goal 3 above.

11.6 Performance Criteria

The selection of performance criteria is based on potential sources of study error (i.e., field error, analytical error), methods that will be applied to reduce the potential sources of error, and an approach on how team decisions will be managed relative to potential occurrences of error.

Sources of Error

For the Phase IV RI, sources of error consist of two main categories: sampling errors and measurement errors. A sampling error occurs when the sampling design, planning, and implementation do not provide for a representative range of heterogeneity at the site. A measurement error occurs when there is a performance variance from laboratory instrumentation, analytical methods, and/or operator error. USEPA identifies the combination of all these errors as a "total study error" (USEPA, 2006). The team has prepared this QAPP Addendum to reduce (and essentially eliminate) the potential for total study error by documenting the DQOs, decision strategy, sampling design, analytical requirements, and other details, all of which provide team alignment with the study objectives and goals.

Managing Decision Error

This investigation will use decision-error minimization techniques in sampling design, sampling methodologies, and laboratory measurement of constituents of potential concern. Possible decision errors will be minimized during the Phase IV RI by using the following methods:

- Use standard field sampling methodologies (as discussed in **Worksheet #14**, **Worksheet #18**, and **Worksheet #21**).

- Use applicable analytical methods and standard operating procedures (SOPs) for sample analysis by a competent analytical laboratory having state appropriate National Environmental Laboratory Accreditation Program accreditation and be accredited through the DoD Environmental Laboratory Accreditation Program.

- Confirm analytical data to identify and control potential laboratory error and sampling error by using matrix spikes, blanks, and duplicate samples.

Decision Error

Decision errors associated with judgmental sampling are based on sample design and measurement errors. Assuming that the best possible professional judgment was used to develop the judgmental sampling plan (e.g., selection of sampling locations, well screen depths, and analytical parameters), remaining decisions and opportunities to mitigate potential errors will be associated with field decisions on refined sampling locations and depths, managing insufficient groundwater yields or quality, managing and packaging analytical samples, and managing analytical results through the data validation process. Analytical data will be considered acceptable if they meet the appropriate data validation criteria presented in **Worksheet #34, 35, and 36**.

11.7 Detailed Plan for Obtaining Data

The detailed plan for obtaining data is provided in **Worksheet #17** and **Worksheet #18**.

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WORKSHEET #12: MEASUREMENT PERFORMANCE CRITERIA

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)
Equipment Blank	VOCs, SVOCs, PCBs, metals/mercury, hexavalent chromium	One per 10 samples per matrix per sampling equipment	Accuracy/Bias/ Contamination	No analytes > ½ LOQ
Field Duplicate	VOCs, SVOCs, PCBs, metals/mercury (total and dissolved), hexavalent chromium (total and dissolved),	One per 10 field samples	Precision	RPD ≤ 30 for aqueous samples if both results are ≥2 x LOQ
Trip Blank	VOCs	One per cooler	Accuracy/ Bias/ Contamination	No target analytes ≥ ½ LOQ (>LOQ for common laboratory contaminants), unless target analytes in field samples are > 10x those in trip blank.
Cooler Temperature Indicator	VOCs, SVOCs, metals/mercury (total and dissolved), PCBs, hexavalent chromium (total and dissolved),	One per cooler	Representativeness	Temperature must be above freezing and ≤ 6°C.
Matrix Spike/ Matrix Spike Duplicate	VOCs, SVOCs, PCBs, metals/mercury (total and dissolved), hexavalent chromium (total and dissolved)	One pair per 20 field samples	Accuracy/ Precision	See **Worksheet #15** for percent recoveries and RPDs
Lab Control Sample/Lab Control Sample Duplicate	VOCs, SVOCs, PCBs, metals/mercury (total and dissolved), hexavalent chromium (total and dissolved)	One pair per batch	Accuracy/ Precision	See **Worksheet #15** for percent recoveries and RPDs
Surrogate	VOCs, SVOCs, PCBs	Per sample (including MS/MSD, LCS, and Blanks)	Accuracy	See **Worksheet #15**

Notes:

(1) Collect only if non-dedicated, non-disposable equipment is used.

°C	degrees Celsius
DQI	data quality indicators
LCS	laboratory control sample
LOQ	limit of quantification
MS/MSD	matrix spike/matrix spike duplicate
PCB	polychlorinated biphenyls
RPD	relative percent difference
SVOC	semivolatile organic compound
VOC	volatile organic compound

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WORKSHEET #14: SUMMARY OF PROJECT TASKS

The following project tasks are to be performed as a part of the Camp Hero Phase IV RI field investigation, as summarized below:

- Field Tasks
- Analytical Data Management and Review
- Human Health Risk Screening
- RI Report Addendum Preparation

14.1 Field Tasks

The following subsections present field tasks that will be completed as part of the Phase IV RI field investigation at Camp Hero. Field tasks will be completed following the SOPs listed in **Worksheet #21** and provided in **Appendix C**.

Personnel Qualifications

As established in the Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) (AECOM-Tidewater JV, 2020), personnel mobilized to the site will meet applicable Occupational Safety and Health Administration (OSHA) training including hazardous waste operations and emergency response training, medical surveillance requirements, and First Aid/automated external defibrillator/cardiopulmonary resuscitation certification.

The Site Safety and Health Officer (SSHO) will have completed the 30-hour OSHA General Industry or Construction Industry Safety Class, as specified in EM-385 (USACE, 2014). The SSHO will be responsible for managing, implementing, and enforcing the health and safety program in accordance with the accepted APP. The SSHO will be a competent person that can identify existing and predictable hazards in the working environment or working conditions that are dangerous to personnel, and who has authorization to take prompt corrective measures to eliminate them.

The Site Supervisor (SS) will have completed the 8-hour OSHA SS training, as specific in EM-385. The SS will lead field operations, coordinate field activities, and act as the liaison between site and laboratory personnel, among other responsibilities. The UXO Technician II will have the appropriate level of training and experience as stated in DoD Explosives Safety Board (DDESB) Technical Paper 18.

Site-Specific Training

As part of the mobilization process, site-specific training for on-site personnel will be conducted by the SSHO prior to performance of work. Site-specific training will include, but is not limited to, Ordnance Recognition Training to identify potential explosive hazards and react appropriately, by all employees and the subcontract employees. **Stop work authority will be used immediately if ordnance or Chemical Warfare Materiel (CWM) is suspected.**

Training will be provided by the SSHO and the other project staff, as required. The purpose of this training is to ensure that personnel fully understand the operational procedures and methods to be used at Camp Hero, individual duties and responsibilities, and safety and environmental concerns associated with the planned investigation activities.

Digital and paper copies of required project documents will be maintained on site for reference. Site workers, whether arriving at the start of the project or rotating on site as a substitution for another employee, will not be allowed to conduct their daily field operations without receiving site-specific training, reviewing the required documents, and signing off that they have reviewed, understood, and will follow the project QAPP.

Site Coordination

In accordance with project kick-off meetings, anticipated work hours will be 0700 to 1900. All Phase IV activities conducted under this QAPP Addendum will be coordinated with the Camp Hero State Park Superintendent, Tom Dess, to ensure activities do not impact park visitors and seasonal work restrictions. Additionally, activities under this RI QAPP will be coordinated with the State Historic Preservation Officer and other interested parties and stakeholders, in accordance with Section 106 of the National Historic Preservation Act of 1996, as amended and 36 Code of Federal Regulations (CFR) 800.

Mobilization/Demobilization

The team will schedule the arrival of its workforce, and subcontracted workforce, in a manner that is most effective and designed to meet the project schedule. Personnel mobilized to the Site will meet the OSHA training and medical surveillance requirements specified in the APP (AECOM-Tidewater JV, 2020). As part of the mobilization process, site-specific training for on-site personnel will be performed.

UXO Anomaly Avoidance

Based on a UXO probability analysis completed by USACE Baltimore District, it has been determined that the Camp Hero site activities have a low probability of encountering munitions and explosives of concern (MEC), except for areas H and K (**Figure 10-2**), which will not be entered at any point during RI field activities. Anomaly avoidance will be conducted in accordance with EM 385-1-97 during subsurface investigations. "Anomaly avoidance" is defined as the avoidance of surface MEC and any subsurface anomalies where the specific activity can be moved to another location. A UXO Technician II will conduct anomaly avoidance during RI field activities. The UXO Technician II will have the appropriate level of training and experience as stated in DDESB Technical Paper 18.

Additionally, all field personnel, including project staff, site visitors, and subcontractors, will complete Ordnance Recognition Training prior to the start of field activities. **Stop work authority will be used immediately if ordnance or CWM are suspected, and the SS will call 911 to notify authorities.** It should be noted that anomaly avoidance is only applicable to MEC hazards.

Brush Clearing and Rare Plant Survey

Portions of Camp Hero are significantly overgrown with vegetation, which will have to be removed to access existing monitoring wells and install two new permanent monitoring wells. To facilitate access, hand tools and mechanized equipment will be used to trim the overgrowth of vegetation along the site access roads and clear paths to the sampling locations. Only small shrubs and brush will be cleared; no hardwood trees will be removed. Cut brush will be left on site in the general vicinity of its generation; however, cut brush will not be left in wetlands or buffer zones. The vegetation will be cleared prior to the initiation of field activities.

Additionally, a botanist will survey areas needing vegetation removal prior to removal activities to flag endangered or rare species, including the southern arrowwood. The removal of snags will be avoided, and no large hardwood trees, defined as a tree with greater than or equal to 3 inches in diameter, will be cleared, to ensure protected habitat for the endangered Northern long-eared bat and preserve potential bird nesting. Clearing will be minimized to the maximum extent practicable. Also, because many sample locations are near streams, the team will take measures to avoid and minimize impacts to streams and riparian wetlands. Any ruts which may be created when crossing wet areas will be restored.

During previous phases of investigation, field efforts were coordinated with Julie Lundgren (New York Natural Heritage Program of the State University of New York Environmental Science and Forestry in partnership with NYSOPRHP), NYSDEC, and the US Fish and Wildlife Services (USFWS), whom provided guidance on the known occurrence of rare, threatened, or sensitive species in the vicinity of the RI field and appropriate protection measures. The field team will sweep the path ahead of the drill rig or other equipment at all sampling locations to check for box turtles or other significant species.

Utility and Subsurface Structure Clearance

Per AECOM and USACE policies, utility clearance is required for all intrusive work, regardless of planned intrusive depth. Prior to intrusive activities, the SS is responsible for marking the planned intrusive locations and contacting DigSafe of New York (Long Island) per pre-notification requirements. As a precaution, the first 5 feet of each boring will be pre-cleared using hand tools (e.g., post-hole diggers, augers, etc.) if utility clearance is not confirmed. Lack of confirmation can include areas with insufficient utility information or areas with multiple utility lines. Utility Clearance will be conducted in accordance with *SOP 3-01: Utility Clearance* (**Appendix C**).

Field Instrument Calibration and Quality Control

Upon delivery, field equipment will be checked to ensure its completeness and operational readiness. Any equipment found damaged or defective will be returned to the point of origin, and a replacement will be secured. Instruments and equipment that require routine maintenance and/or calibration will be checked initially upon arrival and then prior to use each day, if needed, to support that day's operations. See *SOP 3-20: Operation and Calibration of a PID* (**Appendix C**) for more details.

This system of checks ensures that the equipment is functioning properly. If an equipment check indicates that any piece of equipment is not operating correctly and field repair cannot be made, the equipment will be tagged and removed from service, and a request for replacement equipment will be placed immediately. Replacement equipment will meet the same specifications for accuracy and precision as the equipment removed from service.

Site Reconnaissance and Synoptic Gauging of Existing UGA Monitoring Wells

Site reconnaissance will be conducted to locate up to 20 existing UGA wells for purposes of groundwater gauging. The depth to groundwater will be gauged with an electronic water level meter equipped with 300 feet of measuring tape. The water level in each well will be recorded from the top of the well casing and ground surface at up to 20 of the existing wells. The total depth of the each well will also be measured. Each well will be photographed, and the condition of the well will be detailed on groundwater gauging field forms. The wells will be gauged within as short of period of time as feasible. The locations of historical and current UGA supply and monitoring wells in the vicinity of Camp Hero are shown on **Figure 10-5**. Available information for the existing UGA wells is summarized on **Table 10-2**.

UGA Soil Borings

Borings will be advanced into the UGA at two locations downgradient of known subsurface impacts associated with DU01 in advance of installation of permanent monitoring wells to characterize subsurface lithology and collect soil samples for analysis physical (geotechnical) parameters. The subsurface lithology of the pilot borings will be used to determine the depth of the UGA and select the screen elevations for the new monitoring wells to be installed. Based on the lithologic logs of former nearby USGS monitoring wells S72283 and S70626, it is estimated that the boreholes will be advanced to approximately 140 feet bgs, and that this depth will intercept at least 50 feet of the UGA. Refer to **Worksheet #17** for the sampling design and rationale.

The boreholes will be conducted by a driller licensed by the State of New York. An exclusion zone will be established with cones surrounding the drilling operation. Each soil boring will be hand-cleared to 5 feet bgs prior to drilling in accordance with AECOM utility clearance procedures. The drilling team will place plastic sheeting under the sonic drill rig and will pull it up around the tracks to act as a containment barrier. The sonic drill will be advanced through a tub or surface casing at the ground surface.

A 3-inch core barrel will be advanced into the subsurface in 5-foot long increments. Once the subsurface soil sample is retrieved from the 3-inch core barrel, the 5-inch override casing will be advanced to the same depth as the 3-inch core barrel. The process is then repeated. Once the UGA is intercepted with the 3-inch core barrel and the thickness of the overlying confining unit is identified, a 6-inch or 7-inch override casing will be driven over the 3-inch and 5-inch core casing from the ground surface into the confining unit. The 6-inch or 7-inch override casing will be driven into the confining unit above the UGA to isolate groundwater lenses in the upper till from the UGA. The 3-inch and 5-inch core barrels will then be advanced through the UGA to the targeted depth.

Continuous soil cores will be collected from the borings. Soil within each 5-foot long core barrel will be extruded from the core barrel into a plastic sleeve within the sonic drive casing. The soil core will be placed horizontally on clean plastic sheeting for logging and sampling. The soil core will be screened for VOCs immediately upon opening the sleeve with a PID. Details regarding the air monitoring procedures and specific action levels are provided in the APP (AECOM-Tidewater JV, 2020). The soil core will be logged for descriptions by the AECOM field geologist, and observations and measurements will be recorded on a soil boring log. At a minimum, depth interval, recovery thickness, PID concentrations, moisture, relative density, color (using a Munsell soil color chart), and texture using the Unified Soil Classification System (USCS) will be recorded. Additional observations to be recorded may include detectable odors, groundwater or perched water depth, organic material, cultural debris, or color changes. See *3-16: Soil and Rock Classification* (**Appendix C**) for more details.

Soil samples will be collected from each borehole for laboratory analysis of % moisture and grain size at rate of one per 10-feet, with up to 13 soil samples per boring. Soil samples will be collected in accordance with *SOP 3-21: Surface and Subsurface Soil Sampling* (**Appendix C**). No QC samples will be collected for grain size analysis or % moisture. Samples will be transferred to the appropriate sample container for laboratory analysis and placed in a cooler on ice. The required sample containers, preservatives, and holding times are specified in **Worksheet #19**.

The soil cores will be containerized following lithologic logging and transported to the IDW storage location at the end of each day, in accordance with the procedures outlined below and in *SOP 3-05: Investigation-Derived Waste Management* (**Appendix C**). The pilot boreholes will be abandoned with grout with a tremie pipe as the sonic casing is removed to prevent potential vertical migration of potential contamination. The surface will be restored to match the surrounding area.

Monitoring Well Installation

Sonic drilling will be used to install the new monitoring wells. Monitoring wells will be constructed in accordance with all New York State guidelines and procedures specified in *SOP 3-12: Monitoring Well Installation* (**Appendix C**). The sonic drill rig will advance a 3-inch diameter core barrel to obtain continuous subsurface samples in 5-foot increments. After a sample is obtained from the 3-inch core barrel, the 5-inch override casing is advanced to the same depth as the 3-inch core barrel. Once the UGA is intercepted with the 3-inch core barrel and the thickness of the overlying confining unit is identified, a 6-inch or 7-inch override casing will be driven over the 3-inch and 5-inch core casing from the ground surface into the confining unit to isolate groundwater lenses in the upper till from the UGA. The 3-inch and 5-inch core barrels will then be advanced through the UGA to the targeted depth of approximately 140 feet bgs. The exact depth of the wells may be adjusted in the field if evidence of saltwater intrusion is encountered during the completion of the initial borings, such as encountering the marine clay geology that exists below the UGA.

One well will be constructed in the upper 0 to 10 feet of the UGA and a second well will be constructed in the 40 to 50 feet below the top of the UGA inside the 5-inch casing. The well construction will consist of a 2-inch diameter, schedule 40 poly-vinyl chloride (PVC), 10-foot long, 0.01-inch slotted screen, and 10-foot sections of schedule 40 PVC flush threaded riser pipe though the 5-inch casing to ground surface.

The deeper well will include a 10-foot screen that will be installed at an elevation equivalent to 40 to 50 feet into the UGA. A silica sand filter pack material will then be placed in the annulus between the well pipe and casing. The height of the sand above the top of the screen interval will be at least 2 feet. Once the filter placement process is initiated, the casing will periodically be vibrated and pulled up, allowing the well materials to settle into the newly created borehole. This process is continued until a bentonite clay seal is installed and allowed to hydrate. The hydration time will be per the recommendations of the bentonite manufacturer, which is two hours for typical types of bentonite chips. The bentonite seal above the filter pack of the lower well screen is will be at least 15 feet thick to seal the zone between the deep well screen and the upper well screen. A fine silica sand will be placed over the top of the bentonite at this interval to provide a solid footer for the upper well screen. To ensure the well is constructed in the center of the sonic casing and the sand pack is uniform in thickness, PVC or stainless steel centralizers will be placed around the well at the top and bottom of the well screen.

