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SAMPLING AND ANALYSIS PLAN VOLUME II OF II NSTC GREAT LAKES IL

3/1/2010

NAVFAC MIDWEST

138

Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan)

for the

NTC Lakefront Site
Volume II

Naval Station Great Lakes
Great Lakes, Illinois

Naval Facilities Engineering Command Midwest

Contract Number N62472-03-D-0057

Contract Task Order F274

March 2010

SAP Worksheet #1 -- Title and Approval Page

QUALITY ASSURANCE PROJECT PLAN/SAMPLING AND ANALYSIS PLAN FOR SITE INSPECTIONS AT MUNITION RESPONSE PROGRAM RANGES

Volume II of II - Munitions of Explosive Concern Plan

March 2010

NTC Lakefront Site
Naval Station Great Lakes
Great lakes, Illinois

Prepared for:
Naval Facilities Engineering Command Midwest
201 Decatur Avenue, Building 1A
Great Lakes, Illinois 60088

Prepared by:
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Ralph Basinski / 412.921.8308

Prepared under:
Contract Number N62472-03-D-0057
Contract Task Order F274

Review Signatures:

Ralph Basinski
Project Manager
Tetra Tech NUS, Inc.

_____Date:_____

Tom Johnston
Quality Assurance Manager
Tetra Tech NUS, Inc.

_____Date:_____

Approval Signatures:

Mike Green
MRP Senior Technical Advisor
NAVFAC LANT

_____

Brian Conrath
Illinois EPA Remedial Project Manager
Illinois Environmental Protection Agency

_____

Howard Hickey
NAVFAC Midwest RPM

_____

SAP Worksheets

Volume 2 List of Tables

Volume 2 List of Figures

Appendix

ACRONYMS

AA	Anti-Aircraft
bgs	Below Ground Surface
BL&P	Blind Loaded and Plugged
BTEM	Bottom Towed EM
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CLEAN	Comprehensive Long-Term Environmental Action Navy
CSM	Conceptual Site Model
CSP	Certified Safety Professional
CTD	Conductivity, Temperature, Depth
CTO	Contract Task Order
DGM	Digital Geophysical Mapping
DGPS	Differential Global Positioning System
DI	Dark Ignition
DID	Data Item Description
°	Degree
DMM	Discarded Military Munitions
DN	Deficiency Notice
DoD	Department of Defense
DQO	Data Quality Objective
DTM	Digital Terrain Model
EM	Electromagnetic
EPA	Environmental Protection Agency
ERCP	Emergency Response/Contingency Plan
ESS	Explosives Safety Submission
FTMR	Field Task Modification Request
GIS	Geographic Information System
GP QC	Geophysical QC Manager
GPS	Global Positioning System
GSV	Geophysical System Verification
HASP	Health and Safety Plan
HE	High Explosive

HEI	High Explosive Incendiary
HEIT-SD	High Explosive Incendiary Tracers-Self Destruct
HET	High Explosive Tracers
HET-SD	High Explosive Tracers-Self Destruct
HSM	Health and Safety Manager
HSO	Health and Safety Officer
HTRW	Hazardous, Toxic, or Radiological Waste
ISFL	In-water Survey Field Lead
IVS	Instrument Verification Strip
kHz	Kilohertz
MBE	Multi-beam Echosounder Sonar
MC	Munitions Constituents
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MGA	Marine Gradiometer Array
mm	Millimeter
MPPEH	Munitions Potentially Presenting an Explosive Hazard
MRP	Munitions Response Program
mV	Millivolts
NA	Not Applicable
NAVFAC LANT	Naval Facilities Engineering Command, Atlantic
NAVSTA	Naval Station
Navy	U.S. Department of Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCR	Nonconformance Report
NIRIS	Naval Installation Restoration Information System
NSGL	Naval Station Great Lakes
nT	Nanotesla
NTC	Naval Training Center
1-D	One-Dimensional
OE	Ordnance and Explosives
OSHA	Occupational Safety and Health Administration
%	Percent
PA	Preliminary Assessments
PF	Project File
PM	Project Manager

POC	Point of Contact
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
ROV	Remotely Operated Vehicle
RPM	Remedial Project Manager
RTK	Real Time Kinematic
RV	Recreational Vehicle
SAP	Sampling and Analysis Plan
SDZ	Safety Danger Zone
SI	Site Inspection
SOP	Standard Operating Procedure
SSC	Service School Command
SSO	Site Safety Officer
SVP	Sound Velocity Profiler
TBD	To Be Determined
TDEMI	Time Domain Electromagnetic Induction
Tetra Tech	Tetra Tech NUS, Inc.
UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers
USBL	Ultra Short Acoustic Baseline Positioning System
USEPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance
WAMS	Water Area Munitions Study

REFERENCES

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USACE, 2007. Engineering and Design, Military Munitions Response Actions, USACE EM 1110-1-4009. U.S. Army Engineering and Support Center, Huntsville, Alabama. June 2007.

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EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (Tetra Tech) has prepared the Uniform Federal Policy Sampling and Analysis Plan (UFP-SAP) under the comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-03-D-0057, Contract Task Order (CTO) F274. This plan has been prepared for a Site Inspection (SI) for Munitions and Explosives of Concern (MEC) under the Munitions Response Program (MRP) at the Naval Training Center (NTC) Lakefront located at the Naval Station Great Lakes (NSGL), Great Lakes, Illinois. Figure ES-1 depicts the general location of NSGL and Figure ES-2 depicts the location of the NTC Lakefront Site.

The U.S. Department of Navy (Navy) has conducted various testing and training activities involving military munitions at the NTC Lakefront Site. Because of these activities, MEC and Munitions Constituents (MC) may be present at NTC Lakefront. The term MEC includes Discarded Military Munitions (DMM), Unexploded Ordnance (UXO), and MC in high enough concentrations to pose an explosive hazard. MC includes constituents associated with munitions such as metals, RDX, and TNT. The Department of Defense (DoD) has established the MRP to address MC and MEC at closed ranges. The DoD is following the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process to investigate and remediate these sites. The Navy implements the MRP at NSGL.

The MRP SI at NSGL will be on-site inspections to identify potential hazards associated with MEC used at the site. This information will define approximate site boundaries, provide broad site information, and point out potential hazards posed by any remaining MEC in support of final recommendations. The SI will augment the data already collected in the Preliminary Assessment (PA) Reports and Water Area Munitions Study (WAMS) investigation phases and generate field data to determine if further response action or Remedial Investigation (RI) is appropriate. The primary objectives of the SI are to differentiate between potential MEC and cultural debris in the lake sediment and determine the distribution patterns (density, gradient, and clustering) of suspected MEC in the sediment of Lake Michigan. However, this MEC SI is not intended as a full-scale study of the nature and extent of explosives hazards.

This UFP-SAP describes the MEC investigation and contains all relevant technical details. The MEC UFP-SAP has been prepared in accordance with DoD requirements for developing UFP-SAPS for the management of environmental data collection and use as described in the UFP for Quality Assurance Project Plans (UFP-QAPP or UFP-SAP). DoD issues a series of 37 worksheets utilized in the development of the UFP-SAPs.

The UFP-SAP worksheets were developed for the collection and evaluation of chemical concentration data in environmental media. These worksheets were not designed for the collection of geophysical data. The Navy MRP Workgroup had modified the UFP-SAP worksheets to be applicable to MEC investigations. The modified worksheets have been used to prepare the MEC SAP, and include 28 completed worksheets of the 37 original worksheets.

The worksheet information resulted from a project scoping meeting among the planning team represented by the Navy, Illinois Environmental Protection Agency (Illinois EPA), and Tetra Tech (see Worksheet #9 for attendees). Worksheet #10 contains summaries of the site-specific Conceptual Site Model (CSM) for the NTC Lakefront site and the problem statement. The CSM was the basis for the development of the project specific data quality objectives (DQOs), which are contained in Worksheet #11. The remaining worksheets describe the data collection and data evaluation procedures including quality requirements specific to the geophysical investigation.

NTC Lakefront

The NTC Lakefront was a 3,728 acre anti-aircraft (AA) range and target training area, located on the eastern edge of the NSGL. In use from 1943 until 1945, the range includes 3.3-acres of beachfront along Lake Michigan and 3,725 acres extending east over the lake. Potential MEC issues arose from the use of AA ammunition with tracers including

- 20-milimeter (mm) high explosive (HE)
- high explosive incendiary (HEI)
- high explosive tracers (HET)
- HET-dark ignition (DI) rounds
- 40-mm blind loaded and plugged (BL&P)
- high explosive tracer – self destruct (HET-SD)
- high explosive incendiary tracer – self destruct (HEIT-SD) rounds
- 1.1-inch AA artillery
- 3-inch .50 caliber artillery
- DI tracers

The AA gun mounts were located on fill material along the shoreline and aimed at targets towed by plane over Lake Michigan. Approximately 1,350 sailors per day were instructed on the 20- and 40-mm guns

firing several million rounds into Lake Michigan over the range's existence. The PA Reports indicated that only AA ammunition was used and the expected dud rate was five percent (%).

The land portion, not suspected to contain MEC is currently bordered by a recreational vehicle (RV) park, and is used for storage of fuel oil for the facility's power plant, MEC may be present within the lake sediment. The initial depth of penetration would have been the upper 1 foot of sediment. The current depths are unknown. MEC investigations at this site will include a bathymetry survey and a geophysical survey to identify anomalies in the Lake Michigan sediment, which may be suspected MEC. As no diver confirmation of anomalies will occur during the SI, UXO Technicians will not be required during the geophysical investigation. The PA Reports, WAMS, and ordnance data sheets will be used to accurately position the geophysical transects over the NTC Lakefront area of concern.