The shallower well will include placement of a 10-foot screen that will be installed at the elevation equivalent to the upper 10 feet the UGA. The screen elevation may be adjusted based on the observations of the UGA documented in the continuous soil boring coring. To ensure the well is constructed in the center of the sonic casing and the screen sand pack is uniform in thickness, PVC or stainless steel centralizers will be placed around the well at the top and bottom of the well screen. A silica sand filter pack material will then be placed in the annulus between the well pipe and casing. The height of the sand above the top of the screen interval will be 2 feet. Once the filter placement process is initiated, the casing will periodically be vibrated and pulled up, allowing the well materials to settle into the newly created borehole. This process is continued until a bentonite clay seal is installed and allowed to hydrate. The bentonite seal above the filter pack will be at least 2 feet thick. Once the bentonite seal has hydrated, cement-bentonite grout will be placed in the annulus throughout the interval from the top of the bentonite seal up to the ground surface. Cement-bentonite grout placement will continue until the outer casing is removed from the borehole.

Monitoring wells will be completed above land surface with a locking 4-inch diameter protective casing cemented 2 feet below ground and surrounded at land surface by a 2 foot by 2 foot by 6-inch thick concrete pad. The well protective casings will be pre-painted dark brown prior to installation.

Well Development (and Redevelopment of Existing Wells)

The four new permanent monitoring wells will be developed prior to the collection of groundwater samples. Additionally, up to three existing UGA supply or monitoring wells within the Camp Hero FUDS boundary will be redeveloped prior to the collection of groundwater samples. The UGA wells in the immediate vicinity of Camp Hero selected for sampling will also be redeveloped prior to sampling, except for wells that are actively being used for drinking or non-potable water supply purposes. Development of newly installed wells will be completed by a combination of surging with a surge block and over-pumping with a submersible monsoon pump or Wattera pump and associated polyethylene tubing, in accordance with *SOP 3-13: Monitoring Well Development* (**Appendix C**). A minimum of three times the standing water volume will be removed from the newly-installed permanent monitoring wells during development. Development of inactive, existing UGA supply wells or monitoring wells on Camp Hero or in the vicinity will be completed by over-pumping with a submersible monsoon pump or Wattera pump and associated tubing. A minimum of three times the standing water volume will be removed from the existing, inactive supply or monitoring wells during redevelopment.

Water clarity will be visually monitored, and water quality parameters, including DO, SC, ORP, pH, temperature, and turbidity will be measured using a flow-through cell per *SOP 3-24: Water Quality Parameter Testing for Groundwater Sampling* every 5 minutes during purging to determine progress of development. The multi-parameter water quality meter will be calibrated initially and continually throughout its usage each day, as needed. A calibration check will be performed at the end of each day. Each well will be developed until the well produces clear (silt-free) water with a minimum of three stable water quality readings as outlined below:

- pH – within ± 0.2 units.
- Dissolved oxygen (DO) – within ± 10%
- Specific conductivity (SC) – within ± 3 %.
- Oxidation-reduction potential (ORP) – within ± 10 millivolts.
- Temperature – within ± 1 degree Celsius.
- Turbidity – at or below 10 nephelometric turbidity unit (NTU) or within ± 10% if above 10 NTU.

If the well has slow groundwater recharge and is purged dry, the well will be considered developed when bailed or pumped dry three times in succession and the turbidity has decreased. If the well does not produce clear (silt-free) water, the well will be developed for a maximum of two hours. Reusable sampling equipment will be properly decontaminated after each use in accordance with *SOP 3-06: Decontamination Procedures*. Excess soil or groundwater generated will be containerized, managed, and disposed of as IDW.

Groundwater Sample Collection

Groundwater samples will be collected from four newly-installed permanent monitoring wells and up to 11 existing UGA wells, as described above. Refer to **Worksheet #17** for additional details on the groundwater sampling design. Wells will be sampled at least 24 hours after completion of development/redevelopment in accordance with *SOP 3-14: Groundwater Sampling* (**Appendix C**). Groundwater levels will be measured in each well prior to sampling using a water level meter (Solonist or equivalent).

For monitoring wells, wells will be purged via low-flow sampling techniques using a bladder or peristaltic pump and disposable tubing. Water clarity will be visually monitored, and water quality parameters, including DO, SC, ORP, pH, temperature, and turbidity, will be measured using a flow-through cell per *SOP 3-24: Water Quality Parameter Testing for Groundwater Sampling*. Readings will be collected every 5 minutes until the well produces clear (silt-free) water with a minimum of 3 stable water quality readings, as outlined above in the well development procedures. The multi-parameter water quality meter will be calibrated initially and continually throughout its usage each day, as needed. A calibration check will be performed at the end of each day. Samples will be collected once the water quality parameters reach stabilization.

For wells being actively used for drinking water, groundwater samples will be collected from an existing tap. A sample will be collected from a tap in an area free of excessive dust, rain, snow, or other sources of cross-contamination. A tap will be selected that is free of devices that could cause potential cross-contamination, such as screens, aeration devices, hoses, purification devices, or swiveled faucets. The faucet will be visually checked to be sure it is clean. Samples will be collected from a tap which is high enough to put a bottle underneath without contacting the mouth of the container with the faucet. The tap will be opened and allowed to thoroughly flush for approximately 2 to 3 minutes. Water flushed from the tap will be containerized by the sampling team and properly disposed. Once the lines are flushed, the flow will be adjusted to fill the sample bottleware.

Samples will be collected in laboratory-supplied bottleware for VOCs, SVOCs, PCBs, and metals, as established in **Worksheet #17**. Both total (unfiltered) and dissolved (filtered) samples will be collected for metals (including Cr^{6+} and mercury). Filtered samples will be field-filtered using a clean, disposable, in-line filter. The pH of dissolved and total Cr^{6+} samples will be adjusted according to the procedures outlined below. In the event of lack of volume of water, the following hierarchy will be followed for sample collection: VOCs, SVOCs, metals (unfiltered), Cr^{6+} (unfiltered), metals (filtered), Cr^{6+} (filtered), and PCBs. Non-disposable sampling equipment will be decontaminated between each well in accordance with the decontamination procedures outlined below.

Land Surveying

Existing wells that are sampled or gauged during the Phase IV investigation will be surveyed during the Phase IV effort to determine the horizontal and vertical position of the existing wells or previous survey data of existing wells that is available from online databases (e.g., in SCDHS and/or USGS databases) will be used. The existing wells and newly-installed permanent monitoring wells will be surveyed by a state-registered surveyor to a horizontal accuracy of 0.1 feet and a vertical accuracy of 0.01 feet. These positions will be tied to a permanent benchmark located near the site and referenced to the North American Datum of 1983 (horizontal) and the North American Vertical Datum of 1988 (vertical). See *SOP 3-07: Land Surveying* for more details.

Community Air Monitoring

Community air monitoring will be performed in accordance with the NYS Department of Health Generic Community Air Monitoring Plan (CAMP), Attachment 1A of the NYSDEC Division of Environmental Remediation-10 Technical Guidance for Site Investigation and Remediation (**Appendix B**). Air monitoring activities will be implemented to protect the community from any potential airborne releases that could result from field activities associated with the RI or remedial action efforts as necessary (NYSDEC, 2010).

The field personnel will monitor their breathing zones during project activities using a PID when working in areas potentially contaminated with petroleum hydrocarbons and organic solvents. An action level for respiratory protection has been established at 5 parts per million (ppm) as averaged over a 15-minute time period. If this limit is exceeded, work will stop, and the SSHO and Project Manager will determine how to proceed. See *SOP 3-20: Operation and Calibration of a PID* (**Appendix C**) for more details.

Hexavalent Chromium Analysis

The pH of groundwater Cr^{6+} samples (total and dissolved) will be adjusted in the field according to the following procedures:

- If possible, pour approximately 200 milliliters (mL) of the sample into the Chromium 6 sample bottle (roughly 1 inch from the lip). Repeatedly invert for 1 minute.
- Using the pipette, draw a portion of preserved sample and drop onto pH paper. DO NOT dip pH paper into bottle. Only use pH strip ONCE; DO NOT reuse the pH strip.
- Read the pH. The target pH is 9.5; the acceptable pH range is 9.3 to 9.7.
  - If the pH is too high (>9.7), add a small portion of unpreserved sample, invert for a minute, retest using the pipette and pH paper.
  - If the pH is too low (<9.3), add Ammonium Hydroxide/Ammonium Sulfate buffer one drop at a time to the bottle. Add ten drops, invert for a minute, and retest using the pipette and pH paper. Document total drops added.
- Tightly close bottle lid when target pH is achieved, complete documentation, and store in cooler.

Field Quality Control Samples

Field QC samples will be collected as part of this investigation, including field duplicates (FDs), matrix spikes/matrix spike duplicates (MS/MSDs), equipment blanks (EBs), trip blanks (TBs), and temperature blanks. FD samples will be collected at a rate of 10% and analyzed for the same parameters as the accompanying samples. MS and MSD samples will be collected at the rate of 5% and analyzed for the same parameters as the accompanying samples.

TBs will accompany each cooler containing samples for VOC analysis and will be analyzed for select VOCs. If non-dedicated sampling equipment is used, an EB will be collected and analyzed for whatever parameters were collected using the non-dedicated sampling equipment. A temperature blank shall be placed in each cooler to ensure that samples are preserved at or below 4 degrees Celsius (ºC) during shipment.

Sampling Handling, Storage, and Transport

Samples will be stored on ice, packaged, and submitted to the analytical laboratory for analysis as specified in **Worksheet #15**. **Worksheet #17** provides the soil sampling design and rationale. **Worksheet #18**, **Worksheet #19**, **Worksheet #20**, and **Worksheet #30** provide sample identifications, necessary sample volume and preservative requirements, and hold time limitations. Samples will be quality-control checked by the field team (label correctness, completeness, etc.) and recorded on chain of custody (CoC) forms. Samples will be packaged on ice and transported via overnight commercial carrier or a laboratory courier under standard CoC procedures to the laboratory. See *SOP 3-04: Sample Handling, Storage, and Shipping* (**Appendix C**) for additional information.

Field Documentation

Field documentation will be performed during this investigation in accordance with *SOP 3-02: Logbooks* (**Appendix C**). Sample collection information will be recorded in bound field notebooks, tablet computers, or specific field forms. A summary of field activities will be properly recorded in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and stored in a secured area when not in use. All entries will be written in indelible ink, and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction, and the person making the correction will initial and date the change. Sampling forms and other field forms will also be used to document field activities. See *SOP 3-02: Logbooks* (**Appendix C**) for additional information.

Equipment Decontamination

To the maximum extent possible, the team will utilize dedicated and disposable sampling equipment to avoid the potential for cross contamination of samples due to inadequate decontamination processes. The dedicated/disposable sampling equipment will include disposable polyethylene tubing, disposable gloves, and laboratory-supplied sample bottles.

Non-disposable or non-dedicated sampling equipment (e.g., bladder pumps, water level meters, water quality meters, etc.) will be decontaminated prior to sampling and between samples following *SOP 3-06: Decontamination* (**Appendix C**). Cleaning of equipment is performed to prevent cross-contamination between samples and to maintain a clean working environment for all personnel. Decontamination will generally consist of a water rinse station to remove gross contamination (if needed), followed by a non-phosphate detergent (e.g., Liquinox) water rinse, and a rinse with de-ionized water (provided by the laboratory). Paper towels containing recycled paper content are prohibited. If smaller equipment is to be stored or transported, it will be wrapped in aluminum foil after air-drying.

IDW Management

IDW generated during site field activities will be managed pursuant to applicable Federal, State, and local regulations and guidance, including the USEPA Management of Investigation-Derived Wastes during Site Inspections (USEPA, 1992b) and USACE guidance (USACE, 2013). Refer to *SOP 3-05: Investigation-Derived Waste Management* (**Appendix C**) for procedures related to IDW management. Department of Transportation (DOT)-compliant shipping containers will be used to stage IDW prior to off-site transport. Solid IDW (e.g., drill cuttings from boring/monitoring well installation that cannot be returned to the borehole of origin) will be stored in 55-gallon metal drums and/or a 10 cubic yard closed-top roll-off bin; liquid IDW (e.g., monitoring well development water, purge water, decontamination water) will be stored in frac tanks and/or 55-gallon metal drums.

The IDW containers will be properly labeled, sampled for waste characterization, and temporarily staged on-site at a designated secure location until waste characterization is completed. The IDW containers will subsequently be transported to the approved off-site disposal facility; the intended facility will confirm their acceptance of the waste prior to transport. IDW removal from the site will be documented by manifest or bill of lading prepared by the waste disposal subcontractor. Based on the team's understanding of this site and prior field investigations, only non-hazardous IDW is anticipated during this Phase IV field investigation.

Per the expectations in the HTRW Contract for this project, as well as per specific direction established in previous phases of investigation by USACE, an AECOM field representative will complete and sign the non-hazardous manifest or bill of lading on behalf of USACE. However, per discussions with USACE, if hazardous IDW is identified during this Phase IV RI field investigation, then USACE will complete and sign the hazardous waste manifest per USEPA and NYSDEC requirements.

14.2 Analytical Data Management and Review

The AECOM Project Chemist will track the samples from collection through analysis. Data deliverables will be provided by the laboratory within 15 business days of sample receipt. The laboratory will submit the Level II sample results in PDF via email. Final data deliverables (Level IV) will be submitted in PDF (bookmarked and searchable) and loaded to FUDSChem.

Analytical results from the final data deliverables will be reviewed according to the procedures in **Worksheet #34, 35, and 36**. Only results from final data deliverables will be formally validated. ADR will perform an automated data review of the project samples including but not limited to: holding times; sample temperature upon laboratory receipt; laboratory and field blank contamination; and accuracy and precision of laboratory control samples, MS/MSD, surrogates, FDs, and laboratory duplicates. ADR will produce validation outlier reports and assign qualifiers; the reports and qualifiers will be reviewed and approved by the AECOM Project Chemist.

Analytical Laboratory Sample Management

Data will be managed through the FUDSChem database. Copies of the field forms, CoCs, air bills, and logbooks will be placed in the project files after completion of the field program. CoCs are also documented in FUDSChem. The field logbooks for this project will be used only for this Site and will also be categorized and maintained in the project files after completion of the field program. Project records will be maintained in a secure location.

Data Tracking

Data are tracked from the sampling event planning phase through the completion of validation through the FUDSChem database. Electronic data deliverables will be submitted to FUDSChem in a Staged Electronic Data Deliverable (SEDD) 2a format and will be uploaded by the laboratory directly to the database. Reports are uploaded in PDF format. The laboratory is responsible for screening the SEDD file for errors and for ensuring that the SEDD file matches the hardcopy report. Once data are successfully submitted, the Project Chemist will oversee the data validation effort.

Data Review and Validation

Upon successful upload of data packages to FUDSChem by the analytical laboratory, data will undergo verification and validation through the ADR software. The Chemist will then verify the validation conducted by ADR and augment with manual validation as needed. To assess whether the analytical results meet the project quality objectives, the laboratory data will undergo verification and validation as cited in **Worksheet #34, 35,** and **36** and described below. The usability assessment processes are described in **Worksheet #37**.

Prior to data validation, electronic laboratory data will be verified for accuracy against the hardcopy laboratory report, and the eQAPP will be established using the project-specific criteria defined in **Worksheet #12**, **Worksheet #15**, **Worksheet #19**, and **Worksheet #28**. The laboratory will be requested to resubmit electronic data found to be inaccurate.

Data Storage, Archiving, and Retrieval

Fixed laboratory data packages are stored in the FUDSChem database along with validated analytical results and completed validated reports. Field data from up to 20 UGA wells, such as water quality parameters and groundwater level measured during low-flow sampling and synoptic gauging, are entered into the FUDSChem database as environmental measurement and groundwater level files. Lithology information from the two newly-installed monitoring wells will also be entered into FUDSChem database. See Electronic Data Specification tables (**Appendix E**) for additional information. Field-related data will be entered into FUDSChem within 3 weeks of sampling. Field records including field logbooks, sample logs, CoC records, and field calibration logs will be submitted by the SS to be entered into the file system before archiving in secure project files. Project files will be kept in a secured, limited access area.

14.3 Human Health Screening Evaluation

This section describes the data evaluation, risk-based screening, and cumulative screen evaluation for the HHSE.

Data Evaluation

With the exception of "R"-flagged (rejected) data, all of the flagged data will be carried forward for quantitative evaluation in the HHSE. Flagged results such as "J" flags (i.e., estimated values) will be carried forward into the HHSE in all exposure media. A "J"-flagged result indicates that the analyte is positively identified, and the associated numerical value is an estimated quantity with an unknown bias. Results that are biased high are flagged "J+" and results that are biased low are flagged "J-". The "J"-flagged result is treated as a detected concentration even though the chemical's true concentration is unknown (USEPA, 1989). The uncertainties associated with the evaluation of the flagged data will be also qualitatively discussed in an uncertainty assessment.

For sample locations in which a duplicate sample is also collected, the duplicate sample results for each chemical will be processed prior to the calculation of summary statistics. Duplicates will be resolved as follows: 1) when both the sample and duplicate are detected, the average of field and duplicate will be used to calculate summary statistics; 2) when both the sample and duplicate are non-detects (NDs), the sample with the lower limit of detection (LOD) will be used; and 3) when one of the pair is reported as ND and the other is detected, the detected result will be used.

Data Sensitivity Analysis

Maximum LODs will be compared to PSLs (see **Worksheet #15**) to determine whether analytical quantitation limits are adequate for risk assessment purposes. The following steps will be taken:

- If the LOD is elevated due to dilution, then the intended LOD (prior to the sample being diluted) will be used as the reference point for whether the LOD is greater than the PSL
- If a chemical is all ND and has a maximum LOD lower than the PSL, then it will be eliminated from further evaluation.
- If a chemical is both detected and ND, with a maximum LOD lower than the PSL, it will be evaluated in the HHSE.
- If a chemical is all ND but the maximum LOD is higher than the PSL, then it will be selected as an LOD-COPC for further evaluation in HHSE.

- If a chemical has some "J"-flagged detections and NDs, but the LOD is higher than the PSL, it will be selected as a LOD-COPC for further quantitative evaluation. In these cases, the chemical may be present in the deeper groundwater at a concentration that exceeds the PSL, but its true concentration is unknown.