SAP Worksheet #2 -- SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number: Naval Station Great Lakes (NSGL), Great Lakes, Illinois/ Naval Training Center (NTC) Lakefront

Operable Unit: Not Applicable (NA)
Contractor Name: Tetra Tech NUS, Inc. (Tetra Tech)
Contract Number: No. N62472-03-D-0057
Contract Title: Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Task Order (CTO): F274

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (USEPA, 2005) and *Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (USEPA, 2002).*

2. Identify regulatory program: Department of Defense (DoD) Munitions Response Program (MRP), consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the processes established by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Site visit and Data Quality Objective (DQO) Development	June 15 through 16, 2009

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation

Title	Date
No previous UFP-SAP documents have been prepared for this site.	

6. List organizational partners (stakeholders) and connection with lead organization:
Illinois Environmental Protection Agency (EPA) – regulatory stakeholder

7. Lead organization (see Worksheet #7 for detailed list of data users)
Naval Facilities Engineering Command (NAVFAC), Midwest

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:
NA

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	NA
2	SAP Identifying Information	NA
3	Distribution List	NA
4	Project Personnel Sign-Off Sheet	NA
Project Organization		
5	Project Organizational Chart	NA
6	Communication Pathways	NA
7	Personnel Responsibilities and Qualifications Table	NA
8	Special Personnel Training Requirements Table	NA
Project Planning/ Problem Definition		
9	Project Scoping Session Participants Sheet	NA
10	Conceptual Site Model and Problem Definition	NA
11	Project Quality Objectives/Systematic Planning Process Statements	NA
12	Measurement Performance Criteria Table	NA
13	Secondary Data Criteria and Limitations Table	NA
14	Summary of Project Tasks	NA
15	Reference Limits and Evaluation Table	Not used – No samples are proposed for collection/analysis during the Munitions and Explosives of Concern (MEC) geophysics survey/investigation.
16	Project Schedule/Timeline Table	NA
B. Measurement Data Acquisition		
Sampling Tasks		
17	Project Design and Rationale	NA
18	Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements Table	Not used – No samples proposed for collection/analysis during MEC geophysics survey/ investigation.
19	Analytical SOP Requirements Table	Not used – No samples are proposed for collection/analysis during the MEC geophysics survey/investigation.
20	Field Quality Control Sample Summary Table	NA

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
21	Project SOP References Table	NA
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	NA
Analytical Tasks		
23	Analytical SOP References Table	Not used – No samples are proposed for collection/analysis during the MEC geophysics survey/investigation.
24	Analytical Instrument Calibration Table	Not used – No analytical instrument calibration data will be required to support MEC geophysics surveys/investigations.
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Not used – No analytical instrument equipment maintenance, testing, or inspections will be required to support MEC geophysics surveys/investigations.
Sample Collection		
26	Munitions Potentially Presenting an Explosive Hazard (MPPEH) Handling System	Not used. No analytical sample handling system will be required to support MEC geophysics survey.
27	Sample Custody Requirements Table	Not used – No samples are proposed for collection/analysis during the MEC geophysics survey/investigation.
Quality Control Samples		
28	Laboratory Quality Control (QC) Samples Table	Not used – No analytical laboratory QC sampling will be required to support MEC geophysics surveys/investigations.
Data Management Tasks		
29	Project Documents and Records Table	NA
30	Analytical Services Table	Not used – No analytical services will be required to support MEC geophysics surveys/investigations.

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
C. Assessment Oversight		
31	Planned Project Assessments Table	NA
32	Assessment Findings and Corrective Action Responses Table	NA
33	QA Management Reports Table	NA
D. Data Review		
34	Verification (Step I) Process Table	NA
35	Validation (Step IIa and IIb) Process Table (Teir 2) QC Process Summary Table - Follow-Up Inspections	NA
36	Analytical Data Validation (Steps IIa and IIb) Summary Table	NA
37	Data Usability Assessment	NA

SAP Worksheet #3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipient	Title/Role	Organization	Telephone Number	E-Mail Address or Mailing Address	Document Control Number
Howard Hickey	NAVFAC Remedial Project Manager (RPM)/Manages project activities for the Navy	NAVFAC-Midwest	847.688.2600 x243	howard.hickey@navy.mil	NA
Mike Green (electronic upload)	NAVFAC MRP Senior Technical Advisor/Reviews UFP-SAP and quality assurance documentation for Navy	NAVFAC Atlantic (LANT)	757.322.8108	mike.green@navy.mil	NA
Bonnie Capito (final cover letter only)	Administrative Record Librarian/Manages Navy project records	NAVFAC LANT	757.322.4785	bonnie.capito@navy.mil	NA
Brian Conrath	Illinois EPA RPM/ Provides Illinois regulatory input	Illinois EPA	217.557.8155	brian.conrath@illinois.gov	NA
John Trepanowski	Program Manager/Manages the Navy CLEAN Program	Tetra Tech	610.491.9688	john.trepanowski@tetratech.com	NA

Name of SAP Recipient	Title/Role	Organization	Telephone Number	E-Mail Address or Mailing Address	Document Control Number
Ralph Basinski	Project Manager (PM)/Manages project activities for Tetra Tech	Tetra Tech	412.921.8308	ralph.basinski@tetratech.com	NA
Tom Johnston	Quality Assurance Manager (QAM)/ Reviews plan, quality assurance for Tetra Tech	Tetra Tech	412.921.8615	tom.johnston@tetratech.com	NA
Matt Soltis (Health and Safety Plan [HASP] only)	Tetra Tech Health and Safety Manager (HSM)/Manages Corporate Health and Safety Program	Tetra Tech	412.921.8912	matt.soltis@tetratech.com	NA
Bob Feldpausch	In-water Survey Manager /Manages in-water project Multi-beam Echosounder Sonar (MBE) and Marine gradiometer array (MGA) surveys	Tetra Tech	425.482.7862	robert.feldpausch@tetratech.com	NA
Richard Funk	In-water Survey Field Lead (ISFL)/Conducts in-water surveys on site	Tetra Tech	425.482.7629	richard.funk@tetratech.com	NA
Burr Bridge	MBE QC Manager/Manages MBE QC	Tetra Tech	425.482.7859	burr.bridge@tetratech.com	NA

Name of SAP Recipient	Title/Role	Organization	Telephone Number	E-Mail Address or Mailing Address	Document Control Number
Michael McGuire	In-water Geophysical QC Manager (GP QC)/Manages project MGA/Time Domain electromagnetic induction (TDEMI) geophysical data QC	Tetra Tech	303.980.3538	michael.mcguire@tetratech.com	NA
Ryan Cross	Tetra Tech Site Safety Officer (SSO)/Managers site safety issues	Tetra Tech	425.482.7786	ryan.cross@tetratech.com	NA
Grey Coppi	Tetra Tech Health and Safety Officer (HSO)/Manages Corporate Health and Safety Program	Tetra Tech	973.630.8101	grey.coppi@tetratech.com	NA

SAP Worksheet #4 -- Project Personnel Sign-Off Sheet

(UFP-QAPP Manual Section 2.3.2)

Certification that project personnel have read the text will be obtained by one of the following three methods as applicable:

1. In the case of regulatory agency personnel with oversight authority, approval letters or emails stating approval will constitute verification that applicable sections of the UFP-SAP have been reviewed. Copies of regulatory agency approval letters or emails will be retained in the project files and are listed in Worksheet #29 as project records.
2. Emails will be sent to Navy, Tetra Tech, and subcontractor project personnel who will be requested to verify by email that they have read the applicable UFP-SAP Worksheets and the date on which they were reviewed. Copies of the verification email will be included in the project fields and are identified in Worksheet #29.
3. A copy of the signed Worksheet #4 will be retained in the project files and is identified as a project document in Worksheet #29.

Name	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Tetra Tech Project Team Personnel					
Ralph Basinski	PM/Manages project activities for Tetra Tech	412.921.8308		All	
Matt Soltis	HSM/Manages Corporate Health and Safety Program	412.921.8912		HASP[1]	
Tom Johnston	QAM/Reviews plan quality assurance	412.921.8615		All	
Bob Feldpausch	In-water Survey Manager/Manages In-water surveys	425.482.7862		All	

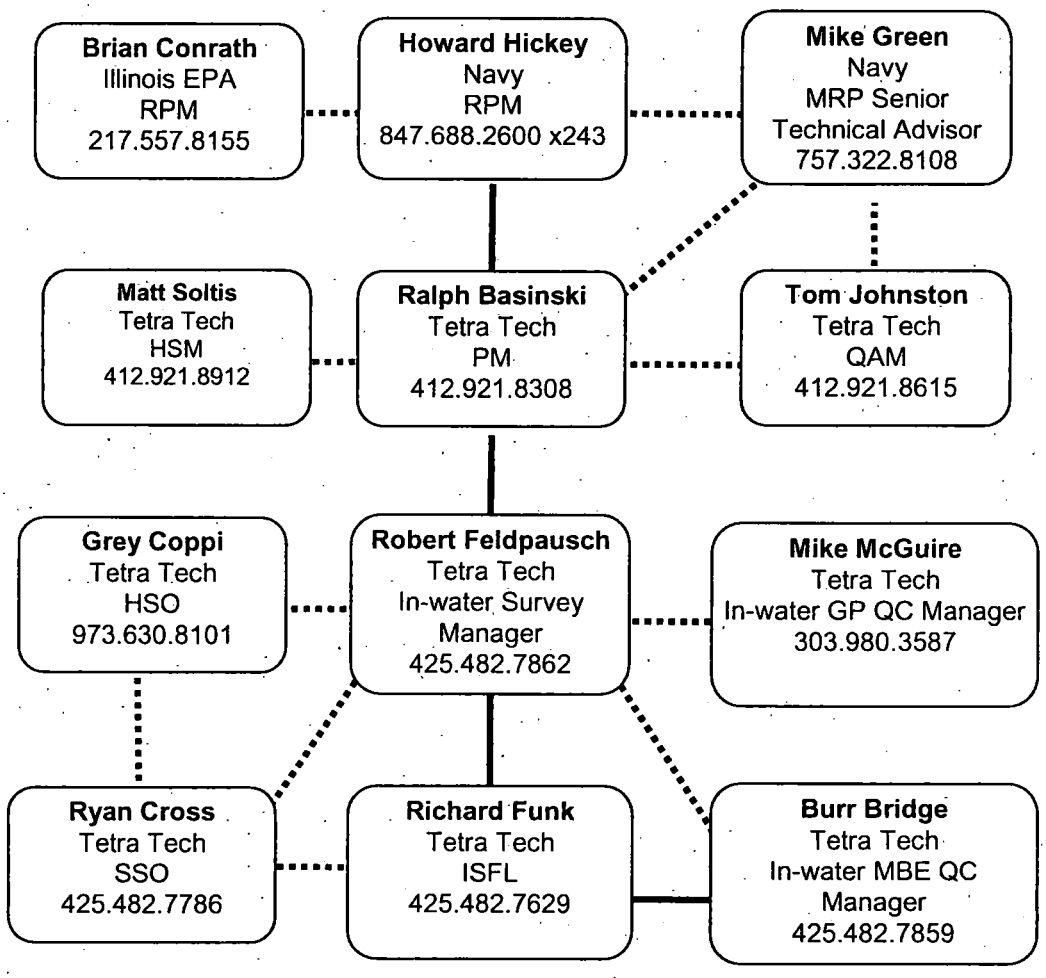
Name	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Richard Funk	ISFL/Field Management	425.482.7629		All	
Burr Bridge	MBE QC Manager/Manages MBE QC	425.482.7859		All	
Michael McGuire	GP QC Manager/ Manages project MGA/TDEMI geophysical data QC	303.980.3538		All	
Ryan Cross	SSO/Manages site safety issues	425.482.7786		All	
Grey Coppi	HSO/Manages Corporate Health and Safety Program	973.630.8101		HASP[1]	

1. The HASP is a stand-alone document, which is provided to the Navy separately.

SAP Worksheet #5 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)

Line of Authority ..... Line of Communication



SAP Worksheet #6 -- Communication Pathways

Communication Driver	Responsible Person Affiliation	Name	Phone Number and/or E-Mail	Procedure
UFP-SAP/QAPP amendments	Tetra Tech PM Navy RPM Illinois EPA RPM	Ralph Basinski Howard Hickey Brian Conrath	412.921.8650 847.688.2600 x243 217.557.8155	Tetra Tech PM will notify Navy RPM via e-mail within 1 business day. Navy RPM will inform Illinois EPA RPM within 1 business day.
Field work schedule changes	Tetra Tech PM Navy RPM Illinois EPA RPM	Ralph Basinski Howard Hickey Brian Conrath	412.921.8650 847.688.2600 x243 217.557.8155	Tetra Tech PM will verbally inform Navy RPM on the day that schedule change is known and document via schedule impact letter as soon as impact is realized if the schedule impact is significant. Navy will notify the Illinois EPA RPM on the day that schedule change is known and document via schedule impact letter if necessary.

Communication Driver	Responsible Person Affiliation	Name	Phone Number and/or E-Mail	Procedure
Field issues that require changes in field tasks	Tetra Tech In-Water Survey Manager Tetra Tech ISFL Tetra Tech PM Navy RPM Illinois EPA RPM	Bob Feldpausch Richard Funk Ralph Basinski Howard Hickey Brian Conrath	425.482.7862 973.216.9295 412.921.8650 847.688.2600 x243 217.557.8155	The ISFL will inform Tetra Tech In-water survey Manager and Tetra Tech PM on the day the issue is discovered; Tetra Tech PM will inform Navy RPM within 1 business day; Navy RPM will inform the Illinois EPA RPM of issue and propose scope change within 1 business day. Navy RPM will issue scope change approval (verbally or via e-mail) if warranted; scope change to be implemented before work is executed.
Field issues that require changes in scope of field work	Tetra Tech In-Water Survey Manager Tetra Tech ISFL Tetra Tech PM Navy RPM Illinois EPA RPM	Bob Feldpausch Richard Funk Ralph Basinski Howard Hickey Brian Conrath	425.482.7862 973.216.9295 412.921.8650 847.688.2600 x243 217.557.8155	The responsible party will verbally inform Tetra Tech PM on the day that the issue is discovered. Tetra Tech PM will inform Navy RPM. Navy RPM will inform Illinois EPA RPM within 1 business day of discovery. Tetra Tech PM will document the change via Field Task Modification Request (FTMR) form within 2 days of identifying the need for change.

Communication Driver	Responsible Person Affiliation	Name	Phone Number and/or E-Mail	Procedure
Recommendation to stop work and initiate work upon corrective action	Tetra Tech In-Water Survey Manager Tetra Tech ISFL Tetra Tech PM Tetra Tech QAM Tetra Tech HSM Tetra Tech HSO Navy RPM Illinois EPA RPM	Bob Feldpausch Richard Funk Ralph Basinski Tom Johnston Matt Soltis Grey Coppi Howard Hickey Brian Conrath	425.482.7862 973.216.9295 412.921.8308 412.921.8615 412.921.8912 973.630.8101 847.688.2600 x243 217.557.8155	Within 1 hour, the responsible party will (verbally or via e-mail) inform Tetra Tech PM, Tetra Tech In-water Survey Manager, ISFL Tetra Tech QAM, and Tetra Tech HSM or HSO. Tetra Tech PM will inform Navy RPM (verbally or via e-mail) of any work stoppage within 1 day Navy RPM will inform Illinois EPA RPM (verbally or via e-mail) of any work stoppage within 1 day.
Bathymetric data issues	Tetra Tech ISFL Tetra Tech MBE QC	Richard Funk Burr Bridge	973.216.9295 425.482.7859	Geophysical field team will notify (verbally or via e-mail) Tetra Tech In-water Survey Manager within 1 hour. Tetra Tech In-water Survey Manager will notify (verbally or via e-mail) Tetra Tech PM and Project QAM on the same day.
Geophysical data issues	Tetra Tech In-Water Survey Manager Tetra Tech ISFL Tetra tech GP QC Tetra Tech PM	Bob Feldpausch Richard Funk Mike McGuire Ralph Basinski	425.482.7862 973.216.9295 303.980.3538 412.921.8308	Geophysical field team will notify (verbally or via e-mail) Tetra Tech In-water Survey Manager within 1 hour. Tetra Tech In-water Survey Manager will notify (verbally or via e-mail) Tetra Tech PM and Project QAM on the same day.

Communication Driver	Responsible Person Affiliation	Name	Phone Number and/or E-Mail	Procedure
Corrective action for field program	Tetra Tech In-water MBE or GP QC Manager	Burr Bridge Mike McGuire	425.482.7859 303.980.3538	The In-water QC Manager will notify the Project QAM and the Tetra Tech PM within 1 day that the corrective action has been completed.

SAP Worksheet #7 -- Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Howard Hickey	RPM	NAVFAC Midwest	Oversees project scoping implementation, including, data review, and evaluation and approves UFP-SAP. Serves as the on-site point of contact and oversees site activities and participates in scoping, data review, and evaluation.	Available Upon Request
Brian Conrath	RPM	Illinois EPA	Participates in scoping, data review, evaluation, and approves the UFP-SAP.	Available Upon Request
John Trepanowski	Program Manager	Tetra Tech	Oversees NAVFAC CLEAN Program.	M.S., Mining Engineering, B.S., Mining Engineering, 27 years of engineering experience

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Ralph Basinski	PM	Tetra Tech	Oversees project, financial, schedule, and technical day-to-day management of the project. • Ensures timely resolution of project-related technical, quality, and safety questions associated with Tetra Tech operations. • Functions as the primary Tetra Tech interface with the Navy RPM Tetra Tech field and office personnel, and laboratory point of contact (POC). • Ensures that Tetra Tech health and safety issues related to this project are communicated effectively to all personnel and off-site laboratories. • Monitors and evaluates all Tetra Tech subcontractor performance. • Coordinates and oversees work performed by Tetra Tech field and office technical staff (including data validation, data interpretation, and report preparation). • Coordinates and oversees maintenance of all Tetra Tech project records. • Coordinates and oversees review of Tetra Tech project deliverables. • Prepares and issues final Tetra Tech deliverables to the Navy.	B.S. Chemistry, 25 years experience

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Robert Feldpausch	In-water Survey Manager	Tetra Tech	Oversees project, financial, schedule, and technical management of the In-water Survey Program. • Ensures timely resolution of project-related technical, quality, and safety questions associated with in-water geophysics. • Coordinates and oversees in-water geophysical work performed by Tetra Tech field and office technical staff, including data collection and interpretation. • Coordinates preparation and review of geophysical deliverables.	BS, Environmental Studies and Policy, Michigan State University, 1998 A.S., Geographic Resources and Environmental Technology, Lansing Community College, 1996 Eleven years experience in conducting and managing hydrographic, geophysical and other in-water studies and projects. Specializes in performing and managing single and multibeam echosounder hydrographic surveys in accordance with the U.S. Army Corps of Engineers (USACE) Hydrographic Surveying Manual Standards. Additional experience includes management of marine unexploded ordinance (UXO)/MEC, sediment MC investigations and offshore survey projects and Hydrographic Tech training provided by the USACE and Shallow Water Multibeam training provided by NOAA and University of New Hampshire.