For the final selected LOD-COPCs, a separate cumulative screen evaluation will be conducted to quantify the associated potential risk. A qualitative weight-of-evidence analysis will be incorporated into the uncertainty assessment of the HHSE addressing how the range of risk results may affect the overall HHSE conclusions (see "Cumulative Screen Evaluation" subsection further below).

Metals

The groundwater media will include filtered (dissolved) and unfiltered (total) results for metals. Only the filtered results will be quantified in the cumulative screen and used during potential risk management. The unfiltered results will be discussed in the uncertainty assessment section of the HHSE.

The essential nutrients calcium, magnesium, potassium, and sodium will be eliminated in all exposure media from evaluation in the HHSE. Essential nutrients are toxic only at very high doses (i.e., much higher than those that could be associated with contact at Camp Hero) (USEPA, 1989).

As presented in Section 10.6, naturally-occurring constituents that are not associated with DoD activities at Camp Hero are known have the potential to be present within the UGA. These constituents may include arsenic, iron, and manganese. Statistical methods will be used to qualify the results of the HHSE by collecting samples from UGA wells in the vicinity of Camp Hero representing local groundwater conditions (see "Uncertainty Assessment - Evaluation of Local Groundwater Conditions" subsection further below). Evaluation of this data representing local conditions will be considered as part of the uncertainty assessment included in the HHSE.

Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)

Carcinogenic PAHs exhibit similar toxicological properties, but they differ in the degree of toxicity. The HHSE will use toxicity equivalence factors (TEFs) to adjust measured concentrations of carcinogenic PAHs in relation to benzo(a)pyrene, which is the most toxic PAH. **Table 14-1** presents the carcinogenic PAHs and their corresponding TEFs (USEPA, 1993 and 2020).

Table 14-1: Carcinogenic Polycyclic Aromatic Hydrocarbons and Toxicity Equivalence Factors

Carcinogenic PAH	Toxicity Equivalence Factor (TEF)
Benzo(a)pyrene	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-cd)pyrene	0.1

Notes:

Table Sources: USEPA 1993 and 2020

The individual carcinogenic PAH concentrations will be multiplied by the TEF and then summed for each sample. When one or more of the carcinogenic PAHs are ND, the LOD will be used as the censoring limit, and the TEF-multiplied concentrations will be summed using the Kaplan Meier (KM) method (Helsel, 2009). USEPA's statistical software, ProUCL Version 5.1, will be used to conduct the KM calculations (USEPA, 2016). Benzo(a)pyrene toxicity equivalence concentrations will be derived for each sample and screened against benzo(a)pyrene's human health screening level.

Total PCB Summations

The calculation of total PCB summations will be similar to the total PAH summation procedure. ProUCL Version 5.1 will be used to conduct the KM calculations where ND results are present in the sample (USEPA, 2016). The purpose of the total PCBs summations is to represent exposure to carcinogenic and noncarcinogenic Aroclors. Aroclors are chlorinated compounds associated with dielectric and coolant fluids used in electrical equipment that tend to be pervasive in the environment if released. High-risk PCBs (cancer) and Aroclor 1254 (non-cancer) human health screening levels will be used to evaluate the total PCB summation results.

Risk-Based Screening

A COPC selection process will be implemented to identify a subset of chemicals detected in the deeper groundwater that could pose a potential risk to human receptors that may come into contact with the groundwater. The COPC selection process will be conducted separately for the groundwater data collected from the existing permanent monitoring wells and the newly-installed permanent monitoring wells. The criteria used to determine if a chemical is a COPC are as follows:

- If a chemical is ND in all samples collected from the deeper groundwater, and measurement quality objectives for sensitivity are met (see **Worksheet #14, Data Sensitivity Analysis**), the chemical will not be selected as a COPC.
- Maximum detected concentrations (MDCs) will be compared to PSLs (see **Worksheet #15**).
  - If a chemical's MDC is greater than the PSL, it will be retained as a COPC and carried forward into a cumulative screen evaluation.
  - If a chemical's MDC is less than the PSL, then the chemical will be eliminated from consideration as a COPC and will not be carried forward into a cumulative screen evaluation.

Lead will be screened using the USEPA residential tap water regional screening level (RSL) of 15 micrograms of chemical per liter (µg/L) that is protective of a blood lead threshold of 10 micrograms of chemical per deciliter (µg/dL). The lead tap water RSL is considered an action level because it was derived using USEPA's Integrated Exposure-Uptake Biokinetic (IEUBK) model (USEPA, 2010) and not in accordance with the USEPA RSL guidance for carcinogenic and noncarcinogenic chemicals (USEPA, 2020a). If the MDC for lead exceeds its RSL, a mean concentration for the deeper groundwater will be calculated and compared to the tap water RSL (USEPA, 2007). If the mean concentration exceeds the lead tap water RSL, lead will be identified as a preliminary COC for the deeper aquifer. Lead will not be carried forward into the cumulative screen evaluation because its tap water RSL derivation differs from the other chemicals being evaluated.

Cumulative Screen Evaluation

A screening level cumulative risk assessment will be conducted to conservatively assess the potential cancer risk and non-cancer hazard associated with exposure to COPCs identified in deeper groundwater. The evaluation will assume that any monitoring well evaluated as part of the Phase IV RI may be used as a tap water source as part of the hypothetical on-site and off-site residential scenarios evaluation. USEPA tap water RSLs will be used in the cumulative evaluation to estimate carcinogenic risk and noncarcinogenic hazards from ingestion of drinking water, dermal contact while bathing or showering, and inhalation of shower vapors. Additionally, the monitoring well data will be used to identify potential vapor intrusion COPCs (i.e., volatile COPCs that are detected within 100 feet of the ground surface). USEPA vapor intrusion screening levels (VISLs) will be used in a separate cumulative evaluation to estimate carcinogenic risk and noncarcinogenic hazards from inhalation of vapors in indoor air due to vapor intrusion.

The PSLs (see **Worksheet #15**) come from various NYSDEC and USEPA screen criteria (e.g., federal or state MCLs) and are not necessarily risk-based screening levels. Risk-based screening levels are necessary for estimating potential cumulative carcinogenic risk and noncarcinogenic hazards.

The purpose of the cumulative screen evaluation is to determine if residential exposure to groundwater of the UGA exceeds the USEPA thresholds, which are as follows:

- A target excess lifetime cancer risk (ELCR) of 1E-04 (one in 10,000 people) will be used as the cancer threshold for both cumulative and individual chemical cancer risk estimates (USEPA, 1991).
- For non-cancer hazards, the potential for adverse health effects cannot be ruled out if the target hazard index (HI) is greater than 1. If the total HI is greater than 1 based on all the COPCs combined, then the total non-cancer HI will be calculated by segregating the chemicals based on the mechanism of action (i.e., target organ endpoints). Only chemicals that act upon the same target organ endpoint are expected to be additive (USEPA, 1989).

Potential cancer risk and non-cancer hazard estimates will be generated using the MDCs from the deeper groundwater COPCs and dividing concentrations by the USEPA tap water RSLs or USEPA VISLs (USEPA, 2020a and 2020b). The cumulative risk evaluation will be conducted separately for the existing and newly-installed permanent monitoring wells. Additionally, LOD-COPCs will be evaluated in a separate cumulative screen evaluation from the detected deeper groundwater COPCs. For the evaluation of LOD-COPCs, frequency of detection from the Phase III RI will be used to establish constituents that are unlikely to be present (i.e. less than 5% detection across all media). This sub-group of LOD-COPCs will be used to qualify the conclusions of the HHSE but will be quantified separately and not included in the cumulative total. Phase IV results from the proposed off-site local condition wells will be used to qualify the results and conclusions of the HHSE within the uncertainty assessment (see **Section 10.6** and the "Uncertainty Assessment Data Evaluation" subsection below for further discussion).

The PSLs used in the risk-based screening to identify COPCs are protective of residential tap water use and vapor intrusion exposure pathways. If more than one volatile chemical is identified as a groundwater COPC, an additional evaluation may be conducted that specifically evaluates the vapor intrusion exposure pathway using USEPA VISLs instead of tap water RSLs in the equations listed below (USEPA, 2020b).

The cumulative screening level cancer risk estimate will be derived using the following equation (USEPA, 2020a):

Equation 1:

$$ELCR\ (unitless) = \frac{Rep\ Conc\ \left({}^{\mu g}/_{L}\right)}{Cancer\ RSL\ \left({}^{\mu g}/_{L}\right)} \times TCR\ (unitless)$$

Where:

ELCR = Excess lifetime cancer risk estimate (unitless)

Rep Conc = Representative concentration in groundwater (i.e., the MDC) (micrograms per liter [µg/L])

Cancer RSL = USEPA tap water RSL for the chemical with a carcinogenic endpoint (µg/L)

TCR = Target cancer risk of the tap water RSL (1E-06)

The screening level non-cancer hazard estimate will be derived using the following equation (USEPA, 2020a):

Equation 2:

$$Non - Cancer\ Hazard\ (unitless) = \frac{Rep\ Conc\ \left(\mu g/_{L}\right)}{Non - Cancer\ RSL\ \left(\mu g/_{L}\right)} \times THQ(unitless)$$

Where:

Non-Cancer Hazard = Chemical-specific non-cancer hazard estimate (unitless)

Rep Conc = Representative concentration in groundwater (i.e., MDC) (µg/L)

Non-Cancer RSL = USEPA tap water RSL for a chemical with a noncarcinogenic endpoint (µg/L)

THQ = Target hazard quotient of the tap water RSL (0.1)

Multiplying the ratio by the target threshold (i.e., TCR and THQ) cancels out the TCR and THQ used in the RSL calculation; the chemical-specific potential cancer risk and/or non-cancer hazard associated with exposure to the representative concentration will be derived.

The chemical-specific cancer risk and non-cancer hazard estimates will be summed separately to provide potential ELCR and HI results. Chemicals with cancer and non-cancer endpoint RSLs or VISLs will be assessed both ways. The dissolved (field filtered) groundwater results will be used to be representative of tap water exposure.

The HHSE will follow the general format of the 2019 HHRA (i.e., five steps of a HHRA) and discuss the cumulative cancer risk and non-cancer hazard results for the on- and off-site residential scenarios. If the HHSE indicates the potential for unacceptable risk within any well sampled, the project team will reconvene and discuss a refined approach to provide an alternative (i.e. less conservative) estimate of exposure and risk.

Uncertainty Assessment – Evaluation of Local Groundwater Conditions

As indicated previously in this RI QAPP Addendum, up to eight UGA wells located in the vicinity of Camp Hero will be sampled for the purposes of establishing local groundwater conditions. Results from these off-site, local conditions wells may be used to evaluate the results of the HHSE using statistical methods such as BTVs, geochemical ratios, or hypothesis testing. A description of methods not previously used within the Phase III RI are included below. Refer to the RI Report for additional details (AECOM-Tidewater JV, 2019a) on potential geochemical evaluations or hypothesis testing that may be employed during the Phase IV HHSE uncertainty assessment following a comparison to BTVs.

The primary statistical method for determining the BTVs will be a non-parametric inter-well prediction limit (Gibbons et al., 2009). These BTVs will likely be derived for naturally-occurring constituents (i.e., heavy metals) within off-site, local conditions wells. It has been determined that eight data points are the minimum number to achieve approximately a 95% confidence level for a non-parametric prediction limit, based on "Pass 1 of 2" sampling strategy as described by Gibbons (Gibbon et al., 2009). Two rounds of off-site groundwater samples will be conducted if less than eight samples are able or appropriate to be collected to represent the local conditions from the first round. The results (if two rounds are collected) will be combined to create a bigger data set. If a second round of sampling is warranted based on the results of the analysis, the second round of samples will be collected a minimum of six weeks after the first round of samples.

Given the aforementioned off-site sample size, the maximum value of the off-site dataset is set to be the prediction limit. If an on-site concentration value exceeds the prediction limit (a point-to-threshold comparison), then a second round of sampling (i.e., resampling) of the given exceeding on-site well-chemical will be collected. If the second round's on-site concentration value does not exceed the prediction limit, then the exceedance is not confirmed, and the on-site concentrations are considered to be no different from the off-site, local groundwater conditions. If no on-site concentration value exceeds the prediction limit from the first round, then a second round of on-site sampling is not required, and the on-site concentrations are considered to be no different from the off-site, local groundwater conditions.

14.4 RI Report Addendum Preparation

Following the completion of data collection, laboratory analysis, and data validation, an RI Report Addendum will be prepared (AECOM-Tidewater JV, 2019a). The RI Report Addendum will demonstrate whether impacts to the UGA exists due to historical activities at Camp Hero.

Additionally, the RI Report Addendum will include the following elements:

- Restatement of program goals;
- Summary of field investigation conducted (e.g., sampling dates, soil samples collected, wells sampled, parameters analyzed, field procedures, etc.);
- Tables summarizing the samples collected and sample analytical data;
- Figures showing locations of monitoring wells identified and gauged or sampled during the Phase IV field effort;
- Data validation and quality assurance (QA)/QC discussion; and
- Deviations from the QAPP Addendum.

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Worksheet #15.1 Reference Limits and Evaluation for Groundwater

		Project Screening Levels $^{1, 2, a, b}$		PQLGs ^{3}	Achievable Laboratory Limits			Precision and Accuracy Method Performance Criteria, Percent	
Analyte	**CAS Number**	**Value**	**Source**	**Value**	**LOQ**	**LOD**	**MDL**	**LCS/MS/MSD Recovery Limits**	**LCS/MS/MSD Precision Maximum RPD**
Metals by SW6020A, ug/L									
Aluminum	7429-90-5	2000	Tapwater RSL/TOGS 1.1.1	667	25	20	19.7	84-117	20
Antimony	7440-36-0	0.78	Tapwater RSL	2	2	0.8	0.406	85-117	20
Arsenic	7440-38-2	0.052	Tapwater RSL	2	2	1.6	0.68	84-116	20
Barium	7440-39-3	380	Tapwater RSL	127	2	1	0.746	86-114	20
Beryllium	7440-41-7	2.5	Tapwater RSL	0.833	0.5	0.25	0.119	83-121	20
Cadmium	7440-43-9	0.92	Tapwater RSL	0.5	0.5	0.4	0.151	87-115	20
Calcium	7440-70-2	NA	--	500	100	80	73.6	87-118	20
Chromium	7440-47-3	0.035	Tapwater RSL	1	1	0.8	0.334	85-116	20
Cobalt	7440-48-4	0.6	Tapwater RSL	0.5	0.5	0.4	0.156	85-118	20
Copper	7440-50-8	80	Tapwater RSL	26.7	1	0.8	0.362	85-118	20
Iron	7439-89-6	300	NYS MCL	100	50	40	22.8	87-118	20
Lead	7439-92-1	15	USEPA RSL/Action Level	5	0.5	0.25	0.071	88-115	20
Magnesium	7439-95-4	NA	--	250	50	25	10.4	83-118	20
Manganese	7439-96-5	43	Tapwater RSL	14.3	2	1.6	0.634	87-115	20
Nickel	7440-02-0	39	Tapwater RSL	13	1	1	0.604	85-117	20
Potassium	7440-09-7	NA	--	1000	200	160	107.327	87-115	20
Selenium	7782-49-2	10	USEPA RSL/TOGS 1.1.1	3.33	1	0.8	0.278	80-120	20
Silver	7440-22-4	9.4	Tapwater RSL	3.13	0.5	0.4	0.17	85-116	20
Sodium	7440-23-5	NA	--	1000	200	160	50	85-117	20
Thallium	7440-28-0	0.02	Tapwater RSL	0.5	0.5	0.4	0.13	82-116	20
Vanadium	7440-62-2	8.6	Tapwater RSL	2.87	0.5	0.4	0.236	86-115	20
Zinc	7440-66-6	600	Tapwater RSL	200	10	8	6.177	83-119	20
Mercury by SW7470A, ug/L									
Mercury	7439-97-6	0.063	Tapwater RSL	0.3	0.3	0.2	0.079	82-119	20
Chromium Speciation by EPA 218.6, ug/L									
Hexavalent Chromium	18540-29-9	0.035	Tapwater RSL	10	10	9	5	90-110	20
Trivalent Chromium (calculated)	16065-83-1	2200	Tapwater RSL	733	10	9	5	NA	--
Polychlorinated Biphenyls by SW8081A, ug/L									
PCB-1016	12674-11-2	0.14	Tapwater RSL	0.25	0.25	0.15	0.05	46-129	30
PCB-1221	11104-28-2	0.0047	Tapwater RSL	0.25	0.25	0.15	0.05	NA	--
PCB-1232	11141-16-5	0.0047	Tapwater RSL	0.25	0.25	0.15	0.05	NA	--
PCB-1242	53469-21-9	0.0078	Tapwater RSL	0.25	0.25	0.15	0.05	NA	--
PCB-1248	12672-29-6	0.0078	Tapwater RSL	0.25	0.25	0.15	0.05	NA	--
PCB-1254	11097-69-1	0.0078	Tapwater RSL	0.25	0.25	0.15	0.05	NA	--
PCB-1260	11096-82-5	0.0078	Tapwater RSL	0.25	0.25	0.15	0.05	45-134	30
PCB-1262	37324-23-5	0.0078	Tapwater RSL	0.25	0.25	0.15	0.05	NA	--
PCB-1268	11100-14-4	0.0078	Tapwater RSL	0.25	0.25	0.15	0.05	NA	--
Total PCBs (calculated)	PCBs	0.0078	Tapwater RSL	0.25	0.25	0.15	0.05	NA	--
Decachlorobiphenyl (surrogate)	2051-24-3	--	--	--	--	--	--	10-148	--
tetrachloro-m-xylene (surrogate)	877-09-8	--	--	--	--	--	--	33-137	--
Volatile Organic Compound by SW8260C, ug/L									
1,1,1,2-Tetrachloroethane	630-20-6	0.57	Tapwater RSL	1	1	0.5	0.2	78-124	20