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Richard Funk	ISFL	Tetra Tech	Oversees day-to-day field operations for hydrographic studies and in-water geophysical mapping. Coordinates all activities associated with equipment setup, data collection and field data processing. Staff scheduling and supervision.	M.S., Geological Sciences, University of California at Riverside, 1998, B.S., Geological Sciences, Rutgers University, 1994, B.A., History, Rutgers University, 1990 Registered Professional Geologist, Tennessee Eleven years experience conducting and managing terrestrial and in-water geophysics tasks and projects. Marine geophysical methods used include single and multibeam bathymetry, side scan sonar, seismic refraction, seismic reflection (sub-bottom profiling) and magnetometry. Experience also includes more than nine years of UXO investigations (terrestrial and marine) on sites from New Jersey to Adak Island Alaska. Note: In accordance with USACE Date Item Description (DID) OE-025, in order to manage the field geophysical studies this individual has a degree in geophysics, geology, geological engineering, or closely related field, and shall have a minimum of 5 years of directly related geophysical experience.

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Burr Bridge	In-water MBE QC Manager	Tetra Tech	Responsible for all MBE data quality review. Responsible for implementation of corrective actions and final QC of data packages.	B.S., Management, Rensselaer Polytechnic Institute, 1973 Various Coursework, Computer Science, UC Santa Barbara & Ventura College 27 years of experience including more than 14 years supporting field survey programs and more than 20 years in software development for data analysis and support of various types of geophysical survey operations.
Mike McGuire	GP QC Manager	Tetra Tech	Responsible for review of MGA and/or TDEMI geophysical data. Responsible for implementation of corrective actions.	B.S., Geophysical Engineering, Colorado School of Mines, 1981 28 years experience dedicated to engineering and environmental geophysics, with a special emphasis on ordnance and explosives (OE). Experience includes the design and management of integrated geophysical programs that have utilized electromagnetic, magnetic, resistivity, gravity, seismic, and borehole geophysical methods to investigate and assess OE, geotechnical, geologic, hydrogeologic, and cultural resource features.

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Tom Johnston	QAM	Tetra Tech	Reviews UFP-SAP, oversees preparation of laboratory scope, coordinates with laboratory, and conducts data quality reviews. Ensures quality aspects of the CLEAN program. • Develops, maintains, and monitors QA policies and procedures. • Provides training to Tetra Tech staff in QA/QC policies and procedures. • Conducts systems and performance audits to monitor compliance with environmental regulations, contractual requirements, UFP-SAP requirements, and corporate policies and procedures. • Audits project records. • Monitors subcontractor quality controls and records. • Assists in the development of corrective action plans and ensuring correction of non-conformances reported in internal or external audits. • Ensures that this UFP-SAP meets Tetra Tech, Navy, and Illinois EPA requirements. • Oversees the responsibilities of the Tetra Tech Project QA/QC Advisor. • Prepares QA reports for management.	PhD, Analytical Chemistry, 31 years experience

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Matt Soltis	HSM	Tetra Tech	Oversees CLEAN Program Health and Safety Program • Provides technical advice to the Tetra Tech PM on matters of health and safety. • Oversees the development and review of the HASP. • Conducts health and safety audits. • Prepares health and safety reports for management.	B.S., Industrial Safety Sciences, 24 years of environmental experience

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Ryan Cross	SSO[1]	Tetra Tech	The SSO will be responsible for training and monitoring site conditions. The SSO reports to the HSO and indirectly to the ISFL and Tetra Tech PM. Details of the SSO's responsibilities are presented in the HASP and include: • Controlling specific health and safety-related field operations such as monitoring of worker heat or cold stress, and distribution of safety equipment. • Conducting and documenting a daily health and safety briefing each day while on site. • Assuring that field personnel comply with all procedures established in the HASP. • Identifying an assistant SSO in his/her absence. • Terminating work of an imminent safety hazard, emergency situation, or other potentially dangerous situation is encountered. • Assuring the availability and condition of health and safety monitoring equipment. • Coordinating with FOL and PM to institute and document any necessary HASP modifications. • Ensuring that facility personnel and subcontractors are adequately advised and kept clear of potentially contaminated materials.	24-hour Tetra Tech in-house training program

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and/or Experience Qualifications (Optional)
Grey Coppi	HSO	Tetra Tech	The HSO is responsible for the overall health and safety program for the project. Details of the HSO's responsibilities are presented in the HASP and include: • Provide for the development and approval of the HASP; • Serve as the primary contact to review health and safety matters that may arise. • Approve revised or new safety protocols for field operations. • Coordinate revisions of the HASP with field personnel. • Oversee and approve the Emergency Response/Contingency Plan (ERCP) and perform audits to determine that the plan is in effect and all pre-emergency requirements are me. • Act as a liaison to applicable regulatory agencies and notify OSHA of reportable accidents and fatalities. • Notify the Occupational Safety and Health Administration (OSHA) if an accident/incident results in an OSHA reportable (i.e. three or more workers hospitalized, over $10,000 in property damage, or a fatality). • Assist in the investigation of major accidents.	Certified Industrial Hygienist (CIH) and Certified Safety Professional (CSP). 20+ years experience in occupational health and safety

In some cases, one person may be designated responsibilities for more than one position.
(1) For this project, the ISFL may be responsible for SSO duties. This action will be performed only as credentials, experience, and availability permits.

SAP Worksheet #8 -- Special Personnel Training Requirements Table

(UFP-QAPP Manual Section 2.4.4)

Project Function	Specialized Training by Title or Description of Course	Training Provider/ Verifier	Training Date	Personnel/ Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/ Certificates
While no specific routine training requirements exist for marine UXO surveys, the project team has extensive hydrographic and geophysical experience and training as described in Worksheet #7.						
Project Operations	Accident Prevention and First Aid	SSO	Upon arrival at NSGL	All personnel	Tetra Tech and Subcontractors	Documentation of special training requirements will be maintained on site. After the field investigation is complete, special training documentation will be maintained in the permanent project file.
	Overview of Project Plans	In-water Survey Manager				
	29CFR1910.120 Training	Vendor	Prior to arrival at NSGL	All field personnel		
Hydrographic Survey, Geophysical Survey, Transect layout	Use of Differential Global Positioning System (DGPS) equipment	In-water Survey Manager, ISFL	Training will have been received prior to participation in field activities	Geophysical Survey Team		
	Use of MBE sonar	In-water Survey Manager, ISFL		Geophysical Survey Team		
	Use of geophysical survey sensor	In-water Survey Manager, ISFL		Geophysical Survey Team		
	Geophysical Survey SOP 01	In-water Survey Manager, ISFL		Geophysical Survey Team		
	Geophysical Data Processing SOP 02	In-water Survey Manager, ISFL		Data Processors and Interpreters		

SAP Worksheet #9 -- Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1)

Project Name: MEC Inspection at the NTC Lakefront Site **Projected Date(s) of Sampling**: April, 2010 **Project Manager:** Ralph Basinski	**Site Name:** NSGL, NTC Lakefront **Site Location:** Great Lakes, Illinois

Date of Session: June 15-16, 2009
Scoping Session Purpose: The purpose of the meeting was to conduct a windshield tour of the sites, develop a project schedule, obtain relevant supplemental information necessary to support update of the CSMs, begin to discuss Site Investigation (SI) sampling plan, and preparation of initial project DQOs.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Howard Hickey	RPM	NAVFAC Midwest	847.688.2600 x243	howard.hickey@navy.mil	Navy Project Management
Benjamin Simes		Navy	847.688.2600 x320	benjamin.simes@navy.mil	NSGL Representative
Brian Conrath	Illinois EPA RPM	Illinois EPA	217.557.8155	brian.conrath@illinois.gov	Regulatory Input
Ralph Basinski	PM	Tetra Tech	412.921.8308	ralph.basinski@tetratech.com	Tetra Tech Project Management
Peggy Churchill	DQO Facilitator	Tetra Tech	321.636.6470 x1300	peggy.churchill@tetratech.com	DQO Facilitator
Robert Feldpausch	In-water Survey Manager	Tetra Tech	425.482.7862	robert.feldpausch@tteci.com	Underwater Geophysicist

Comments/Decisions: Discussed the general information provided to the Project Team for the site. A general CSM was developed, and DQOs were developed, but sample locations were not determined. A summary of meeting minutes regarding the NTC Lakefront MEC site are included below. All meeting minutes regarding MC will be contained in the MC UFP-SAP.

Action Items:

1. Tetra Tech requested all available Preliminary Assessment (PA) data or other historical information as information inputs to the CSMs.
2. Geophysical Data to be collected in the water portion of the NTC Lakefront Site will be obtained using a combination of one or all of the following technologies to identify anomaly distribution on the lake bottom (detection capabilities will be documented);
   a. MBE
   b. MGA
   c. Bottom-Towed EM (BTEM)
3. Robert Feldpausch to evaluate the possibility of using a drop camera or Remotely Operated Vehicle (ROV) on a video sled to confirm the anomalies detected by the MBE bathymetry survey without using a human diver.
4. Robert Feldpausch to evaluate the possibility of using a towed sled setup to collect the EM survey data.
5. Tetra Tech to determine if the site boundaries are sufficient based on the available background information and/or determines how the AA range fan was developed.
6. Tetra Tech will prepare and submit the draft UFP-SAP to the project team for the NSGLNTC Lakefront Site.

Consensus Decisions:

The consensus decisions below concerning the geophysical survey program were based on the understanding of the CSM at the time of the meeting.

1 The NTC Lakefront Site (Water Portion) boundaries will be the AA range fan/the safety danger zone (SDZ) in the horizontal direction and the vertical boundary will be sediment less than 120-feet below the water surface. MEC investigation will not take place in waters deeper than 120-feet.

2 The DQO of this investigation is to differentiate geophysical anomalies from cultural debris on the lake bottom.

3 The DQO is to determine the distribution patterns, density, gradient, and clustering of munitions related debris or MEC on the lake bottom assuming the MEC includes primarily 20-mm rounds, 40-mm rounds, and 1.1–inch AA artillery.

4 The CSM should consider the exact location of gun placement, projectile trajectory data, gun arch during training, water depth, and potential transportation of the MEC by lake currents.

5 If anomaly distribution (fields, clustering, and banding) is representative of AA range MEC then further investigation will take place during a Remedial Investigation (RI).

6 If anomaly distribution (discrete points, size variations, random distribution) is not representative of AA range MEC and is more representative of cultural debris, then project team decision for no further investigation of MEC is required.

7 If there are no anomalies, because of burial of MEC or lack of survey depth detection capabilities, then no further investigations.

SAP Worksheet #10 -- Conceptual Site Model and Problem Definition

(UFP-QAPP Manual Section 2.5.2)

10.0 INTRODUCTION

NSGL sits on approximately 1,628 acres in Great Lakes Illinois, approximately 20 miles north of Chicago, in Lake County, Illinois. The installation is located along the western shores of Lake Michigan just east of U.S. Route 41 and south of an adjacent town, North Chicago. The other population center in the vicinity is the town of Waukegan, approximately eight miles north on U.S. Route 43. NSGL is bound by Lake Michigan to the east and Skokie Highway (U.S. Route 43) to the west. The Shore Acres Country Club is the southern border of NSGL. Figure ES-1 shows the general location of NSGL.

NSGL is the largest, active duty DoD Naval training center in the U.S. NSGL is home to enlisted men training and officer accession training. The installation is one of Illinois' largest employers with over 25,000 military and civilian personnel. The Great Lakes Naval Hospital trains 4,000 Navy Corpsmen annually and is the Navy Regional Processing Site for several hundred reservists.

NSGL provides support for the Navy through the intense training and specialized itinerary for enlisted men preparing for the fleet. Major commands at NSGL include Naval Station (NAVSTA), a shore activity reporting command; the Recruit Training Command, which trains sailors; and the Service School Command (SSC), which provides initial technical training. The SSC can also be broken down into combat systems schools, engineering systems schools, and a training department.

Between 1942 and 1945, personnel stationed at NTC used the NTC Lakefront for AA artillery training. At that time, twenty-five gun mounts located on the beachfront were used to fire at targets towed over Lake Michigan. For purposes of the SI field investigation, the site has been divided into two portions: the land portion, which includes the firing line and all structures, and the water portion, which includes the range fan over Lake Michigan. This UFP-SAP addresses only the underwater geophysical survey. Information regarding the NTC Lakefront Site is limited to the history and site description presented in the Final Water Area Munitions Study (WAMS) NTC Lakefront (Malcolm Pirnie, 2005) and the PA (Malcolm Pirnie, 2008). The following sections include the NTC Lakefront site description, CSM and the SI Problem Statement.

10.1 NTC LAKEFRONT SITE LOCATION, HISTORY AND PHYSICAL FEATURES

The land portion of the NTC Lakefront Site is approximately one acre in size and is located east of the bluff on the beachfront of Lake Michigan. Prior to using the site, the shoreline was extended with fill material in order to install the machine gun mounts. The water portion of this site includes a fan area of approximately 4,765 acres that extends out from the shoreline over Lake Michigan. Several million 20-milimeter (mm), 40-mm and 1.1-inch rounds were fired during training activities. Potential munitions issues associated with the site are related to its former use as an AA training area and are not associated with the magazine building sited at this location. Figure ES-2 illustrates the NTC Lakefront Site and the surrounding area.

The NTC Lakefront Site is bordered by Lake Michigan to the east, a recreational vehicle (RV) park to the north, the bluff to the west, and the Outer Harbor and Boathouse to the south. The site is accessible via Ziegemeir Street, which is built over the former gun mount roundels. A magazine, Building 120, is the present lakefront magazine according to a March 17, 2003 listing of known ammunition storage and firing locations at NSGL. Over the years, the buildings associated with the Site, including the Garage and Storage, the Machine Gun Training Building, the Armory, and the Clippings and Empties building, were demolished. A tank farm for fuel storage tanks was constructed in the location of the former Machine Gun Training Building to meet the needs of the power plant sometime after 1962. No construction records for the tank farm were available that could provide information regarding potential munitions findings and no visible signs of the buildings exist today. The power plant, for which the current tank farm is utilized, is located approximately 500 feet from the tank farm (former location of the NTC Lakefront).

Guarded entrance gates limit access to NSGL, however; access to the NTC Lakefront is not restricted once through the main installation gates. Thus, any Navy personnel or authorized visitor who has access through the main installation gates can access the site without restriction. Additionally, access is not limited from the beach side of the installation off Lake Michigan. There are no specific restrictions associated with the site.

The topography of the NTC Lakefront greatly changes from the bluff to the lake. The bluff is steeply sloped and is the western boundary of the site. The former location of the AA training school buildings and firing points is presently paved over with concrete and asphalt and is generally flat. A sandy beach with a concrete breakwater to help control beach erosion is located to the east of the former gun mounts.

10.1.1 Visual Survey Observations and Results

The Malcolm Pirnie survey team visited the site March 17 through 21, 2003, and observed the location of the firing points along Ziegemeir Street. The roundels for the gun emplacements were identified under the asphalt-paved road. There were no visual findings of ammunition or other ordnance during the site walk. No evidence of the former structures or the targets used for training purposes remains on the land surface with exception of the roundels in the street for the AA artillery. A visual survey of the water portion of the range was not conducted.

10.2 NTC LAKEFRONT CONCEPTUAL SITE MODEL

10.2.1 Potential or Known Contaminant Sources

MEC may be present in Lake Michigan sediment as the result of Naval training operation conducted at the NTC Lakefront Site. Approximately 1,350 sailors a day were instructed in AA training using 20- and 40-mm and 1.1-inch guns. Several million rounds were fired at cable-drawn targets towed by airplanes over Lake Michigan. The ammunition used included 20-mm, 40-mm and 1.1-inch High Explosive (HE), High Explosive Incendiary (HEI), High Explosive Tracers (HET) and/or HET-Dark Ignition (DI) rounds. Based on the information obtained during the data collection process, no special consideration munitions are known or suspected to have been used at the site; therefore, the NTC Lakefront is not suspected to contain chemical warfare material filled munitions, electrically fuzed munitions or depleted uranium associated munitions (Malcolm Pirnie, 2005). Additional technical data regarding the munitions used at the NTC Lakefront Site are included in Appendix B.

It is estimated that more than ten million rounds of ammunition were fired. The dud rate is estimated at five to ten percent (%). Therefore, several hundred thousand rounds containing explosives may be present in the Lake Michigan sediment. Some munitions that missed the target could have automatically detonated (or partially detonated) 3,000 yards from the firing point, which indicates that MEC or munitions debris (MD) may be present at this distance from the firing point within the Lake. Munitions that did not detonate at this distance may have traveled a considerable distance before impact depending on the munition type and typical range. Some of the munitions fired had potential ranges of more than 30,000 feet (5.68 miles). There may be "bands" of munitions or related debris stretching across the lake bottom in the safety danger zone (range safety fan) at locations equivalent to the auto detonation distance and at other distances corresponding to impact areas associated with frequently used gun elevations or aerial target corridors. These "bands" would more likely resemble flattened ovals since firing would be concentrated near the center of the SDZ. Bands closer to the shore are expected to have lower density distribution and increasing density towards the middle of the SDZ. The density is then expected

to decrease again closer to the maximum range of the munitions items. These bands correspond to the area of secondary impact and primary impact based on the historical trajectory of munitions and flight paths of the towed targets (Figure ES-2 and 10-1).

10.2.2 Contaminant Migration Pathways

Within the water portion of the Site, MEC in the form of 20-mm and 40-mm HE rounds, 1.1-inch rounds and associated MEC debris, are expected to be located along the lake bottom within the range fan that extends over Lake Michigan. Many times these types of AA rounds used a self-destroying tracer. When the tracer detonated, it would set off the projectile burster, thereby destroying the projectile. The projectile debris would eventually settle on the lake bottom, and in the process, some MC (explosives, and metals) may have been mixed into the lake water at this time. Undetonated AA rounds may corrode and decay over time, depositing explosives and metals to the lake bottom sediment. These MC may become entrained in the water column by lake mixing activities and may be transported beyond the site boundary. These contaminants may eventually settle out onto the lake bottom, or may be diluted to very low levels.

10.2.3 Receptors and Exposure Pathways

Potentially complete exposure pathways exist for surface and subsurface sediment within Lake Michigan. Navy personnel, their visitors, recreationists, and commercial anglers may be exposed to MEC in sediment while diving, fishing, or swimming. Human and ecological receptors could also be exposed to MEC via dredging activities that may take place in Lake Michigan. Wave action, internal mixing, or dredging activities may result in potential MEC in subsurface sediment, being transported to the lake bottom surface. Figure 10-1 presents a graphical conceptual site model of the NTC Lakefront Site.

10.3 NTC LAKEFRONT PROBLEM STATEMENT

Because of historic training activities at the NTC Lakefront Site, Lake Michigan sediment may be contaminated with MEC and MEC debris in the form of AA rounds. Therefore, an SI must be conducted to determine whether potential MEC and MEC debris are present in lake bottom sediment.

SAP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements

11.1 IDENTIFY THE GOALS OF THE STUDY (STEP 2)

The study goal of the SI at NTC Lakefront is as follows:

1. Conduct a hydrographic survey and in-water geophysical survey to determine if lake-bottom anomalies are present in patterns or clusters that are representative of the AA deposition. If so, conduct further investigation during an RI.

11.2 IDENTIFY INFORMATION INPUTS (STEP 3)

Data and information that will be required to make environmental management decisions about Lake Michigan include the following:

1. Control Point Data: Site preparation will consist of locating or establishing an adequate number of control points to provide accurate navigational control for the survey work.