Worksheet #15.1 Reference Limits and Evaluation for Groundwater

Analyte	CAS Number	Project Screening Levels [1, 2, a, b]		PQLGs [3]	Achievable Laboratory Limits			Precision and Accuracy Method Performance Criteria, Percent	
		Value	Source	Value	LOQ	LOD	MDL	LCS/MS/MSD Recovery Limits	LCS/MS/MSD Precision Maximum RPD
1,1,1-Trichloroethane	71-55-6	5	TOGS 1.1.1	1.67	1	0.5	0.3	74-131	20
1,1,2,2-Tetrachloroethane	79-34-5	0.076	Tapwater RSL	1	1	0.5	0.2	71-121	20
1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	5	TOGS 1.1.1	10	10	0.5	0.2	70-136	20
1,1,2-Trichloroethane	79-00-5	0.041	Tapwater RSL	1	1	0.5	0.2	80-119	20
1,1-Dichloroethane	75-34-3	2.8	Tapwater RSL	1	1	0.5	0.2	77-125	20
1,1-Dichloroethene	75-35-4	5	TOGS 1.1.1	1.67	1	0.5	0.2	71-131	20
1,2,3-Trichlorobenzene	87-61-6	0.7	Tapwater RSL	5	5	1	0.4	69-129	20
1,2,4-Trimethylbenzene	95-63-6	5	TOGS 1.1.1	5	5	2	1	76-124	20
1,3,5-Trimethylbenzene	108-67-8	5	TOGS 1.1.1	5	5	1	0.3	75-124	20
1,4-Dioxane	123-91-1	0.46	Tapwater RSL	250	250	100	29	59-139	20
2-Butanone	78-93-3	50	TOGS 1.1.1	16.7	10	1	0.3	56-143	20
4-Methyl-2-pentanone	108-10-1	630	Tapwater RSL	210	10	1	0.5	67-130	20
Acetone	67-64-1	50	TOGS 1.1.1	20	20	2	0.7	39-160	20
Benzene	71-43-2	0.46	Tapwater RSL	1	1	0.5	0.2	42-138	20
Carbon Disulfide	75-15-0	60	TOGS 1.1.1	20	5	0.5	0.2	64-133	20
Carbon Tetrachloride	56-23-5	0.46	Tapwater RSL	1	1	0.5	0.2	72-136	20
Chloroethane	75-00-3	5	TOGS 1.1.1	1.67	1	0.5	0.2	60-138	20
Chloroform	67-66-3	0.22	Tapwater RSL	1	1	0.5	0.2	79-124	20
cis-1,2-Dichloroethene	156-59-2	3.6	Tapwater RSL	1.2	1	0.5	0.2	78-123	20
Cyclohexane	110-82-7	206	USEPA VISL	68.7	5	2	1	71-130	20
Ethylbenzene	100-41-4	1.5	Tapwater RSL	1	1	0.8	0.4	79-121	20
Isopropylbenzene	98-82-8	5	TOGS 1.1.1	5	5	0.5	0.2	72-131	20
m- & p-Xylene	108383/106423	5	TOGS 1.1.1	5	5	2	1	80-121	20
Methyl Acetate	79-20-9	2000	Tapwater RSL	667	5	0.5	0.3	56-136	20
Methyl Tertiary Butyl Ether	1634-04-4	10	TOGS 1.1.1/NYS MCL	3.33	1	0.5	0.2	71-124	20
Methylcyclohexane	108-87-2	206	USEPA VISL	68.7	5	1	0.5	72-132	20
Methylene Chloride	75-09-2	5	TOGS 1.1.1/NYS MCL	1.67	1	0.5	0.3	74-124	20
n-Butylbenzene	104-51-8	5	TOGS 1.1.1	5	5	0.5	0.2	75-128	20
n-Propylbenzene	103-65-1	5	TOGS 1.1.1	5	5	0.5	0.2	76-126	20
o-Xylene	95-47-6	5	TOGS 1.1.1	1.67	1	0.8	0.4	78-122	20
p-Isopropyltoluene	99-87-6	5	TOGS 1.1.1	5	5	0.5	0.2	77-127	20
sec-Butylbenzene	135-98-8	5	TOGS 1.1.1	5	5	0.5	0.2	77-126	20
tert-Butylbenzene	98-06-6	5	TOGS 1.1.1	5	5	1	0.3	78-124	20
Tetrachloroethene	127-18-4	4.1	Tapwater RSL	1.37	1	0.5	0.2	74-129	20
Toluene	108-88-3	5	TOGS 1.1.1	1.67	1	0.5	0.2	80-121	20
Total Xylenes	1330-20-7	19	Tapwater RSL	6.33	6	2	1.4	79-121	20
trans-1,2-Dichloroethene	156-60-5	5	TOGS 1.1.1	1.67	1	0.5	0.2	75-124	20
Trichloroethene	79-01-6	0.28	Tapwater RSL	1	1	0.5	0.2	79-123	20
Vinyl Chloride	75-01-4	0.019	Tapwater RSL	1	1	0.5	0.2	58-137	20
1,2-Dichloroethane-d4 (surrogate)	17060-07-0	--	--	--	--	--	--	81-118	--
Dibromofluoromethane (surrogate)	1868-53-7	--	--	--	--	--	--	80-119	--
Toluene-d8 (surrogate)	2037-26-5	--	--	--	--	--	--	89-112	--

Worksheet #15.1 Reference Limits and Evaluation for Groundwater

Analyte	CAS Number	Project Screening Levels [1, 2, a, b]		PQLGs [3]	Achievable Laboratory Limits			Precision and Accuracy Method Performance Criteria, Percent	
		Value	Source	Value	LOQ	LOD	MDL	LCS/MS/MSD Recovery Limits	LCS/MS/MSD Precision Maximum RPD
Semivolatile Organic Compound by SW8270D, ug/L									
1,1'-Biphenyl	92-52-4	0.083	Tapwater RSL	10	10	9	3	49-115	20
1,4-Dichlorobenzene	106-46-7	0.48	Tapwater RSL	5	5	1	0.5	29-112	20
2-Chloronaphthalene	91-58-7	10	TOGS 1.1.1	3.33	1	0.8	0.4	40-116	20
2-Methylphenol	95-48-7	93	Tapwater RSL	31	2	1	0.5	30-117	20
3/4-Methylphenol	108394/106445	93	Tapwater RSL	31	2	1	0.5	25-120	20
4-Chloro-3-methylphenol	59-50-7	140	Tapwater RSL	46.7	3.5	3.2	1.6	52-119	20
4-Chloroaniline	106-47-8	0.37	Tapwater RSL	10	10	9	4	33-117	20
Benzaldehyde	100-52-7	19	Tapwater RSL	10	10	9	3	45-111	30
Benzoic acid	65-85-0	7500	Tapwater RSL	2500	25	24	12	10-47	30
bis(2-Ethylhexyl)phthalate	117-81-7	5	TOGS 1.1.1	11	11	10	5	55-135	20
Butylbenzylphthalate	85-68-7	16	Tapwater RSL	5.33	5	4	2	53-134	20
Caprolactam	105-60-2	990	Tapwater RSL	330	11	10	5	13-37	30
Carbazole	86-74-8	29	Tapwater RSL	9.67	2	1	0.5	60-122	20
Dibenzofuran	132-64-9	0.79	Tapwater RSL	2	2	1	0.5	53-118	20
Diethylphthalate	84-66-2	50	TOGS 1.1.1	16.7	5	4	2	56-125	20
Dimethylphthalate	131-11-3	50	TOGS 1.1.1	16.7	5	4	2	45-127	20
Di-n-butylphthalate	84-74-2	50	TOGS 1.1.1	16.7	5	4	2	59-127	20
Di-n-octylphthalate	117-84-0	20	Tapwater RSL	11	11	10	5	51-140	20
2,4,6-tribromophenol (surrogate)	118-79-6	--	--	--	--	--	--	43-140	--
2-Fluorobiphenyl (surrogate)	321-60-8	--	--	--	--	--	--	44-119	--
2-Fluorophenol (surrogate)	367-12-4	--	--	--	--	--	--	19-119	--
Nitrobenzene-d5 (surrogate)	4165-60-0	--	--	--	--	--	--	44-120	--
Phenol-d6 (surrogate)	13127-88-3	--	--	--	--	--	--	10-71	--
Terphenyl-d14 (surrogate)	1718-51-0	--	--	--	--	--	--	50-134	--
Polycyclic Aromatic Hydorcarbons by SW8270D-SIM, ug/L									
1,4-Dioxane	123-91-1	0.46	Tapwater RSL	0.153	0.3	0.2	0.1	18-91	20
1-Methylnaphthalene	90-12-0	1.1	Tapwater RSL	0.367	0.05	0.03	0.01	41-115	20
2-Methylnaphthalene	91-57-6	3.6	Tapwater RSL	1.2	0.07	0.06	0.02	39-114	20
Acenaphthene	83-32-9	20	TOGS 1.1.1	6.67	0.05	0.03	0.01	48-114	20
Acenaphthylene	208-96-8	53	Tapwater RSL	17.7	0.05	0.03	0.01	35-121	20
Anthracene	120-12-7	50	TOGS 1.1.1	16.7	0.05	0.03	0.01	53-119	20
Benzo(a)anthracene	56-55-3	0.002	TOGS 1.1.1	0.05	0.05	0.03	0.01	59-120	20
Benzo(a)pyrene	50-32-8	0.025	Tapwater RSL	0.05	0.05	0.03	0.01	53-120	20
Benzo(b)fluoranthene	205-99-2	0.002	TOGS 1.1.1	0.05	0.05	0.03	0.01	53-126	20
Benzo(g,h,i)perylene	191-24-2	12	Tapwater RSL	4	0.05	0.03	0.01	44-128	20
Benzo(k)fluoranthene	207-08-9	0.002	TOGS 1.1.1	0.05	0.05	0.03	0.01	54-125	20
Chrysene	218-01-9	0.002	TOGS 1.1.1	0.05	0.05	0.03	0.01	57-120	20
Dibenz(a,h)anthracene	53-70-3	0.025	Tapwater RSL	0.07	0.07	0.06	0.02	44-131	20
Fluoranthene	206-44-0	50	TOGS 1.1.1	16.7	0.05	0.03	0.01	58-120	20
Fluorene	86-73-7	29	Tapwater RSL	9.67	0.05	0.03	0.01	50-118	20
Indeno(1,2,3-cd)pyrene	193-39-5	0.002	TOGS 1.1.1	0.05	0.05	0.03	0.01	48-130	20
Naphthalene	91-20-3	0.12	Tapwater RSL	0.07	0.07	0.06	0.03	43-114	20

Worksheet #15.1 Reference Limits and Evaluation for Groundwater

Analyte	CAS Number	Project Screening Levels [1, 2, a, b]		PQLGs [3]	Achievable Laboratory Limits			Precision and Accuracy Method Performance Criteria, Percent	
		Value	Source	Value	LOQ	LOD	MDL	LCS/MS/MSD Recovery Limits	LCS/MS/MSD Precision Maximum RPD
Phenanthrene	85-01-8	50	TOGS 1.1.1	16.7	0.07	0.06	0.03	53-115	20
Pyrene	129-00-0	12	Tapwater RSL	4	0.05	0.03	0.01	53-121	20
1-Methylnaphthalene-d10 (surrogate)	38072-94-5	--	--	--	--	--	--	22-129	--
Benzo(a)pyrene-d12 (surrogate)	63466-71-7	--	--	--	--	--	--	26-137	--
Fluoranthene-d10 (surrogate)	93951-69-0	--	--	--	--	--	--	42-136	--

Notes:

The laboratory limits for Limit of Quantitation (LOQ), Limit of Detection (LOD), and Method Detection Limit (MDL) were obtained from Eurofins Lancaster Laboratories (2020) and are meant to be recommended project values. The control limits for LCS/MS/MSD (laboratory control sample/matrix spike/matrix spike duplicate) are specified in DoD QSM Version 5.1.1 (as referenced in Worksheet #28).

[1] The project screening levels (PSLs) for the highlighted analytes are not analytically achievable; the LOD will be used as the PSL for non-detects if the LOD exceeds the PSL.

[2] Selected PSLs are analytically achievable and protective of human receptors, where possible.

[3] The Project Quantitation Limit Goals (PQLGs) were established using the following criteria consistent with the eQAPP:

1. If LOQ < 1/3 PSL, PQLG = 1/3 PSL
2. If LOQ > 1/3 PSL, PQLG = LOQ
3. If no PSL is available, PQLG = 5 x LOQ
4. Highlighting indicates that the LOQ, LOD, and/or DL are greater than the PSL.

ug/L = micrograms per liter
NA = not available
(a) Ecological receptors are not exposed to groundwater so ecological risk-based screening levels were not included in the PSL selection process.
(b) The lowest of the human health risk-based screening levels were selected from the following sources:

Tapwater RSL - USEPA RSLs for Tap Water that are protective of a target cancer risk of 1E-06 and a target hazard quotient of 0.1 (USEPA, 2020a).

The following surrogates (in parentheses) were used to derive RSLs for the following chemicals: Acenaphthylene (acenaphthene); benzo(g,h,i)perylene (pyrene); carbazole (fluorene); dimethylphthalate (diethylphthalate); methylcyclohexane (cyclohexane); 3/4-Methylphenol (lower of m-cresol and p-cresol); PCB-1262 (PCB-1260), PCB-1268 (PCB-1260); phenanthrene (anthracene); and p-isopropyltoluene (cumene).

The hexavalent chromium RSL was used to select limits for chromium that are protective of all forms of chromium that may be present at the Site.

MCL - USEPA Maximum Contaminant Levels (MCLs) (USEPA, 2018) or New York State (NYS) MCL (NYSDOH, 2018).

VISL - USEPA Residential Vapor Intrusion Screening Levels (VISLs) (USEPA, 2020b). Residential VISLs were derived using a target cancer risk of 1E-06, target hazard quotient of 0.1, and an average groundwater temperature of 9.2ºC (per Phase II Camp Hero groundwater monitoring well data).

TOGS 1.1.1 - New York State Technical and Operational Guidance Series (TOGS), 1.1.1. Groundwater Effluent Limitations, Table 5 (Class GA), dated June 1998, January 1999 Errata, April 2000 Addendum, and June 2004 Addendum (NYSDEC, 1998, 1999, 2000, and 2004).

WORKSHEET #16: PROJECT SCHEDULE

The following table presents a summary of the Phase IV RI schedule.

Activity	Dates	
	Anticipated Date of Initiation	**Anticipated Date of Completion**
Phase IV RI QAPP	August 2020	November 2020
Phase IV RI Field Activities	October 2020	December 2020
Laboratory Analysis	December 2020	January 2021
Phase IV RI Report Addendum	February 2021	May 2021

Notes:

QAPP	Quality Assurance Project Plan
RI	Remedial Investigation

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WORKSHEET #17: SAMPLING DESIGN AND RATIONALE

17.1 Overview

This worksheet provides the proposed sampling design and rationale based on the CSM summarized in **Worksheet #10** and the DQOs established in **Worksheet #11**. The proposed Phase IV field investigation is designed to complete the RI phase of the CERCLA process by evaluating the potential for DoD contamination within the UGA at Camp Hero, as well as to provide data to support risk-based decisions. The results of this field investigation will also be used to refine the CSM relative to the relationship between the shallow perched groundwater lenses and the UGA at Camp Hero. The proposed locations of samples to be collected as part of this Phase IV RI field investigation are shown on **Figure 10-5** (existing UGA wells) and **Figure 17-1** (proposed UGA monitoring wells). The specific sampling rationale for each medium are included in **Table 17-1** and **Table 17-2**.

Analytical parameters have been selected to be consistent with the groundwater sampling conducted during the Phase III RI field effort. For simplicity, analytical parameter groups warranting further analysis are referred to as VOCs, SVOCs, PCBs, and metals in this worksheet. Refer to **Worksheet #15** for specific details on the parameter groups and specific parameters selected for this Phase IV RI field investigation. PSLs have been selected based on potentially relevant regulatory screening values applicable to groundwater and the potential exposure pathways and receptors identified for human health. Analytical requirements to achieve project objectives and support the quantification of potential risks are also detailed in **Worksheet #15**. The following subsections provide the specific sampling design and rationale for the selection of sampling locations, depths, and distribution.

17.2 Soil Sample Collection from Pilot Borings

Borings will be advanced into the UGA at two locations between the known subsurface impacts at DU01 (former Building 203 with subsurface LNAPL impacts) and the potential receptors (drinking water wells) along Old Montauk Highway to the southwest of Camp Hero. The deep borings will be conducted in advance of completing new permanent monitoring wells to characterize subsurface lithology and collect soil samples for physical (geotechnical) parameters. Based on the lithology of the borings, the field geologist will determine the depth of the UGA and select the screen elevations of the new wells (refer to **Section 17.3** for additional details).

The procedures for collection of soil samples are presented in **Worksheet #14**. The rationale for the soil samples collected from pilot borings is presented in **Table 17-1**.

Table 17-1: Soil Sample Rationale

Location IDs	Target Depth (feet bgs)	Sample Quantity	Analytes	Rationale
CH-MW044S CH-MW044D	TBD by field geologist (est. 5-140)	Up to 13 (approx. one per 10 feet)	Grain size, % moisture	Characterize subsurface lithology. Determine depth of UGA and select screen interval of CH-MW044S/D.
CH-MW045S CH-MW045D	TBD by field geologist (est. 5-140)	Up to 13 (approx. one per 10 feet)		Characterize subsurface lithology. Determine depth of UGA and select screen interval of CH-MW045S/D.

Notes:

%	percent
bgs	below ground surface
DoD	Department of Defense
TBD	to be determined
UGA	Upper Glacial Aquifer

17.3 Monitoring Well Installation and Groundwater Sample Collection

Site reconnaissance will be conducted to locate up to 20 existing UGA wells for gauging and potential sampling. If existing UGA supply or monitoring wells are determined to be viable for sampling, samples will be collected from up to three wells within the Camp Hero FUDS boundary and from up to eight wells located within the immediate vicinity of Camp Hero FUDS to determine local groundwater conditions. One or two rounds of groundwater samples will be collected from each monitoring well, dependent upon the results of the first round and potential statistical evaluation of data as described in **Worksheet #14, Section 14.3**. The locations of historical and current UGA supply and monitoring wells in the vicinity of Camp Hero that may potentially be sampled are presented in **Table 10-2** and shown on **Figure 10-5**. Existing pumps and/or equipment potentially within the wells will not be disturbed. Existing wells will be redeveloped prior to sampling unless they are actively used for drinking water purposes. The procedures for monitoring well installation, well development/redevelopment, and groundwater sample collection are presented in **Worksheet #14**.

The rationale for the groundwater samples collected is presented in **Table 17-2**. The preferred existing UGA wells to be sampled within the Camp Hero FUDS boundary are presented in **Table 17-3**. The preferred existing UGA wells in the immediate vicinity of Camp Hero FUDS to be sampled to determine local groundwater conditions are presented on **Table 17-4**.

Table 17-2: Groundwater Sample Rationale

Location IDs	Estimated Depth[1] (feet bgs)	Number of Locations	Sample Quantity[3]	Analytes[2]	Rationale
CH-MW044S CH-MW044D CH-MW045S CH-MW045D	TBD by field geologist ("S" est. 100 and "D" est. 140)	4	4 – 8 (1 to 2 per well)	VOC, SVOCs, metals (total and dissolved), mercury (total and dissolved), PCBs, hexavalent chromium (total and dissolved)	Newly-installed monitoring wells located between DU01 and potential receptors along Old Montauk Highway. Sample wells to determine whether chemicals attributable to a release from historical DoD activities are present or absent in the UGA. If chemicals are detected, determine whether concentrations are above acceptable risk levels.
TBD – Existing Well within Camp Hero FUDS (see **Table 17-3**)	TBD (est. 60-163)	3	3 – 6 (1 to 2 per well)		Existing UGA supply or monitoring wells on Camp Hero FUDS property. Sample wells to determine whether chemicals attributable to a release from historical DoD activities are present or absent in the UGA. If chemicals are detected, determine whether concentrations are above acceptable risk levels.
TBD – Off-site Existing Well (see **Table 17-4**)	TBD (est. 60-163)	Up to 8	8 – 16 (1 to 2 per well)		Existing off-site UGA supply or monitoring wells in the vicinity of the Camp Hero FUDS. Sample wells to determine local groundwater conditions.

Notes:

[1] Estimated depths of existing wells that may be sampled are based on reported depths as shown on **Table 10-2**.

[2] In the event of lack of volume of water, the following hierarchy will be followed for sample collection: VOCs, SVOCs, metals (unfiltered), Cr^{6+} (unfiltered), metals (filtered), Cr^{6+} (filtered), and PCBs.

[3] The number of rounds of sampling will be determined by the statistical evaluations described in **Worksheet # 14**, **Section 14.3**.

bgs	below ground surface
DoD	Department of Defense
PCB	polychlorinated biphenyls
SVOC	semivolatile organic compound
TBD	to be determined
UGA	Upper Glacial Aquifer
VOC	volatile organic compound

Table 17-3: Preferred Existing UGA Wells within Camp Hero FUDS Boundary to be Sampled

Well Name	Description
S 17231S	Former USAF Supply Well inside Pump House
S 19495	Building 3001 Well in Vault (Former AT&T Building)
S 19494	USGS Test Well

Notes:

AT&T	American Telephone & Telegraph
USAF	United States Air Force
USGS	United States Geological Survey

Table 17-4: Preferred Existing UGA Wells in the Vicinity of Camp Hero to be Sampled

Well Name	Description
S 70627	USGS Gauging Well on Route 27
S 15812	Former Montauk Point State Park Well
S 79269	Montauk Point State Park Well
S 76304	Former Madison Hill Well Field, Well #1
S 121808	Former Madison Hill Well Field, Well #2
S 121811	Former Madison Hill Well Field, Well #3A
S 1202	Montauk Lighthouse
S 3599	Montauk Lighthouse

Notes:

USGS	United States Geological Survey

WORKSHEET #18: SAMPLING LOCATIONS AND METHODS

This worksheet identifies the individual samples (including QA/QC samples) to be collected and the associated analytes for each sample. The soil and groundwater sampling locations are presented in **Worksheet #17**, with associated sample rationale tables and sampling location figures. See **Worksheet #19** for additional details on analytical methods and SOPs. See **Worksheet #21** for field SOPs.

Location Identifier[1]	Sample Identifier	Matrix	Depth (feet bgs)	Type (Sampling Tool)	Analyte/Analytical Group	Sampling SOP
Soil Samples						
CH-MW044D	CH-MW044D-SB-[Depth-Depth]	Subsurface Soil	TBD by field geologist (approx. one per 10 feet, up to 13 samples per boring)	Sonic	Grain Size (ASTM D-6913 and ASTM D 7928) and % moisture (ASTM D-2216)	3-21
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW044D	CH-MW044D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					
CH-MW045D	CH-MW045D-SB-[Depth-Depth]					

Location Identifier[1]	Sample Identifier	Matrix	Depth (feet bgs)	Type (Sampling Tool)	Analyte/Analytical Group	Sampling SOP
Groundwater Samples						
CH-MW044S	CH-MW044S-[MMYY]	Groundwater	Mid-screen	Bladder Pump	VOCs (SW8260C) SVOCs (SW8270D/ SW8270D SIM) Metals, total and dissolved (SW6020A) Mercury, total and dissolved (SW7470A) PCBs (SW8082A) Hexavalent Chromium, total and dissolved (USEPA218.6)	3-14
CH-MW044D	CH-MW044D-[MMYY]					
CH-MW045S	CH-MW045S-[MMYY]					
CH-MW045D	CH-MW045D-[MMYY]					
S17231S	S17231S-[MMYY]					
S19495	S1949-[MMYY]					
S19494	S19494-[MMYY]					
S70627	S70627-[MMYY]					
S15812	S15812-[MMYY]					
S79269	S79269-[MMYY]					
S1202	S1202-[MMYY]					
S3599	S3599-[MMYY]					
S76304	S76304-[MMYY]					
S121808	S121808-[MMYY]					
S121811	S121811-[MMYY]					
S121811[2]	S121811-[MMYY]D[2]					
S121811[2]	S121811-[MMYY]MS[2]					
S121811[2]	S121811-[MMYY]MSD[2]					
QA/QC Samples						
N/A	CH-EB-[MMYY]-01 CH-EB-[MMYY]-02 CH-EB-[MMYY]-03 CH-EB-[MMYY]-04	Equipment Blank	N/A	N/A (Pour laboratory-supplied water)	VOCs (SW8260C) SVOCs (SW8270D/ SW8270D SIM) Metals, total (SW6020A) Mercury, total (SW7470A) PCBs (SW8082A) Hexavalent Chromium, total and dissolved (USEPA218.6)	3-14, 3-21
N/A	CH-TB-[MMYY]-01 CH-TB-[MMYY]-02 CH-TB-[MMYY]-03 CH-TB-[MMYY]-04	Trip Blank	N/A	N/A (provided by laboratory)	VOCs (SW8260C)	3-14, 3-21

Notes:

[1] Preferred existing UGA wells to be sampled are identified in **Worksheet #18** but are subject to change.

[2] Locations of field quality control samples (duplicates and MS/ MSDs) will be selected in the field at the rates specified in **Worksheet #20** of this SI QAPP Addendum. The location and sample identifiers listed in **Worksheet #18** are included as examples only.

%	percent
bgs	below ground surface
EB	equipment blank
GW	groundwater
N/A	not applicable
PCB	polychlorinated biphenyl
SB	soil boring
SVOC	semivolatile organic compound
TB	trip blank
VOC	volatile organic compound

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WORKSHEET #19: SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES

This worksheet provides the project-specific sample containers, preservation, and holding time requirements. Sample containers will be certified pre-cleaned according to USEPA protocols. The purity of preservation chemicals will be guaranteed by the manufacturer. Field sampling personnel will obtain sample containers from the analytical laboratory and will inspect them prior to use. Containers that have not been pre-cleaned according to USEPA protocols or do not meet the requirements of **Worksheet #19** will not be used. Each sample will be collected into a new, unused container.

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Containers (Number, Size, and Type)	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/ Analysis)
Water	VOCs	SW-846 8260C; WI8194	3 x 40 mL Glass	HCl or None, 2-6°C	14 days preserved; 7 days not preserved
	SVOCs	SW-846 8270C/D; WI9617	2 x 250 ml Amber glass; 250 ml	None, 2-6°C	7 days/40 days
	SVOCs SIM	SW-846 8270/C/D SIM; WI9995	2 x 250 ml Amber glass; 250 ml	None, 2-6°C	7 days/40 days
	PCBs	SW-846, 8082A; WI9238	2 x 250 ml Amber glass; 250 ml	None, 2-6°C	7 days/40 days
	Metals (total and dissolved)	SW-846 6020 A/B WI11933	250 mL plastic	HNO_3, 2-6°C	6 months
	Mercury (total and dissolved)	SW-846 7470A; WI7965	250 mL plastic (included with Metals)	HNO_3, 2-6°C	28 days
	Hexavalent Chromium, low-level (total and dissolved)	USEPA 218.6; WI11641	250 mL Plastic/Glass	Cool, 6°C $NH_4OH/(NH_4)_2SO_4$	28 days
Soil	Grain Size	ASTM D-6913 and ASTM D-7928)	448 g Plastic/Glass (16 ounce glass jar or plastic bag)	None	N/A
	Percent Moisture	ASTM D-2216	Included in above 448 g Plastic/Glass (16 ounce glass jar or plastic bag)	None	N/A

Notes:

ASTM	American Society for Testing and Materials
G	grams
HCl	hydrochloric acid
mL	milliliter
N/A	not applicable
$NH_4OH/(NH_4)_2SO_4$	Ammonium Hydroxide/Ammonium Sulfate
PCB	polychlorinated biphenyls
SIM	selected ion monitoring
SVOC	semivolatile organic compounds
VOC	volatile organic compounds
USEPA	United States Environmental Protection Agency

* Laboratory specific analytical SOP

[1] The reference analytical methods associated with these SOPs can be found in **Worksheet #23**

[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

WORKSHEET #20: FIELD QUALITY CONTROL SAMPLE SUMMARY

Matrix	Analytical Group	Analytical and Preparation SOP Reference[1]	No. of Field Duplicate Pairs	No. of MS/MSD
Aqueous	SVOCs and SVOCs SIM	8270D_WI9617 and WI9995	1 per 10 samples	1 per 20 samples
Aqueous	VOCs	8260C_WI8194	1 per 10 samples	1 per 20 samples
Aqueous	PCBs	8082A_WI9238	1 per 10 samples	1 per 20 samples
Aqueous	Metals (total and dissolved)	6020_WI11933	1 per 10 samples	1 per 20 samples
Aqueous	Mercury (total and dissolved)	7470A_WI7965	1 per 10 samples	1 per 20 samples
Aqueous	Hexavalent Chromium (total and dissolved)	218.6_WI11641	1 per 10 samples	1 per 20 samples

Notes:

MS/MSD	matrix spike/matrix spike duplicate
PCB	polychlorinated biphenyls
SIM	selected ion monitoring
SVOC	semivolatile organic compounds
VOC	volatile organic compounds

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

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WORKSHEET #21: FIELD STANDARD OPERATING PROCEDURES

Reference Number	Title, Revision Date, and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP 3-01	Utility Clearance	AECOM	Flagging for locations, utilities; Additional equipment provided by the subcontractor/agency	N	See SOP for detailed procedures
SOP 3-02	Logbooks	AECOM	Field logbook and field forms	N	See SOP for detailed procedures
SOP 3-03	Recordkeeping, Sample Labeling, and Chain of Custody	AECOM	Sample labels, pen with indelible ink, and sample attribute forms, CoC forms,	N	See SOP for detailed procedures
SOP 3-04	Sample Handling, Storage, and Shipping	AECOM	CoC, custody seals, ice, cooler, resealable bags, bubble wrap, air bills	N	See SOP for detailed procedures
SOP 3-05	Investigation-Derived Waste Management	AECOM	DOT-approved drums or other containers, 5-gallon buckets, PID, labeling material	N	See SOP for detailed procedures
SOP 3-06	Equipment Decontamination	AECOM	Plastic sheeting, buckets, potable water, DI water, isopropanol, Alconox/Liquinox	N	See SOP for detailed procedures
SOP 3-12	Monitoring Well Installation	AECOM	Sonic drill rig, PID, water level meter, water quality meter, submersible pump	N	See SOP for detailed procedures
SOP 3-13	Monitoring Well Development	AECOM	PID, water level meter, water quality meter, submersible pump, tubing, surge block, check valve, power source	N	See SOP for detailed procedures
SOP 3-14	Monitoring Well Sampling	AECOM	PID, submersible pump, tubing, water level meter, water quality meter, power source, laboratory-supplied sample containers	N	See SOP for detailed procedures
SOP 3-15	Monitoring Well and Borehole Abandonment	AECOM	Plastic sheeting, buckets, water	N	See SOP for detailed procedures
SOP 3-16	Soil and Rock Classification	AECOM	Sonic drill rig, field logbook, ruler, tape measure, grain size chart, Munsell color chart	N	See SOP for detailed procedures
SOP 3-20	Operation and Calibration of a Photoionization Detector	AECOM	PID, calibration gas, tedlar bag	N	See SOP for detailed procedures
SOP 3-21	Surface and Subsurface Soil Sampling Procedures	AECOM	Sonic drill rig, PID, laboratory-supplied sample containers	N	See SOP for detailed procedures
SOP 3-24	Water Quality Parameter Testing for Groundwater Sampling	AECOM	submersible pump, tubing, water level meter, water quality meter, power source	N	See SOP for detailed procedures
SOP 3-37	Discrete Groundwater Sampling Techniques	AECOM	PID, submersible pump, tubing, water level meter, water quality meter, power source, laboratory-supplied sample containers	N	See SOP for detailed procedures

Notes:

AECOM	AECOM Technical Services, Inc.	DOT	Department of Transportation
CoC	chain-of-custody	PID	photoionization detector
DI	deionized water	SOP	Standard Operating Procedure

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WORKSHEET #23: ANALYTICAL STANDARD OPERATING PROCEDURES

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
WI8194	VOCs by GC/MS in Waters and Wastewaters by Method 8260C/D, Rev 8, effective 7/18/19	Definitive	Water GC/MS VOCs	GC/MS	ELLE	N
SOP11880	Balance, Syringe, Pipette, and Labware Verification, Rev 10, effective 05/20/19	N/A	Maintenance	Balance	ELLE	N
WI7619	GC and GC/MS Instrument Maintenance, Rev 9, effective 03/10/17	N/A	Maintenance	GC/MS	ELLE	N
WI9598	GC/MS Preventative and Corrective Maintenance, Rev 5, effective 4/13/11.	N/A	Maintenance	GC/MS	ELLE	N
WI7965	Mercury in Aqueous, Solid, and Tissue Samples by USEPA 7471A, 7471B, 7470A, and 245.1 rev 3 by Cold Vapor AA, Rev 18, effective 08/12/2019	Definitive	Solid, liquid, tissues Metals	ICP	ELLE	N
WI11933	Metals by Inductively Coupled Plasma Mass Spectrometry for SW-846 Methods 6020/6020A/6020B (aqueous, solid, tissue), and USEPA 200.8 (aqueous), Rev 8, effective 09/25/18	Definitive	Liquid Inorganic Preparation	ICP/MS	ELLE	N
WI11924	Digestion of Aqueous Samples by SW-846 Method 7470A, Rev 21, effective 08/12/2019	N/A	Liquid Inorganic Preparation SW-846 7470A	N/A	ELLE	N
WI9238	Analysis of Polychlorinated Biphenyls (PCBs) by 8082A in Aqueous Samples using GC-ECD, Rev 6, effective 03/29/2018	Definitive	PCBs	GC	ELLE	N
WI10920	Separatory Funnel Extraction by Method 3510C, 608, 608.3 or 622 for Pesticides and PCBs in Wastewater, Rev 20, effective 03/22/2019	N/A	Organic Preparation Method 3510C	N/A	ELLE	N
WI10007	Preventive and Corrective GC Maintenance, Rev 7, effective 02/04/2019	N/A	Maintenance	N/A	ELLE	N
SOP11880	Balance, Syringe, Pipette, and Labware Verification, Rev 10, effective 05/20/2019	N/A	Maintenance	Balance	ELLE	N
WI9954	Interpretation of Chromatographic Data, Rev 14, effective 07/22/2019	N/A	Data Interpretation	GC & HPLC	ELLE	N

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
WI9617	Semivolatile Organic Compounds by Method 8270D/E in Aqueous and Non-Aqueous Matrices using GC-MS, Rev 10, effective 04/26/2019	Definitive	Water, solid, tissue, leachate GC/MS SVOCs	GC/MS	ELLE	N
WI9995	Semivolatiles in Waters and Soils by Method 8270C/D SIM by GC/MS, Rev 15, effective 07/29/2019	Definitive	Water, solid, tissue GC/MS SVOCs SIM	GC/MS	ELLE	N
WI11432	Separatory Funnel Extraction by Method 3510C for BNAs in Wastewater, Rev 15, effective 04/30/2018	N/A	Method 3510C water prep	N/A	ELLE	N
WI10931	Separatory Funnel Extraction Procedure by Method 3510C for BNAs by 8270 SIM in Wastewater, Rev 9, effective 03/20/2019	N/A	Method 3510C SIM water prep	N/A	ELLE	N
WI9598	GC/MS Preventative and Corrective Maintenance, Rev 5, effective 4/13/2011	N/A	Maintenance	GC/MS	ELLE	N
WI11641	Determination of Hexavalent Chromium by Ion Chromatography in Solids and Waters SW-846 7199 and USEPA 218.6, Rev 15, effective 3/9/19	Definitive	Water	IC Analyzer	ELLE	N

Notes:

ELLE	Eurofins Lancaster Laboratories Environmental, LLC
IC	ion chromatography
ICP	inductively coupled plasma
GC	gas chromatography
GC ECD	gas chromatography-electron capture detector
GC/MS	gas chromatography/mass spectrometry
HPLC	high performance liquid chromatography
N/A	not applicable
PCB	polychlorinated biphenyl
SIM	selectively ion monitoring
SVOC	semivolatile organic compound
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

WORKSHEET #28.1: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTIONS

Matrix: Water
Analytical Group: VOCs
Sampling SOP: See Worksheet #21
Analytical Method/ SOP Reference: 8260C/WI8194
Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Recovery limits per QSM 5.1.1. Laboratory statistical limits for surrogates not in QSM 5.1.1.	If obvious matrix interference report data with a comment. Otherwise, re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Reanalyze to confirm detections. If detects confirm reanalyze samples that are not ND or not >10x the blank value or regulatory limit	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1.1. Laboratory statistical limits for compounds not in QSM 5.1.1; RPD ≤20%	Flag outliers	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1.1. Laboratory statistical limits for compounds not in QSM 5.1.1.; RPD ≤20%	Analytes in the LCS that fail high and are ND in the samples can be reported. For all others reanalyze LCS and samples. If it still fails, perform instrument maintenance, restart the tune period and reanalyze all QC and samples.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
Internal standards	Per sample (including MS/MSD, LCS, and blanks)	-50% to + 100% of internal standard area of 12-hour STD. RT change	Check the instrument for possible problems and then reanalyze samples. If reinject confirms, report with a comment.	ELLE Analyst	Precision	Results within acceptance limits

Notes:

ELLE	Eurofins Lancaster Laboratories Environmental, LLC
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	Limit of Quantitation
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ND	non-detect
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure

WORKSHEET #28.2: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTIONS

Matrix: Water
Analytical Group: SVOCs
Analytical Method/ SOP Reference: 8270C/D/WI9617
Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Recovery limits per QSM 5.1.1. Laboratory statistical limits for surrogates not in QSM 5.1.1.	If obvious matrix interference report data with a comment. Otherwise, re-extract and re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1.1. Laboratory statistical limits for compounds not in QSM 5.1.1.; RPD ≤20%	Flag outliers	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1.1. Laboratory statistical limits for compounds not in QSM 5.1.1.; RPD ≤20%	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance
Internal standards	Per sample (including MS/MSD, LCS, and blanks)	-50% to +100% of internal standard area of 12-hour STD. RT within ±10 sec. of midpoint standard in the ICAL	Flag data	ELLE Analyst	Precision	Results within acceptance limits

Notes:

ELLE	Eurofins Lancaster Laboratory Environmental, LLC
ICAL	initial calibration
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure

WORKSHEET #28.3: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTIONS

Matrix: Water
Analytical Group: SVOCs SIM
Analytical Method/ SOP Reference: 8270C/D/WI9995
Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Laboratory statistical limits	If obvious matrix interference report data with a comment. Otherwise, re-extract and re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1.1. Laboratory statistical limits for compounds not in QSM 5.1.1.; RPD ≤20%	Flag outliers	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1.1. Laboratory statistical limits for compounds not in QSM 5.1.1; RPD ≤20%	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Internal standards	Per sample (including MS/MSD, LCS, and blanks)	-50% to +100% of internal standard area of 12-hour STD. RT within ±10 sec. of midpoint standard in the ICAL	Flag data	ELLE Analyst	Precision	Results within acceptance limits

Notes:

ELLE	Eurofins Lancaster Laboratory Environmental, LLC
ICAL	initial calibration
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
RT	retention time
SOP	standard operating procedure

WORKSHEET #28.4: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTIONS

Matrix: Water
Analytical Group: PCBs
Analytical Method/ SOP Reference: 8082A/WI9238
Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Recovery limits per QSM 5.1.1. Laboratory statistical limits for surrogates not in QSM 5.1.1.	If obvious matrix interference report data with a comment. Otherwise, re-extract and re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Reanalyze to confirm detections. If detects confirm reextract samples that are not ND or not >10x the blank value	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1.1. Laboratory statistical limits for compounds not in QSM 5.1.1.; RPD ≤30%	Flag outliers	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1.1. Laboratory statistical limits for compounds not in QSM 5.1.1.; RPD ≤30%	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits

Notes:

ELLE	Eurofins Lancaster Laboratory Environmental, LLC
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
SOP	standard operating procedure

WORKSHEET #28.5: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTIONS

Matrix: Water
Analytical Group: Metals
Analytical Method/ SOP Reference: 6020A/B/WI11933
Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per prep batch of up to 10 samples	No analytes detected > 1/2 RL or >1/20 the amount measured in any sample	Reanalyze blank to confirm detections. If detects confirm, redigest samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected >1/2 RL or >1/20 the amount measured in any sample
MS/MSD	1 per prep batch of up to 10 samples	Recovery limits per QSM 5.1.1 ±25% for elements not in QSM 5.1.1; RPD ≤20%	Analyze post digestion spike and serial dilution	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
LCS/LCSD	1 per prep batch of up to 10 samples	Recovery limits per QSM 5.1.1 ±20% for elements not in QSM 5.1.1; RPD ≤20%	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-digested and reanalyzed.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
Duplicate	1 per 10 samples	RPD must be ≤20%	Flag data	ELLE Analyst	Precision	Results within acceptance limits
Serial Dilutions	Must be prepared with each background sample, evaluated only when analyte concentrations are >50x the LOQ.	The percent difference must be ≤10%	Flag data	ELLE Analyst	Precision	Results within acceptance limits

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Post Digestion Spike (PDS)	Prepare with each background sample	± 20% True Value	No specific action needed unless required by the project. PDS is reported in data package	ELLE Analyst	Accuracy/Bias	Results within acceptance criteria
Internal Standard	Every sample and QC	Must be 30%-120% of the calibration blank	Reanalyze at a dilution	ELLE Analyst	Precision	Results within acceptance criteria

Notes:

ELLE	Eurofins Lancaster Laboratory Environmental, LLC
LCS	laboratory control spike
LCSD	laboratory control spike duplicate
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
PDS	post digestion spike
QC	quality control
QSM	Quality Systems Manual
RL	Reporting Limit
RPD	relative percent difference
SOP	standard operating procedure

WORKSHEET #28.6: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTIONS

Matrix: Water
Analytical Group: Metals – Mercury (Hg)
Analytical Method/ SOP Reference: 7470A/WI7965
Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per prep batch of up to 10 samples	No analytes detected > 1/2 RL or >1/20 the amount measured in any sample	Reanalyze blank to confirm detections. If detects confirm, redigest samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected >1/2 RL or >1/20 the amount measured in any sample
MS/MSD	1 per prep batch of up to 10 samples	Recovery limits per QSM 5.1.1; RPD ≤20%	Flag outliers	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
LCS/LCSD	1 per prep batch of up to 10 samples	Recovery limits per QSM 5.1.1; RPD ≤20%	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-digested and reanalyzed.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
Duplicate	1 per 10 samples	RPD must be ≤20%	Flag data	ELLE Analyst	Precision	Results within acceptance limits

Notes:

ELLE	Eurofins Lancaster Laboratory Environmental, LLC
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	Limit of Quantitation
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ND	non-detect
QC	quality control
QSM	Quality Systems Manual
RL	Reporting Limit
RPD	relative percent difference
SOP	standard operating procedure

WORKSHEET #28.7: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTIONS

Matrix: Water
Analytical Group: Hexavalent Chromium
Analytical Method/ SOP Reference: 218.6/WI11641
Analytical Organization: Eurofins Lancaster Laboratories Environmental, LLC (ELLE)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per batch	No analytes detected > 1/2 LOQ	Correct problem, reprepare and reanalyze the method blank and all sample associated	ELLE Analyst	Contamination	No analytes detected >1/2 LOQ
Laboratory Control Standard	1 per batch	Laboratory specified recovery limits and RPD ≤20%	Correct problem, reprepare and reanalyze the LCS and all sample associated	ELLE Analyst	Analytical Accuracy	Results within acceptance limits
Duplicate	1 per batch	RPD≤20%	No corrective action, matrix related	ELLE Analyst	Analytical Precision	Results within acceptance limits
Matrix Spike/Matrix Spike Duplicate	1 per batch	Laboratory specified recovery limits and RPD ≤20%	No corrective action, matrix related	ELLE Analyst	Analytical Precision/Bias	Results within acceptance limits

Notes:

ELLE	Eurofins Lancaster Laboratory Environmental, LLC
LOQ	limit of quantitation
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
SOP	standard operating procedure

WORKSHEET #30: ANALYTICAL SERVICES TABLE

Matrix	Analytical Group	Concentration Level	Sample Locations / ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory/ Organization
Aqueous	VOCs	Low	TBD; Reference QAPP	SW8260C	Level IV 21 calendar days	ELLE 2425 New Holland Pike Lancaster, PA, 17601 717-656-2300 (office) 717-656-2681 (fax)	N/A
	SVOCs SIM	Low		SW8270D/ SW8270D SIM			
	Metals (total and dissolved)	Low		SW6020A			
	Mercury (total and dissolved)	Low		SW7470A			
	PCBs	Low		SW8082A			
	Hexavalent Chromium (total and dissolved)	Low		USEPA218.6			

Notes:

ELLE	Eurofins Lancaster Laboratory Environmental, LLC
ID	identification
N/A	not applicable
PA	Pennsylvania
PCB	polychlorinated biphenyl
QAPP	quality assurance project plan
SIM	selective ion monitoring
SVOC	semivolatile organic compound
TBD	to be determined
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

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WORKSHEET #34, 35, AND 36: DATA VERIFICATION AND VALIDATION (STEPS IIA AND IIB) PROCEDURES

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb$^{(1)}$
Verification CoC forms Sample Login/Receipt	Review the sample shipment for completeness, integrity, and sign accepting the shipment. All sample labels will be checked against the CoC form, and any discrepancies will be identified, investigated, and corrected. The samples will be logged in at every storage area and workstation required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms. Verification of sample login/receipt and CoC forms will be documented on the laboratory sample receipt form.	Laboratory sample custodians and analysts	I
Verification CoC forms	Check that the CoC form was signed/dated by the sampler relinquishing the samples and by the laboratory sample custodian receiving the samples for analyses.	Project Chemist or Data Validators	I
Verification QAPP sample tables	Verify that all proposed samples listed in the QAPP tables have been collected. Sample completeness will be documented in the data validation report.	Site Supervisor or Designee	I
Verification Sample log sheets and field notes	Verify that information recorded in the log sheets and field notes are accurate and complete. Sample log sheet verification will be documented by dated signature on the last page or page immediately following the review material.	Site Supervisor or Designee	I
Verification Field QC samples	Check that field QC samples, described in Worksheet #12 and listed in Worksheet #18,19,20, and 30, were collected as required. QC sample completeness will be documented in the data validation report.	Site Supervisor or Designee	I
Verification Analytical data package	All analytical data packages will be verified internally for completeness by the laboratory performing the work. The laboratory project manager (or designee) will sign the case narrative for each data package. All laboratory data package reviews will be documented in the laboratory narratives.	Laboratory Project Manager	I
Verification Analytical data package	Verify the data package for completeness. Missing information will be requested from the laboratory, and validation (if performed) will be suspended until missing data is received. Data package completeness will be documented in the data validation report.	Site Supervisor, Project Chemist or Data Validators	I
Verification Electronic data deliverables	Verify the electronic data against the CoC and hard copy data package for accuracy and completeness before loading into project database. Electronic data deliverable verification will be documented.	Data Manager and/or Data Validators	I
Validation CoC	Examine the traceability of the data from time of sample collection until reporting of data. Ensure that the custody and integrity of the samples were maintained from collection to analysis and that custody records are complete, and any deviations are recorded. CoC verification will be documented in the data validation report.	Project Chemist or Data Validators	IIa

Data Review Input	Description	Responsible for Verification	Step I/IIa/IIb(1)
Validation Holding Times	Review that the samples were shipped and stored at the required temperature, meeting the requirements listed in Worksheet #18,19,20, and 30. Ensure that the analyses were performed within the holding times. If holding times were not met, confirm that deviations were documented. Holding time examination will be documented in the data validation report.	Project Chemist or Data Validators	IIa
Validation Sample results for representativeness	Check that the laboratory recorded both the temperature at sample receipt and the pH of the chemically preserved samples (if applicable) to ensure sample integrity was sustained from sample collection to analysis. Representativeness will be documented in the data validation report.	Project Chemist or Data Validators	IIa/IIb
Validation Laboratory data results for accuracy	Ensure that the laboratory QC samples were analyzed, and that the measurement performance criteria, listed in Worksheet #28, were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed, as listed in Worksheet #12, and that the analytical QC criteria were met. Accuracy will be documented in the data validation report.	Project Chemist or Data Validators	IIa/IIb
Validation Field and laboratory duplicate analyses for precision	Check the field sampling precision by calculating the RPD for field duplicate samples. Check the laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses; MS/MSDs; and LCS/LCS duplicates. Ensure compliance with the precision goals listed in Worksheets #12 and #28. Precision will be documented in the data validation report.	Project Chemist or Data Validators	IIa/IIb
Validation Project action limits	Assess and document the impact on matrix interferences or sample dilutions performed because of the high concentration of one or more contaminant on the other target compounds reported as undetected. Project action limit achievement will be documented in the data validation report.	Project Chemist or Data Validators	IIa/IIb
Validation Data quality assessment report	Summarize deviations from methods, procedures, or contracts. Qualify data results based on method or QC deviation and explain all the data qualifications. Present tabular qualified data and data qualifier codes and summarize data qualification outliers. Determine if the data met the MPC and determine the impact of any deviations on the technical usability of the data. Result qualification will be documented in the in the data validation report.	Project Chemist or Data Validators	IIa/IIb
Validation QAPP QC sample documentation	Ensure that all QC samples specified in the QAPP were collected and analyzed, and that the associated results were within acceptance limits. QC sample documentation will be documented in the data validation report	Project Chemist or Data Validators	IIa/IIb
Validation Analytical data deviations	Determine the impact of any deviation from sampling or analytical methods, and laboratory SOP requirements and matrix interferences effect on the analytical results. Data deviations will be documented in the data validation report.	Project Chemist or Data Validators	IIb

<table>
<tr><th>Data Review Input</th><th>Description</th><th>Responsible for Verification</th><th>Step I/IIa/IIb(1,2)</th></tr>
<tr><td>Validation
Project quantitation limits for sensitivity</td><td>Ensure that the project limit of detection (LOD) and limit of quantitation (LOQ) were achieved. Project quantitation limit achievement will be documented in the data validation report.</td><td>Project Chemist or Data Validators</td><td>IIb</td></tr>
<tr><td>Validation</td><td>Project validation criteria in accordance with QAPP Worksheets #12, 15, 19, 28, and 37 within this document, DoD General Data Validation (DV) Guidelines from the Environmental Data Quality Workgroup (DoD, 2019) and cited USEPA SW-846 methodology. Validation qualifiers applied in accordance with <i>National Functional Guidelines</i> for organic and inorganic data review (USEPA, 2017). Methods for which no data validation guidelines exist will be validated following the <i>National Functional Guidelines</i> deemed most appropriate by the data validator.
Validation will be limited to reviewing laboratory quality control summary information and raw data will not be reviewed.</td><td>Project Chemist or Data Validators</td><td>IIa/IIb</td></tr>
<tr><td>Validation
Data qualifiers</td><td>Qualifiers that will be applied during the data validation process are summarized below and, as indicated, results will be considered usable unless qualified by an R-flag. Data that are qualified as being affected by serious data quality deficiencies will be qualified by the data validator using a X qualifier. Final acceptance or rejection (R qualifier) of the X-qualified data will be decided by the USACE and AECOM project team.
<table>
<tr><th>Data Qualifier</th><th>Qualifier Definition</th><th>Interpret Result as a Detection?</th><th>Result Usable?</th><th>Potential Result Bias</th></tr>
<tr><td>no qualifier</td><td>Acceptable</td><td>Yes</td><td>Yes</td><td>None expected</td></tr>
<tr><td>J+/J-</td><td>Estimated</td><td>Yes</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>U</td><td>Undetected</td><td>No</td><td>Yes</td><td>None expected</td></tr>
<tr><td>UJ</td><td>Undetected and Estimated</td><td>No</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>R</td><td>Rejected</td><td>No</td><td>No</td><td>Unspecified</td></tr>
</table></td><td>Project Chemist or Data Validators</td><td>IIa/IIb</td></tr>
</table>

Notes:

1. IIa=compliance with methods, procedures, and contracts (see Table 10, page 117, UFP-QAPP manual, V.1, March 2005 [IDQTF, 2005a-c]).
2. IIb=comparison with measurement performance criteria in the QAPP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005 [IDQTF, 2005a-c)]

A non-detect result is reported at the LOD.

CoC	chain of custody
DV	data validation
LCS	laboratory control sample
LOD	limit of detection
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate

Data Validation will be conducted by AECOM on all fixed laboratory data with the exception of data generated for characterization of IDW. Data will be loaded to FUDSChem using SEDD Stage 2A deliverables. Validation will be performed using the ADR module. ADR will perform an automated data review of the project samples including but not limited to: holding times; sample temperature upon laboratory receipt; laboratory and field blank contamination; and accuracy and precision of laboratory control samples, MS/MSD, surrogates, FDs, and laboratory duplicates. ADR will produce validation outlier reports and assign qualifiers. Qualifiers will be reviewed by the project chemist and updated if necessary.

Analytical Group/Method	**VOCs, SVOCs, PAHs SIM, Metals, Hexavalent Chromium**
Data deliverable requirements:	PDF of complete data report and SEDD Stage 2a uploaded to FUDSChem
Analytical specifications[1]:	DoD QSM v. 5.1.1 (DoD, 2018)
Measurement performance criteria:	WS #12 and WS #15
Percent of data packages to be validated:	100%
Validation procedure:	ADR
Electronic validation program/version:	ADR Module, FUDSChem
Data Validation Level:	2A
Validator:	AECOM

Notes:

(1) Laboratory analytical SOPs for each matrix and analysis are listed in **Worksheet #19** and **Worksheet #30**.