2. Bathymetric Survey Data: Technicians will use a high-resolution MBE system capable of detecting and identifying features such as potential MEC or MD on the surface of lake sediment. The bathymetric survey will also be used to map the lake bottom and morphology in addition to identifying obstacles and features that may affect the in-water geophysical survey and any MEC removal activities. The bathymetric survey will be conducted in general accordance with SOP 01 - the most recent USACE's Hydrographic Surveying Engineering Manual (EM 1110-2-1003 and appendices; USACE 2002) for an acoustic multi-beam survey as modified by the project-specific technical specifications provided in this work plan.

3. In-Water Geophysical Survey Data: Following the bathymetric survey the study transects will be mapped using either an underwater MGA or BTEM to determine the density and distribution of metallic items that may represent suspect MEC, MPPEH, MD, or scrap metal. All geophysical survey data will be recorded electronically and field notes will be recorded in field logbooks and/or survey log sheets. Any anomalies detected during the geophysical survey will be used to determine whether any suspect MEC may be present on the lake bottom surface or subsurface. These data and their locations will also be used to generate MC sampling locations.

4. Real Time Kinematic (RTK) Geographical Positioning System (GPS) and ultra short acoustic baseline positioning system (USBL): The Leica 1230 RTK GPS/Applanix POS M/V and USBL systems will be used to record watercraft and MGA or BTEM position, dynamics and elevation data.

11.3 DEFINE THE BOUNDARIES OF THE STUDY (STEP 4)

The horizontal boundary for the MEC SI at the NTC Lakefront is shown as the Lake Michigan SDZ as presented in Figure ES-2. However, the horizontal boundary my be modified based on the results of the bathymetric survey so as not to extend beyond the point at which the bottom of Lake Michigan is greater than 120 feet deep. This is the maximum depth covered by the Navy MRP. The vertical boundary of the MEC SI investigation of the lake bottom sediment is limited by the size of the anomalies present and the capabilities of the detection system. Small items (20-mm projectiles) may not be detected unless clustered together. Larger items such as 40-mm projectiles may be detected at depths up to approximately 12 inches in the bottom sediment depending on the technology used.

The southern boundary of the investigation area may be extended to the south if MBE and geophysical surveys indicate the north-south lake currents have transported suspect MEC and associated sediment to the south.

11.4 DEVELOP THE ANALYTIC APPROACH (STEP 5)

The decision-making process for investigating the presence of MEC is presented below.

1. If the hydrographic and geophysical survey data indicate no suspect MEC or if no lake-bottom anomalies representative of the AA deposition are detected, then proceed to No Further Action (NFA) for MEC in the areas surveyed. If the hydrographic data and geophysical survey data results indicate suspect MEC is present on the lake bottom, or if lake-bottom anomalies are present in patterns or clusters that are representative of the AA range deposition, proceed to a RI.

2. If suspect MEC or lake-bottom anomalies are present at the extent of the horizontal SI investigation boundary and the water depth is less than 120 feet, then expand the investigation boundary during the RI. If no suspect MEC or lake bottom anomalies are present at the horizontal boundary, then an expansion of the study area boundary is not required.

QA data to be collected as part of the SI are described in Worksheets #20 and #28.

11.5 SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA (STEP 6)

The criteria for the hydrographic and geophysical surveys will be the results of a go/no go test performed by determining whether the instrument responds to metallic objects placed on the lake bottom.

Performance/acceptance criteria are specified in Table 12-1 in Worksheet #12. The measurement performance criteria for the Instrument Verification System (IVS) are described in Worksheet #12.

The Project Team will review the results of the investigations to verify that all proposed data was collected and that the data quality specifications and the overall data quality is sufficient to support attainment of the project objectives. This will involve a review of anomaly patterns by the Project Team to determine if the data is representative of suspected MEC/MPPEH. The Project Team will review the hydrographic and geophysical survey results and ensure that all stakeholder concerns are included in decision making.

11.6 DEVELOP THE PLAN FOR OBTEMINING DATA

The sampling plan and rationale for the MEC investigation is presented in Worksheet #17.

SAP Worksheet #12 -- Measurement Performance Criteria Table

(UFP-QAPP Manual Section 2.6.2)

Table 12-1. Measurement Performance Criteria

Definable Feature of Work Data Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency
Planning/Site Preparation/ Mobilization	As outlined in Table 12.2			
Hydrographic Surveys	Precision	Cross line data	Data points common to both survey lines and cross lines will have x,y,z coordinates that are repeatable within SOP 01 specified USACE Hydrographic survey standards (refer to Appendix A Table 1). Hydrographic Survey data shall meet or exceed Special Order Standards. Special Order Standards include: Horizontal Accuracy (95% confidence Level) is 2 meter. Depth Accuracy for Reduced Depths (95% Confidence Level) is calculated using the following equation $= +/- [a^2 + (b * d)^2]^{1/2}$ where: a (0.25 meter) is a constant depth error, i.e. the sum of all constant errors, (b = 0.0075)*d is the depth dependent. The 100% Bottom Search is compulsory and system detection capability is measured as cubic features >1 meter.	Minimum one cross line per 20 transects
	Completeness	Visual evaluation of data real-time for verification that intended coverage goals are met	Real-time coverage plots (matrix fills) will be utilized to monitor coverage. 90 % of the matrix will be filled in areas that are accessible for survey (i.e. sufficient water depth, lack of obstacles, safe for navigation) and do not fall into shadow areas due to objects proud (slightly above) of the bottom, or due to depressions.	Continuous visual monitoring during data collection

Definable Feature of Work Data Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency
	Sensitivity	Real-time monitoring and use of gains and gate filters, software quality flags	Data collection depth range is optimized to reduce anomalous reflections and provide optimum data, gains are set to provide appropriate bottom tracking. Internal testing is done by the data acquisition software to check the validity of each ping based on colinearity and brightness and each ping is tagged with a quality flag of 0-3 based on the these tests. During processing, the pings are filtered based on the quality flags to eliminate all but the data with a quality of 3 unless conditions warrant accepting lower quality pings (such as shorelines or vertical structures).	Continuous visual monitoring during data collection, sonar system quality flags
	Accuracy	1. GPS Positioning - Survey crew will check-in on selected third order control points with rover GPS. 2. Water level check – Use RTK GPS rover to check water surface elevation. Compare to survey system navigation reported tide level. 3. Bar check and/or lead line check vs. water surface relative depth from sonar.	1. RTK GPS measurements will match published position to within 0.2 feet x, y and z. 2. RTK GPS water level and survey system tide level will match to within 0.2 feet. 3. Nadir bathymetry depths relative to surface, corrected for draft and attitude match to within 0.2 feet.	1. Daily 2. Daily 3. Daily
Marine Geophysical Mapping (MGA)	Precision	Resurvey of transects	Re-surveyed data points comparable in size, shape and location to original survey. Anomaly amplitude will be within 20% when: 1) gradient field is <100 nanotesla (nT)/feet and 2) measurement locations are within 0.4 feet, 3) altitude of platform is within 5%, and 4) platform attitude is within 1 degree (°).	Daily during mapping to identify issues (resurvey minimum of ~5% (linear feet)

Definable Feature of Work Data Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency
	Completeness	Visual evaluation of data real-time for verification that intended coverage goals are achieved (re: Figure 17-1). Daily instrument checks serve as QC metrics to calculate completeness during field activities.	Sample distance ≤4 feet for 90 % of measurements for each 100 linear feet of data assessed (assess minimum of 5% of transect length per day) or as determined during initial data collection effort at IVS. 90% of the sensor measurements will be at a platform height of ≤10 feet above the bottom or as determined during initial data collection effort at IVS. Platform height is verified with MGA altimeter data.	Daily
	Accuracy, sensitivity	IVS	Instrumentation detects all items in IVS and positions items (x-y) within ± 5 feet of actual position or as determined during initial data collection effort at IVS (*accuracy*). Response from cluster of 40-mm projectiles ≥4 nT peak amplitude or as determined during initial data collection effort at IVS *(sensitivity)*. Daily static test ≤2nT for each array sensor based on two times the standard deviation of the measurements. NOTE: The IVS design and installation are discussed below.	Prior to beginning data collection and at the end of the day for all collection days
Optional Marine Geophysical Mapping [TDEMI Option (BTEM), if used]	Precision	Cross line data	Signal at the intersections will not vary by more than +/- 20% or 6 millivolts, whichever is larger, when: 1) measurement locations are within 0.4 feet, 2) altitude of platform is within +/-5 centimeters, and 3) platform altitude is within 1 degree (°).	Minimum 1 cross line per 20 transects. Remapping will not be performed for BTEM surveys [1]

Definable Feature of Work Data Type	Measurement Data Quality Indicator	QC Sample and/or Activity to Assess Measurement Performance	Measurement Performance Criteria	Frequency
	Completeness	Visual evaluation of data real-time for verification that intended coverage goals are achieved (re: Figure 17-1). Daily instrument checks serve as QC metrics to calculate completeness during field activities	Sample distance ≤2 feet for 95 % of measurements (assess minimum of 5% of transect length per day) or as determined during initial data collection effort at IVS.	Daily
	Accuracy, Sensitivity	IVS	Instrumentation detects all items in IVS and positions items (x-y) within ± 5 feet of actual position or as determined during initial data collection effort at IVS (*accuracy*). Response from cluster of 40-mm projectiles ≥6 millivolts (mV) peak amplitude (time gate 2) or as determined during initial data collection effort at IVS *(sensitivity)*. Daily static test ≤3 mV (time gate 2) for each array sensor based on two times the standard deviation of the measurements. NOTE: The IVS design and installation are discussed below.	Prior to beginning data collection and at the end of the day for all collection days
Demobilization	As outlined in Table 12.2			

Notes:
1. The nature and deployment methods for the BTEM make it impossible to remap transect areas. Cross lines will provide the QC for the data if the BTEM is employed.