WORKSHEET #37: DATA USABILITY ASSESSMENT

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used

AECOM will validate the fixed-laboratory data for all definitive analyses conducted. Validation will be conducted in accordance with the protocols described in **Worksheet #34, 35,** and **36**. These procedures are consistent with USEPA National Data Validation Functional Guidelines (USEPA, 2017). The Project Chemist, in conjunction with the project team, will determine whether the analytical data meet the requirements to support the investigation. The results of laboratory measurements will be compared to the DQOs described in **Worksheet #11**.

At the completion of validation, data qualified by the validators as "X" (affected by serious deficiencies in the ability to analyze the sample and to meet published method and project quality control criteria) will be reviewed by the AECOM and USACE project chemists. The USACE project chemist, with input from the USACE and AECOM project team, will determine which data should be accepted or rejected "R" and excluded from the data set. **Describe the evaluative procedures used to assess overall measurement error associated with the project**

A data assessment will be performed in accordance with USEPA guidance QA/G-9R, *Data Quality Assessment, A Reviewer's Guide* (USEPA, 2006). In accordance with USEPA guidance, a data assessment is intended to provide documentation to clearly demonstrate that the collected data are of the right type, quality, and quantity to meet the objectives of the project. A comprehensive evaluation of how the data meet precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) objectives will also be performed. Soil and groundwater analytical data will be validated in-house and the data packages to be presented in the RI Report Addendum.

The data usability assessment will reconcile the DQOs of this QAPP Addendum to the results of the data collection and analytical results, data validation evaluation (as applicable), and field QC results.

Data quality indicators (DQIs), such as PARCCS measurements, aid in the evaluation process and are discussed in the following subsections.

Precision

The most commonly used estimates of precision are the relative percent difference (RPD) for cases in which only two measurements are available and the percent relative standard deviation (%RSD) when three or more measurements are available. The latter is especially useful in normalizing environmental measurements to determine acceptability ranges for precision because it effectively corrects for the wide variability in sample analyte concentration indigenous to samples.

Precision is represented as the RPD between measurement of an analyte in duplicate samples or in duplicate spikes. RPD is defined as follows:

$$RPD = \frac{\left| C_1 - C_2 \right|}{(C_1 + C_2)/2} \times 100$$

Where:

C_1 = First measurement value

C_2 = Second measurement value

The %RSD is calculated by the standard deviation of the analytical results of the replicate determinations relative to the average of those results for a given analyte. This method of precision measurement can be expressed by the formula:

$$\%RSD = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \left[\sum_{i=1}^{n} x_i\right]^2 / n}{n - 1}} \times 100 / RF$$

Where:

RF = Response factor

n= Number of measurements

Precision control limits for evaluation of sample results are established by the analysis of control samples. The control samples can be method blanks fortified with surrogates (e.g., for organics), or LCS purchased commercially or prepared at the laboratory. The LCS is typically identified as blank spikes (BS) for organic analyses. For multi-analyte methods, the LCS or BS may contain only a representative number of target analytes rather than the full list.

The RPD for duplicate investigative sample analysis provides a tool for evaluating how well the method performed for the respective matrices.

Accuracy/Bias

Accuracy control limits are established by the analysis of control samples, which are water and/or solid/waste matrices. For organic analyses, the LCS may be a surrogate compound in the blank or a select number of target analytes in the BS. The LCS is subjected to all sample preparation steps. When available, a solid LCS may be analyzed to demonstrate control of the analysis for soil. The amount of each analyte recovered in an LCS analysis is recorded and entered into a database to generate statistical control limits. These empirical data are compared with available method reference criteria and available databases to establish control criteria.

The %R for spiked investigative sample analysis (e.g., matrix spike) provides a tool for evaluating how well the method worked for the matrix. These values are used by the USACE to assess a reported result within the context of the project DQOs. For results that are outside control limits provided as requirements in the QAPP, corrective action appropriate to the project will be taken and the deviation will be noted in the case narrative accompanying the sample results. The %R is defined as follows:

$$\% R = \frac{(A_T - A_O)}{A_F} \times 100$$

Where:

A_T = Total amount recovered in fortified sample

A_0 = Amount recovered in unfortified sample

A_F = Amount added to sample

Accuracy for some procedures is evaluated as the degree of agreement between a new set of results and a historical database or a table of acceptable criteria for a given parameter. This degree of agreement is measured as %D from the reference value and is primarily used by the laboratory as a means for documenting acceptability of continuing calibration.

The %D is calculated by expressing, as a percentage, the difference between the original value and new value relative to the original value. This method for precision measurement can be expressed by the formula:

$$\% D = \frac{C_1 - C2}{C_1} \times 100$$

Where:

C_1 = Concentration of analyte in the initial aliquot of the sample.

C_2 = Concentration of analyte in replicate.

Representativeness

Data representativeness for a project is accomplished by implementing approved sampling procedures and analytical methods that are appropriate for the intended data uses and which are established within this project-specific QAPP.

Completeness

Site-wide completeness goals account for all aspects of sample handling, from collection through data reporting. The level of completeness can be affected by loss or breakage of samples during transport, as well as external problems that prohibit collection of the sample. The following calculation is used for determining the percent complete:

$$\text{Completeness} = \frac{A \times 100}{B}$$

Where:

A = Number of usable data points.

B = Total number of data points collected.

The formula for sampling completeness is:

$$\text{Sampling Completeness} = \frac{\text{Number of locations sampled}}{\text{Number of planned sample locations}} \times 100$$

An example formula for analytical completeness is:

$$\text{VOC Analytical Completeness} = \frac{\text{Number of Usable Data Points}}{\text{Expected Number of Usable Data Points}} \times 100$$

The ability to meet or exceed completeness objectives is dependent on the nature of samples submitted for analysis.

The following table (**Table 37-1**) lists the completeness goals for a project. If the completeness goal is not met because of controllable circumstances, then the samples will be recollected and reanalyzed, as necessary, to meet the completeness objective. If the completeness goal is not met because of uncontrollable circumstances, such as inaccessible sample points, matrix interferences, etc., then the deficiency will be evaluated. Note that Project Completeness Goals apply separately to each study area environmental medium.

Table 37-1: Project Completeness Goals

Task	Subtask	Completeness Goal
Sampling	Sample Collection	95% (per media)
Field Measurements	Conductivity	100% of collected samples (per media)
	pH/Turbidity/DO	100% of collected samples (per media)
Analytical Measurements	All Laboratory Analyses	95% of collected analytes (per media)
		80% of each target analyte (per media)

Comparability

Comparability of data sets generated for a project will be obtained through the implementation of standard sampling and analysis procedures, by the use of traceable reference materials for laboratory standards, and by expressing the results in comparable concentration units.

Sensitivity

Sensitivity is the ability of the method or acceptable sensitivity instrument to detect the contaminant of concern and other target compounds at the level of interest. Quantitative MPC need to be determined for acceptable sensitivity to ensure that the quantitation limits can be routinely achieved for each matrix, analytical parameter, and concentration level. The use of standards and instrument calibration will enable the instrument to identify and differentiate between various compounds/ analytes of interest and interferences.

Assessment of Data Usability

In addition, data assessment is considered the final step in the data evaluation process and can be performed only on data of known and documented quality. For a project, all data will be assessed for usability, regardless of the data evaluation/validation process implemented. As mentioned previously, data usability goes beyond validation because it evaluates the achievement of the DQOs. The results of the data usability assessment, and particularly any changes to the DQOs necessitated by the data not meeting usability criteria, will be included in each final data quality assessment report.

Primarily, the assessment of the usability will follow procedures described in appropriate USEPA guidance documents, particularly *Guidance for Data Usability in Risk Assessment* (USEPA, 1992a) and will be conducted according to the process outlined below.

Sampling and Analysis Activities Evaluation

The first step of the data usability evaluation will include a review of the sampling and analysis activities in comparison to Site-wide DQIs. Specific limitations to the data, i.e., results that are qualified as estimated “J/UJ”, or rejected “R”, will be determined and documented in the database.

The data acquisition and evaluation process consists of a series of procedures that were designed to maximize final data quality.

Assessment of DQIs

The second part of data usability pertains to the assessment of the program-specific DQIs. Each investigator will compare the performance achieved for each data quality criterion against the expected and planned performance. In general, this comparison will follow from the DQIs used to define each DQO. The comparison is the most critical component of the assessment process. Any deviation from planned performance will be documented and evaluated to determine whether corrective action is advisable. Potential corrective actions will range from resampling and/or reanalysis of data, to qualification or exclusion of the data for use in the data interpretation. In the event that corrective action is not possible, the limitations of the data with regards to achieving the DQOs, if any, will be noted.

In conjunction with the DQI achievement review, the investigators will need to make decisions for the use of qualified values, which are a consequence of the formalized evaluation/validation process. Data qualifiers will be applied to individual data results. Data usability decisions will be made based on the assessment of the usability of each of these results for the intended purpose. Evaluation will describe the uncertainty (e.g., bias, imprecision) of the qualified results. Cumulative QC exceedances from the DQIs may require technical judgment to determine the overall effect on the usability of the data. Decisions about usability of qualified data for use in risk assessment will be based on the USEPA document mentioned, which allows for the use of estimated values. Finally, data users may choose to determine final data usability qualifiers as a result of the overall examination and decision process.

Achievement of DQOs

The third step in the data usability process concerns achievement of the DQOs. After the data set has been assessed to be of known quality, data limitations have been documented, and overall result applicability/usability for its intended purpose has been determined, the final data assessment can be initiated by considering the answers to the following questions:

- Are the data adequate to determine the extent to which hazardous substances have migrated or to what extent they are expected to migrate from potential hazardous substance source areas?
- Do the data collected adequately characterize the nature and extent of potential hazardous substance source areas at the site?
- Are the data statistically adequate to allow evaluation on a "per chemical" and "per media" basis?

- Do the data collected allow assessment of hydrogeological factors, which may influence contaminant migration/distribution?
- Is the sample set sufficient to develop site-specific removal and disposal treatment methodologies?
- Have sufficient data been collected to evaluate how factors, including physical characteristics of the site and climate and water table fluctuations, affect contaminant fate and transport?
- Have sufficient data been collected to determine the toxicity, environmental fate, and other significant characteristics of each hazardous substance present?
- Has an adequate amount of information been gathered to determine groundwater characteristics and current and potential groundwater uses for locations close to the site?
- Is the data set sufficient to evaluate the potential extent and risk of future releases of hazardous substances, which may remain as residual contamination at the source facility?

The principal investigators, in conjunction with the project team, will formulate solutions if data gaps are found as a result of problems, biases, or trends in the analytical data or if conditions exist that were not anticipated in the development of the DQOs. It is particularly important that each data usability evaluation specifically address any limitations on the use of the data that may result from a failure to achieve the stipulated DQO.

Identify the personnel responsible for performing the usability assessment

Data validation will be coordinated by the AECOM Project Chemist and will be conducted by the AECOM data validation staff. Data usability will be assessed by the AECOM Project Manager with the assistance of the AECOM Project Chemist.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies

The documentation generated during data validation will include a memorandum that describes the information reviewed, the results of this review, and a recommendation on data usability and limitations of specific data points. The memorandum provides information on the samples included in the review and the date they were collected, the condition of samples when received at the laboratory and any discrepancies noted during the receiving process, verification of sample preparation and analysis within the method specified holding time, review of associated QC analyses including blanks, LCSs, MSs, and field and/or laboratory duplicates. As a result of this review standard qualifiers are entered into the database so that data users can readily identify any limitations associated with a specific data point.

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Appendix A

Figures

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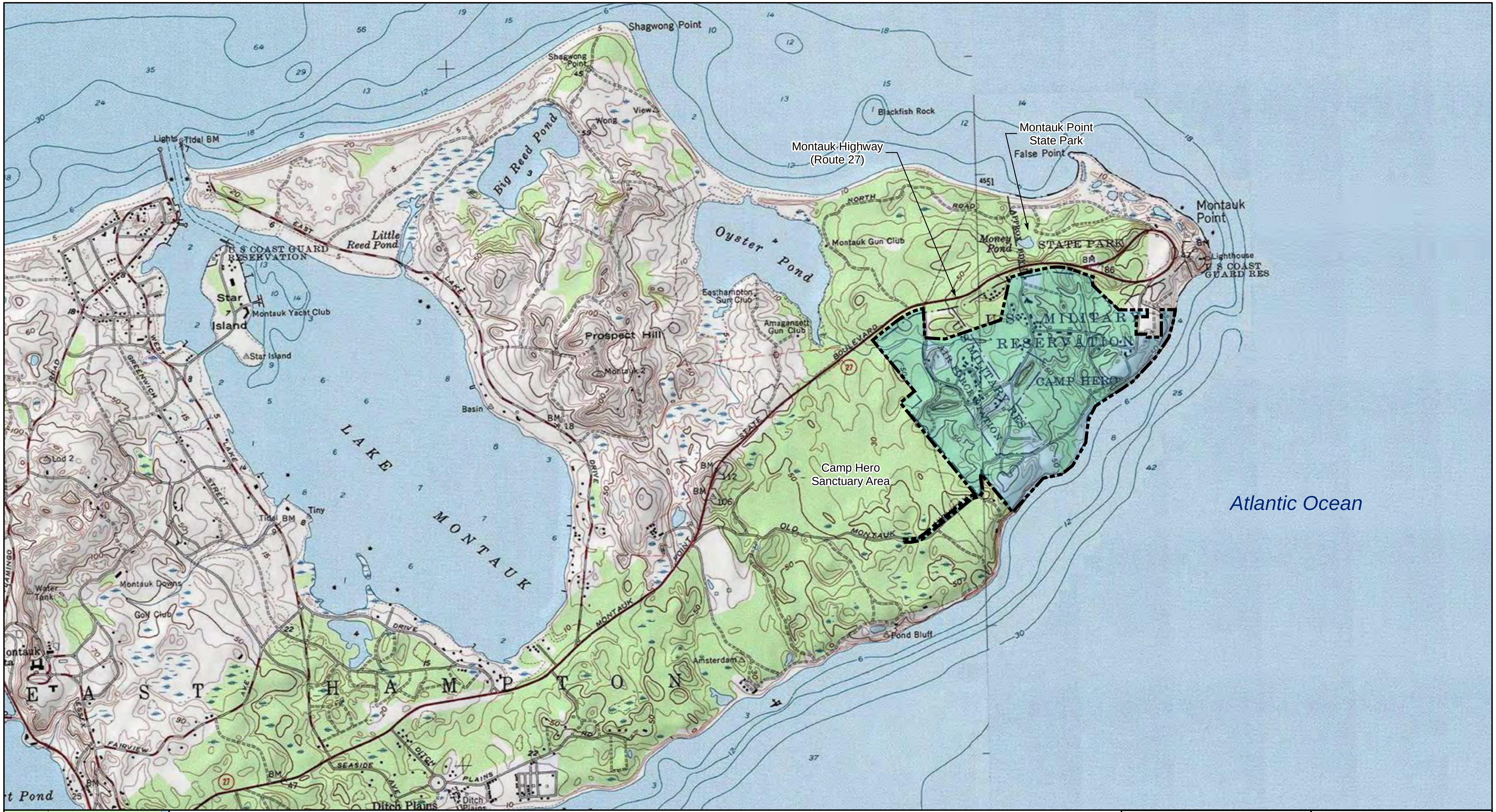

MAP LOCATION

Camp Hero Built Features

⬚ Camp Hero State Park Boundary

NAD 1983 StatePlane Long Island FIPS 3104

Basemap Copyright:© 2013 National Geographic Society, i-cubed

N W E S

0 1,000 2,000 Feet

1 inch = 2,000 feet

AECOM

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General Location Map

Camp Hero Phase IV Remedial Investigation QAPP
Montauk, New York

PROJECT NO.	PREPARED BY:	DATE:	
60443903	JB	July 2020	**Figure 10-1**

Camp Hero Built Features

- ▭ Camp Hero State Park Boundary

Buildings

- ▭ Existing Building
- ▭ Former Building

Restricted Areas

- Area H
- Area K

State Park Trails

- Battery 112 Trail
- Battery 113 Trail
- Paumanok Path

State Park Areas

- Camping
- Picnic
- Fence
- Road

Camp Hero Natural Features

Wetlands

- Class 1 NYSDEC Wetlands
- Class 2 NYSDEC Wetlands
- 2017 Additional Wetlands Observed
- 2017 Additional Wetlands Boundary Observed

Surface Water

- Low Gradient Drainage
- Intermittent Drainage without Revetment
- Intermittent Drainage with Revetment
- Primary Drainage without Revetment
- Primary Drainage with Revetment

Notes
1. No wetland conditions observed within DU boundary of DU01, DU12, or DU18.
2. Wetlands were evaluated only within Decision Units.

MAP LOCATION

N W E S

0 125 250 500 Feet

1 inch = 250 feet

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Site Map

Camp Hero Phase IV Remedial Investigation QAPP
Montauk, New York

PROJECT NO.	PREPARED BY:	DATE:	
60443903	JB	July 2020	**Figure 1-2**

7/23/2020 1:3,000 \\USCHL1FP001\Data\Projects\Govt\Projects\USACE\Camp_Hero\GIS\Projects\Phase_IV_RI_QAPP\MXD\Fig_10_2_Site_Map.mxd

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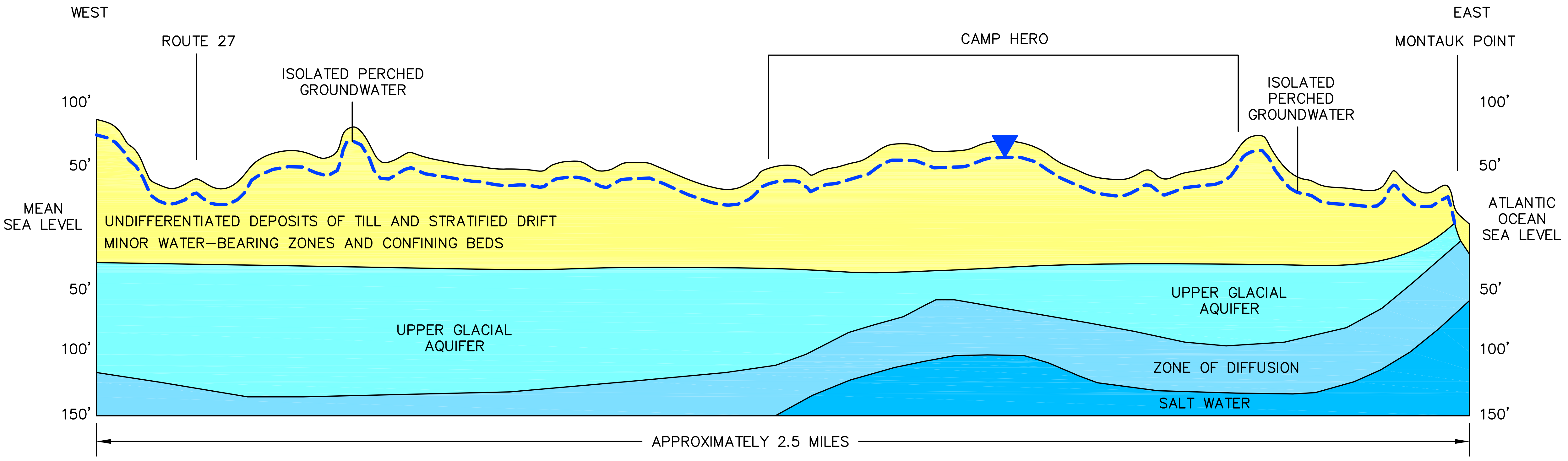

🟨 UPPER UNIT OF UNDIFFERENTIATED DEPOSITS OF TILL AND STRATIFIED DRIFT WITH ISOLATED PERCHED GROUNDWATER

– – – ISOLATED PERCHED GROUNDWATER

🟦 UPPER GLACIAL AQUIFER

🟦 ZONE OF DIFFUSION SALT WATER/FRESH WATER

🟦 SALT WATER

▼ PIEZOMETRIC SURFACE OF PERCHED WATER TABLE (WHERE PRESENT)

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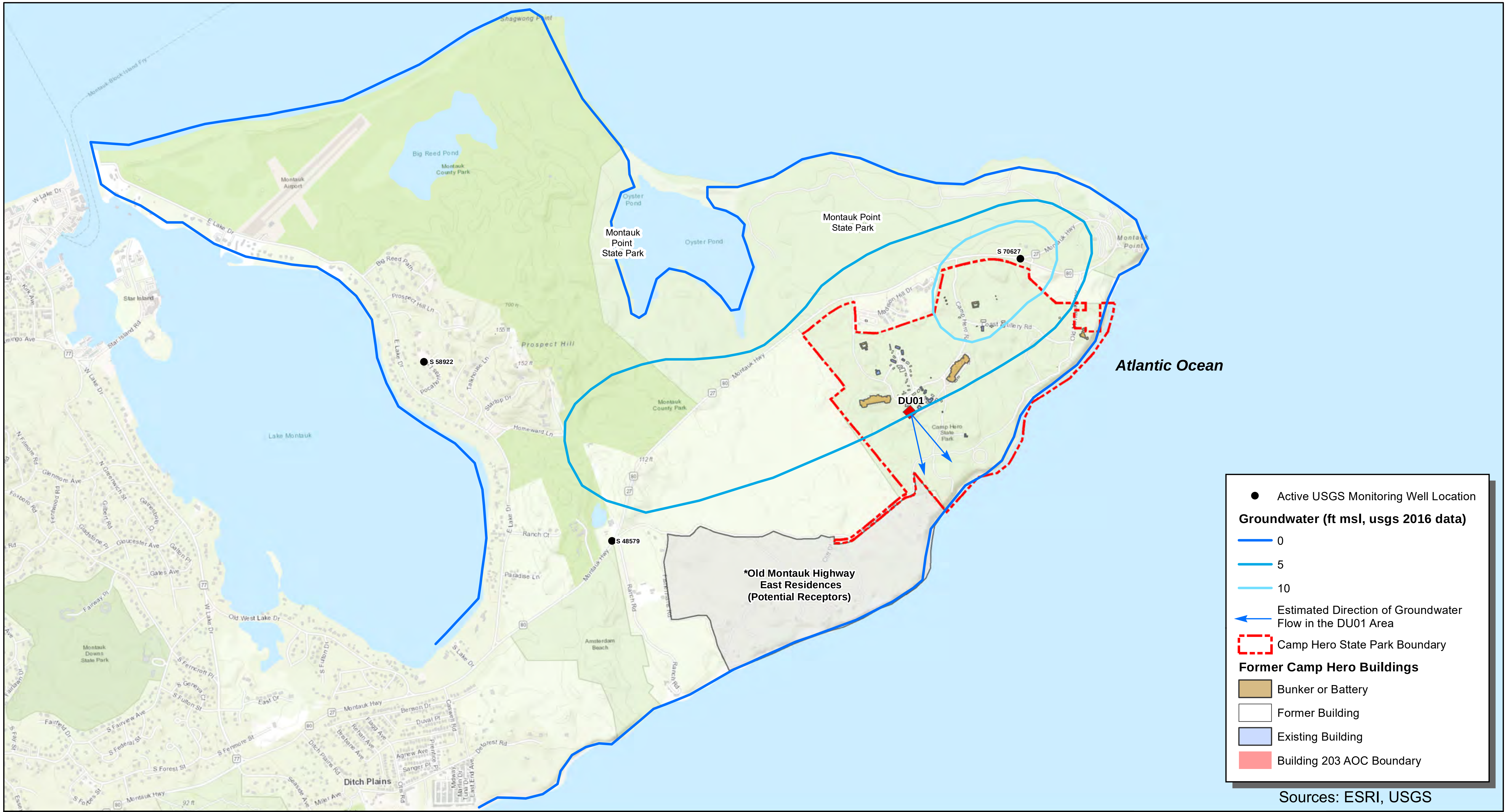
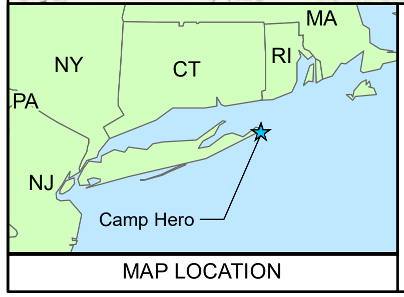
General Hydrology Cross Section

Camp Hero Phase IV Remedial Investigation QAPP
Montauk, New York

PROJECT NO.	PREPARED BY:	DATE:	
60443903	JB	August 2020	**Figure 10-3**



Sources: ESRI, USGS



MAP LOCATION

Description of depth to Water raster obtained via U.S. Geological Survey (https://www.sciencebase.gov): "The U.S. Geological Survey constructed a water table altitude map using ground-water levels measured in the upper glacial and Magothy aquifers during April–May 2016. Contours were constructed at a scale of 1:125,000 from water-level data collected at 424 groundwater monitoring wells. The water table altitude contours were digitized and compared to 1997, 2006, 2010 and 2013 water table altitude maps (USGS, 2016)."

Coordinate System: NAD 1983 StatePlane New York Long Island FIPS 3104 Feet
Datum: North American 1983

*Note
It is estimated that the primary direction of groundwater flow in the UGA from DU01 is toward the south-southeast and the Atlantic Ocean. However, in order for residents on Old Montauk Highway with private wells in the UGA to be impacted by potential contaminants from DU01, a more south-southwesterly direction of flow in the UGA would be necessary.

0 1,950 3,900 Feet
1 inch = 1,950 feet

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Upper Glacial Aquifer Direction of Groundwater Flow

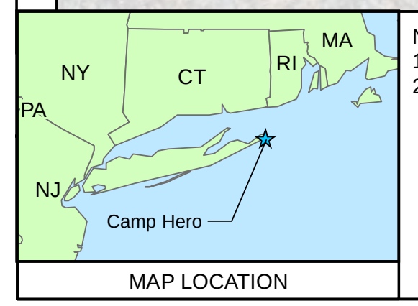
Camp Hero Phase IV Remedial Investigation QAPP
Camp Hero

PROJECT NO.	PREPARED BY:	DATE:	
60443903	JB	October 2018	**Figure 10-4**

9/8/2020 1:23,400 \\USCHL1FP001\Data\Projects\Govt\Projects\USACE\Camp_Hero\GIS\Projects\Phase_IV_RI_QAPP\MXD\Fig_10_4_Upper_Glacial_Aquifer_Direction_of_GW_Flow_2013_2016.mxd

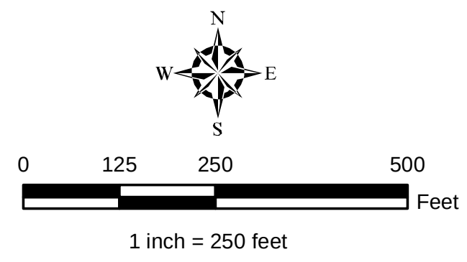
Onsite Existing UGA Wells to be Sampled	
S 17231S	Former USAF Supply Well inside Pump House
S 19494	USGS Test Well
S 19495	AT&T Building Well in Vault

Offsite Existing UGA Wells to be Sampled	
S 76304/ Madison Hill Well Field Well 1	
S 121808/ Madison Hill Well Field Well 2	
S 121811/ Madison Hill Well Field Well 3A	
S 70627	USGS Gauging Well on RT 27
S 79269	Montaulk Point State Park Well
S 15812	Former Montauk Point State Park Well
S 1202	Lighthouse Well
S 3599	Lighthouse Well



MAP LOCATION

Notes
1. No wetland conditions observed within DU boundary of DU01, DU12, or DU18.
2. Wetlands were evaluated only within Decision Units.



1 inch = 250 feet

AECOM

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Existing Upper Glacial Aquifer Wells at Camp Hero

Camp Hero Phase IV Remedial Investigation QAPP
Montauk, New York

PROJECT NO.	PREPARED BY:	DATE:	
60443903	JB	January 2021	Figure 10-5

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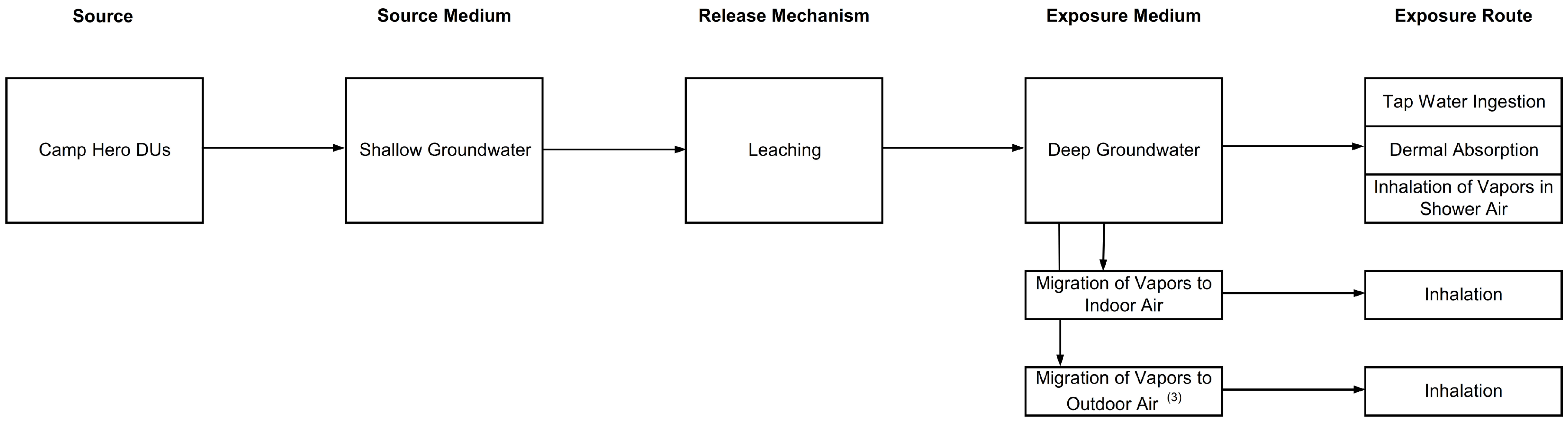

	Human Receptors	
	Future Exposure	Current/Future Exposure
Exposure Route	On-Site Resident (Child/Adult) [1]	Off-Site Resident (Child/Adult) [2]
Tap Water Ingestion	X	•
Dermal Absorption	X	•
Inhalation of Vapors in Shower Air	X	•
Inhalation	X	•
Inhalation		

Notes

COPC = chemical of potential concern
DU = Decision Unit
ft bgs = feet below ground surface
UGA = upper glacial aquifer
UU/UE = unlimited use/unrestricted exposure

Empty block = Incomplete or minimal exposure pathway.
● = Potentially complete exposure pathway to be evaluated.
X = Pathway will be quantified for informational purposes only to address potential UU/UE.

1. There are currently no plans for future on-site residential use (per Mr. Foley of the Long Island State Parks Region on April 3, 2017) so this exposure scenario is highly conservative and unlikely. The on-site residential scenario will be evaluated for informational purposes to address possible UU/UE within the Phase IV Remedial Investigation (RI).
2. Off-site receptors currently exist downgradient of the Camp Hero site and currently use well water from the deep aquifer (UGA) as a potable source.
3. The depth to the top of the UGA groundwater is approximately 55-60 feet below ground surface. Groundwater vapors from the deep aquifer are unlikely to migrate through the subsurface and reach outdoor air.

MAP LOCATION

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Potential Human Health Exposure Pathways and Receptors

Camp Hero Phase IV Remedial Investigation QAPP
Montauk, New York

PROJECT NO.	PREPARED BY:	DATE:	
60443903	JB	July 2020	**Figure 10-6**

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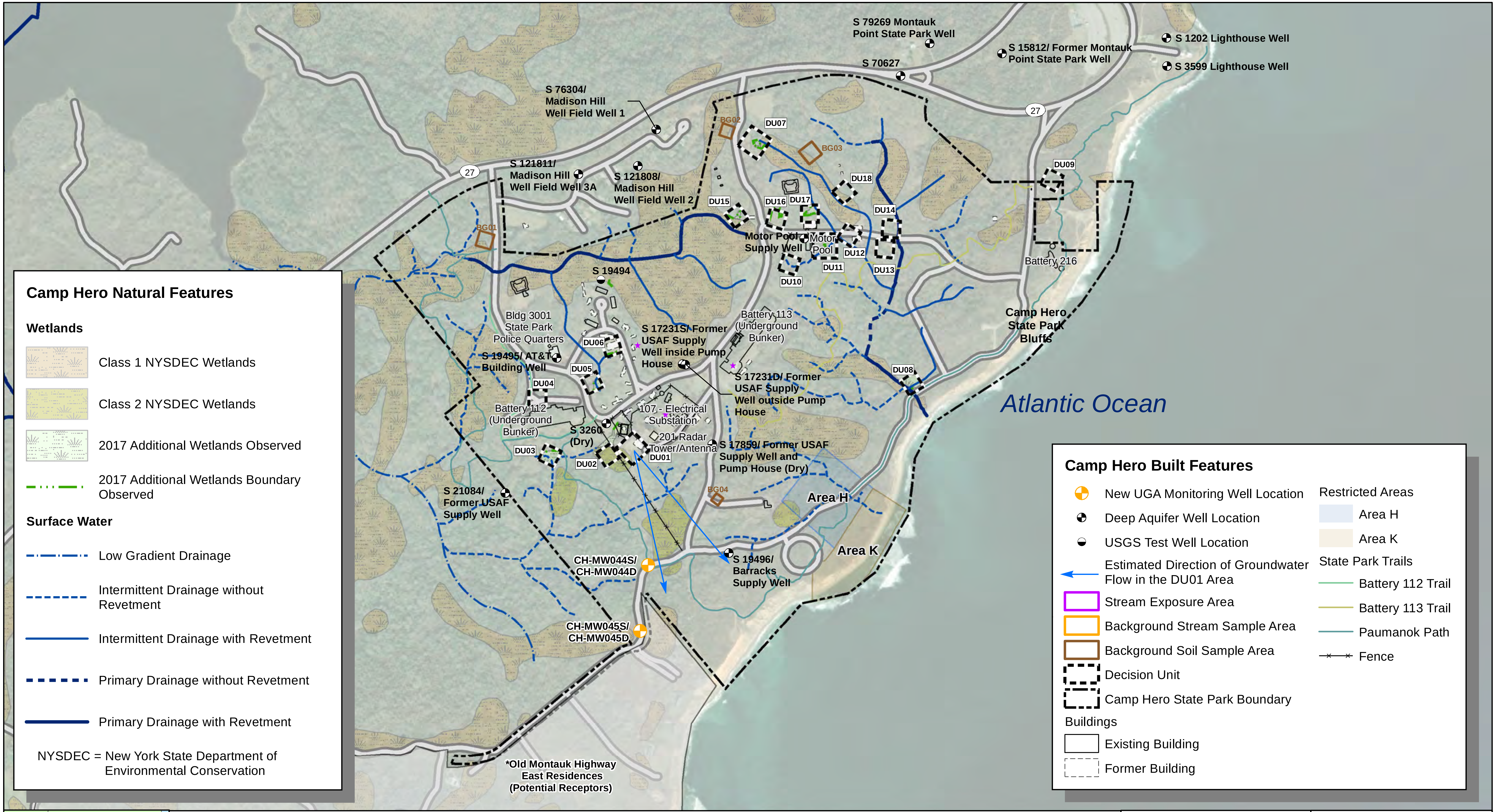
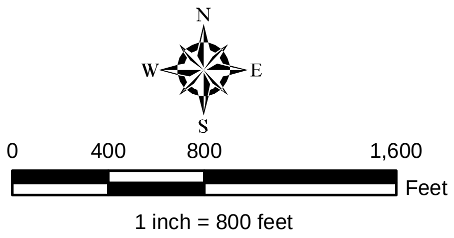


MAP LOCATION



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New UGA Monitoring Well Locations

Camp Hero Phase IV Remedial Investigation QAPP
Montauk, New York

PROJECT NO.	PREPARED BY:	DATE:	
60443903	JB	January 2021	**Figure 17-1**

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