12.1 INSTRUMENT VERIFICATION STRIP (IVS)

An IVS will be developed and utilized to validate the sensor systems and survey techniques for this project. Approximately four individual metal objects (inert munitions or surrogates) and two clusters of these items will be placed in 6-10 feet of water in a straight line. The distance between each item or cluster of items will be approximately 5-15 feet. The area will have a relatively flat bottom with no large obstructions so that there is no damage to the underwater arrays. Items will be measured, weighed and photographed prior to emplacement then located on the lake bottom to an accuracy of ±1 feet using a RTK GPS antenna mounted on an elongated pole. The start and ends of the IVS will be entered to the survey vessel navigation software so that the IVS can be repeated consistently with the sensor systems. Buoys offset from the start and end of the IVS may be used to visually demarcate the location of the test strip.

Table 12-2 Instrument Test Strip Area

Item	Potential Max Burial Depth (feet)	Orientation	Number of Items	Northing	Easting
40-mm	bottom	1 perpendicular	1	TBD	TBD
20-mm	bottom	1 parallel	1	TBD	TBD
40-mm	bottom	1 perpendicular, 1 parallel	2	TBD	TBD
20-mm	bottom	1 perpendicular, 1 parallel	2	TBD	TBD
40-mm	bottom	2 perpendicular, 2 parallel	4	TBD	TBD
20-mm	bottom	2 perpendicular, 2 parallel	4	TBD	TBD
40-mm cluster	bottom	Small pile	5-12	TBD	TBD
20-mm cluster	bottom	Small pile	5-12	TBD	TBD

Notes:
Perpendicular means long axis perpendicular to direction of sensor system.
Parallel means long axis parallel to direction of sensor system.

Prior to seeding, a background geophysical survey of the general instrument verification strip area will be conducted with the MGA and/or BTEM to document any existing metal items. Data will be acquired directly over the top of the seed items and two more parallel survey lines will be surveyed at a 1.5- and 2.5-feet offset from the initial survey line on both sides of the initial line (five lines total). The initial survey line will be used to validate the performance metrics listed in Table 12-1 and the offset survey lines will be used to provide the project team with information on the lateral detection capabilities of the sensor systems.

The specific objectives of the IVS are to:

- verify that the performance metrics in Table 12-1 are achieved on a daily basis (as necessary, the sensor system configuration and settings may be refined for optimal function and data collection with respect to specific site conditions and characteristics), and
- define the preliminary anomaly interpretation criteria for the project.

12.2 RATIONALE FOR SELECTION OF GEOPHYSICAL AND SURVEYING EQUIPMENT

There are no standardized or proven sensor systems for in-water geophysics to detect MEC. The primary systems selected are Tetra Tech proprietary, state-of-the-art multi-instrument arrays that have been tested and successfully used at several project sites. They are designed to provide efficient collection of high quality data over a broad area. The systems are capable of detecting individual items as small as a 37-mm projectile, as well as clusters of smaller items. An RTK GPS is used for above water positioning, while a combination of depth, attitude, cable counter and/or USBL is used for below water positioning. Pitch, roll, and heave sensors are used to correct for vessel dynamics.

The IVS will be surveyed with the MBE, MGA and (if used) BTEM. At this time, Tetra Tech anticipates primarily using the MBE and MGA sensor systems during the large-scale field program, as the BTEM is currently under phase II of fabrication and development. The BTEM could be used as an additional QC tool to compare to the MGA by acquiring data in a subset of areas of low anomaly concentrations to determine if there are any non-ferrous items present.

12.3 PERSONNEL QUALIFICATIONS

The IVS and geophysical investigation will be managed and performed by a qualified In-water Survey Manager and ISFL who are broadly experienced with the survey techniques and specifically experienced with the proposed system. Worksheet #7 describes the personnel qualifications and experience of the individuals managing the in-water survey work.

12.4 SEED ITEMS

Tetra Tech will seed the test strip. Each seed item will be measured, weighed, labeled with a unique identifier, and photographed with an appropriate scale. Surrogates will be painted orange and inert munitions blue.

Each seed item will be attached to an anchor rope to prevent significant shifting and the ends of the rope will be anchored with weights and buoys to mark the IVS area. Alternatively, the seed items may be attached to a sectional non-metallic rigid grid for placement on the bottom. The final method of placement for sections of seed item will be based on the site conditions and the location of the IVS.

SAP Worksheet #13 -- Secondary Data Criteria and Limitations Table

(UFP-QAPP Manual Section 2.7)

Secondary Data	Data Source (originating organization, report title, and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
Final Preliminary Assessment	Final Preliminary Assessment Naval Station Great Lakes, Illinois, NTC Lakefront and TSA Ranges,	Malcolm Pirnie, February, 2008	PA Report data will be used as a guide to identify former target locations and to establish the SDZ boundary and investigation boundary.	None
Final Water Area Munitions Study	Final Water Area Munitions Study - Naval Training Center Lakefront, Naval Station Great Lakes, Illinois (Malcolm Pirnie, Inc.)	Malcolm Pirnie, April, 2005	Final Water Area Munitions Study data will be used as a guide to identify former target locations and to establish the SDZ boundary and investigation boundary.	None

SAP Worksheet #14 -- Summary of Project Tasks

(UFP-QAPP Manual Section 2.8.1)

The implementation of the MEC investigation has been divided into definable features of work and the tasks required to complete each definable feature of work have been identified. Procedures for these tasks, including recording data, forms and checklists, data generation, QC checks, data management, and information management, are defined in the SOPs for the project indexed in Worksheet #21 (Appendix A).

Definable Feature of Work	Tasks
Planning/Site Preparation/Mobilization	• Project Plan Preparation/Work Plan review, Geographic Information System (GIS) setup, document and data management, procedure setup, confirmation of approved work plan, subcontractors and schedule • Verification of Personnel Qualifications • Coordination with local authorities and establish communication logistics • Administrative Offices Setup • Equipment Setup and Checkout • Initial Orientation and Training (including Safety and Emergency Response)
IVS	• Pre-survey IVS location • Install IVS in Lake Michigan • Survey ends of IVS • Perform survey over IVS
Hydrographic Surveys (MBE) and Marine Geophysical Mapping (MGA/BTEM Option, if selected)	• Test Equipment • Acquire Data
Hydrographic (MBE) Data Processing and Analysis	• Data analysis • Evaluation of bottom conditions • Identify Anomalies
Geophysical Data Processing and Interpretation	• Data Processing • Initial Target Selection • Correlation of geophysical, MBE and Camera/ROV data (if used) • Final Target Selection • Preparation of Anomaly Mapping to Stakeholders to aid in MC Sampling Location Selection
Demobilization	• Remove IVS • Complete all Field Forms • Close-Out Field Log Books • Return Equipment • Provide all Field Documentation (verify requirements established in the Work Plan)
Site-Specific Final Report Preparation and Approval	• Collect all documentation from the field activities • Prepare Site-Specific Final Report • Receive approval of Final Report

SAP Worksheet #15 -- Reference Limits and Evaluation Table

(UFP-QAPP Manual Section 2.8.1)

☑ **Worksheet Not Applicable**

No samples are proposed for collection/analysis during this MEC geophysics survey/investigation.

SAP Worksheet #16 -- Project Schedule/Timeline Table

(UFP-QAPP Manual Section 2.8.2)

Activity	Organization	Dates (MM/YYYY)	
		Anticipated Date(s) of Initiation	Anticipated Date of Completion
Prepare Rough Draft SI Work Plan and Appendices	Tetra Tech	10/2009	11/2009
Submit Rough Draft SI Work Plan and Appendices	Tetra Tech	**11/2009**	**11/2009**
Navy Review	Navy	12/2009	12/2009
Receive Comments/Comment Resolution	Tetra Tech and Navy	12/2009	01/2010
Prepare Draft SI Work Plan and Appendices	Tetra Tech	12/2009	01/2010
Submit Draft SI Work Plan and Appendices	Tetra Tech	**01/2010**	**01/2010**
Regulator Review	Illinois EPA	02/2010	03/2010
Receive Comments/Comment Resolution	Tetra Tech, Navy, and Illinois EPA	03/2010	03/2010
Prepare Final SI Work Plan and Appendices	Tetra Tech	03/2010	03/2010
Submit Final SI Work Plan and Appendices	Tetra Tech	**03/2010**	**03/2010**
Field Investigation	Tetra Tech	04/2010	04/2010
Prepare Rough Draft SI Report	Tetra Tech	04/2010	06/2010
Submit Rough Draft SI Work Plan and Appendices	Tetra Tech	06/2010	**06/2010**
Navy Review	Navy	06/2010	06/2010
Receive Comments/Comment Resolution	Tetra Tech	06/2010	06/2010
Prepare Draft SI Report	Tetra Tech	06/2010	07/2010
Submit Draft SI Report	Tetra Tech	07/2010	**07/2010**
Regulator Review	Illinois EPA	07/2010	08/2010
Receive Comments/Comment Resolution	Tetra Tech, Navy, and Illinois EPA	08/2010	08/2010
Prepare Final SI Report	Tetra Tech	08/2010	09/2010
Submit Final SI Report	Tetra Tech	09/2010	09/2010

SAP Worksheet #17 -- Project Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

Table 17-1. Reference Documents/Specifications

Definable Feature of Work	SOP	Supporting Document(s)
Planning/Site Preparation/Mobilization	--	As defined and specified within this UFP-SAP
IVS	--	As defined and specified within this UFP-SAP (See Worksheet #12)
Hydrographic Surveys and Marine Geophysical Mapping	SOP 01	USACE. 2002. Hydrographic Surveying Engineering Manual (EM 1110-2-1003 and appendices)
Hydrographic Data Processing, Analysis and Interpretation	SOP 01	USACE. 2002. Hydrographic Surveying Engineering Manual (EM 1110-2-1003 and appendices)
Geophysical Data Processing and Interpretation	SOP 02	• Data Processing • Initial Target Selection • Camera/ROV visual Identification • Final Target Selection • Provide Anomaly Mapping to Stakeholders to aid in MC Sampling Location Selection
Demobilization	--	As defined and specified within this UFP-SAP

17.1 SAMPLING DESIGN AND RATIONALE

This section describes in detail the approach, methods, and operational procedures Tetra Tech will use to collect hydrographic and marine geophysical data to identify anomalies potentially related to MEC in the marine portions of the former NTC Great Lakes, AA training range. The data collected will be used for several purposes including:

- Evaluation of site bathymetry, water depths, and areas of sediment erosion and deposition.
- Evaluation of obstacles and features that may impact MGA and/or BTEM survey.
- Evaluation of anomalies in multibeam sonar data that are potentially MEC or MD.
- Evaluation of metallic anomalies that are potentially MEC or MD.
- Evaluation of obstacles and features that may impact MEC removal.

Ultimately, the data will be used to design an efficient and effective RI/Feasibility Study and removal action, if warranted. Specifically, this UFPSAP documents the site-specific application of hydrographic and geophysical sensors, navigation equipment, data processing and analysis, and personnel in a manner capable of meeting the site-specific project goals as presented in Worksheet #11 of this UFP-SAP.

Figure 17-1 shows the selected preliminary transects. Adjustments may be made based on actual field conditions observed such as indications that the suspect MEC and associated sediment have been transported to the south due to strong north-south lake currents. Each transect will first be surveyed using a high resolution MBE sonar system to map the bathymetry in high resolution, to determine water depths, and to indicate the presence of possible features of interest and/or potential hazards to the towfish within the planned survey corridors. Tetra Tech will then survey the same transects with the MGA or the BTEM to detect metal objects and clusters of metal objects along each transect.

17.2 GENERAL PROCEDURES

17.2.1 Site Accessibility and Marine Traffic Control

The NTC Great Lakes installation is a controlled area accessible only through the main gate of the installation. The proposed hydrographic and marine geophysical work will be conducted in Lake Michigan, which is not a controlled area. Because these activities do not involve intrusive activities or contact with MEC, an exclusion zone is not required for munitions safety. However, because the work will require deployment of subsurface survey and mapping equipment, Tetra Tech will maintain a separation distance from other surface craft that may be present in the work areas. We will coordinate with the installation and other agencies to maintain a safe separation distance that will protect the public and prevent damage to the survey equipment.

17.2.2 Site Security

Site security as such is not required for the marine survey work. The survey vessels will be moored nightly at a safe location and equipment will be secured aboard the vessel.

17.2.3 Site Preparation

While aquatic vegetation can obstruct in water survey operations, vegetation removal will not be conducted for the marine survey tasks. Site preparation will consist of locating or establishing an

adequate number of control points to provide accurate navigational control for the survey work, as well as installing a minimum of four grid corners at the IVS area.

17.2.4 Hydrographic Survey (MBE)

A high resolution MBE system will be used to survey identified sampling transects in the study area. The transects have been selected based upon evaluation of the most likely areas where MEC may be located. Figure 17-1 shows the selected preliminary transects. Adjustments may be made based on actual field conditions observed. The MBE system provides high-resolution bathymetry and is capable of detecting and identifying features above the surface of bottom sediment. If objects such as MEC are partially or mostly covered with sediment, the scour and deposition patterns around the location of the object may provide indications of the presence of an object of potential interest.

The bathymetric survey will be conducted in general accordance with SOP 01 - the most recent USACE's Hydrographic Surveying Engineering Manual (EM 1110-2-1003 and appendices; USACE 2002) for an acoustic multibeam survey as modified by the project-specific technical specifications provided in this work plan.

17.2.5 MBE Equipment

The MBE used for this project will have the following technical specifications and capabilities:

- An angular resolution of 0.5° x 1.0° and a range resolution of 6-mm, currently the highest resolution multi-beam system on the market.
- Wide angular coverage so that in addition to normal bottom mapping, the system will be able to map steeper banks up to the elevation of the sonar.
- A horizontal accuracy of 9 centimeter (RTK GPS) or 1.0 meter (DGPS/inertial).
- Ability to detect objects ranging in size from approximately 0.25 meter to 1.0 meter cross sectional area (water depth/range dependent).

The most critical characteristic for resolving and identifying features on the bottom with multibeam sonar is the system's beam width. Table 17-2 shows the beam footprint at nadir and 60° off nadir (flat bottom assumed) at depths from 10 to 40 meters (33-feet to 131-feet) below the sonar head.

Table 17-2. Estimated Across Track Beam Width Diameter for Shallow Water MBE

Footprint Size (Across x Along Track)[1]				
	400 Kilohertz (Khz) (0.5°x1°)[2]		200 KHz (1°x2°)[2]	
Depth (meter)	Nadir (meter)	±60° (meter)	Nadir (meter)	±60° (meter)
10	0.09 x 0.17	0.35 x 0.35	0.17 x 0.35	0.70 x 0.70
20	0.17 x 0.35	0.70 x 0.70	0.35 x 0.70	1.40 x 1.40
30	0.26 x 0.52	1.05 x 1.05	0.52 x 1.05	2.09 x 2.10
40	0.35 x 0.70	1.40 x 1.40	0.70 x 1.40	2.79 x 2.79

Notes:
1. All calculations are based on the assumption that the bottom is flat.
2. As the distance from nadir increases the soundings footprint changes from circular to elliptical.

In 10-meter water depth, the nadir footprint for a 1.5° x 1.5° sonar, like the RESON 8101 or Kongsberg Simrad EM3002, is over 0.25 x 0.25 meter. Under the same conditions, the higher resolution RESON SeaBat 7125 or R2Sonic 2024 has a footprint of 0.17 meter along track and 0.09 meter across track.

Since the primary purpose of this survey is to locate and, if possible, identify MEC on the bottom, Tetra Tech will use the highest resolution multibeam sonar sounders available for this work. These sonar sounders operate in the 400-kilohertz (kHz) range. Tetra Tech will employ a RESON SeaBat 8125 or 7125, or a R2Sonic 2024 MBE. These systems will provide swath coverage of approximately 120° to 130°, depending on model, with a swath of about 3.5 to 4 times water depth.

The survey system components that will be used to conduct the hydrographic survey of the study area are shown in Table 17-3. The MBE system configuration for a dual head system is shown in Figure 17-2. Singe sonar head system components are identical with the exception that only a master sonar processor and projector/receiver array are utilized.

Table 17-3. MBE System Components

System	Manufacturer & Model	Parameters
Multibeam Sonar System	RESON Seabat(s) 7125/8125 or R2Sonic 2024	256 focused 0.5° x 1.0° beams at 400 kHz
Motion Compensation IMU	Applanix POS MV	0.03° accuracy – Roll, Pitch and Heading
Multibeam Sonar Data Acquisition	HYPACK Inc.	HYPACK/HYSWEEP
Multibeam Sonar Data Processing	CARIS	HIPS
3-D Visualization and Final QC Analysis	IVS 3D	Fledermaus Professional
Global Positioning System	Leica 1230 RTK GPS/Applanix POS M/V	Kinematic mode – Horizontal: Vertical:
Conductivity, temperature & depth (CTD)	Sea-Bird SBE-19/FSI NXIC	Conductivity, temperature & pressure profiler for sound speed vs. depth
Sound Speed	Sea-Bird Microcat	Sound speed at the multi beam array to assist beam forming

Position and water height data will be provided using a RTK GPS system, with corrections from a local RTK network (e.g. Trimble VRS Now, or equivalent), if available. If a local network correction is not available, a local base station will be established at an existing third order monument on base to provide the RTK correction. Using the RTK GPS system for vessel elevation, together with appropriate data quality checks, will eliminate the vertical uncertainties inherent with modeling vessel settlement and squat. It also will automatically compensate for changes in the vessel draft due to crew and material loading. In general, RTK GPS provides more reliable elevation data (+/- 2 centimeter) and processed sounding heights than can be obtained using other common survey methods and systems.

Heading will be obtained from an integrated inertial system (Applanix POS MV or equivalent). This high-performance system will also measure vessel roll, pitch, and heave, which will be used to compensate the bathymetry data for vessel motion induced by wave action and other vessel dynamics.

A sound speed profiler, such as the Seabird SBE-19, will be used to determine sound speed versus depth through the water column. These data will be input to CARIS software to model the refraction and path length effects of any changes in the sound speed with depth and to apply the appropriate corrections in calculating the positions of the soundings on the water body bottom. The frequency and location of the

sound speed to be used in processing the data will be determined by the local conditions at each survey site. In general at least two CTD casts will be done each full survey day.

17.2.6 MBE Data Processing/Analysis

Preliminary bathymetry data editing will be completed concurrently with acquisition and prior to departure of the survey vessel and crew from the project site, allowing Tetra Tech to verify that the survey objectives have been met prior to demobilization. Tetra Tech will typically have preliminary bathymetry charts of near final quality within two days of data collection. These products will be used as a quality control tool and to track project progress. Final editing of the survey data will occur after demobilization from the site has occurred.

CARIS HIPS software will be used to process and convert sounding data into final positions and elevations: During post processing, the multibeam data will be corrected for tide, true heave, pitch, roll, and speed of sound, and anomalous data will be removed by means of manual and automatic filtering. Multibeam calibration offsets from patch test results will also be applied during the CARIS editing process. During editing and processing, each survey line will be individually reviewed. This review consists of visual and automated inspection of speed of sound data, RTK tides, RTK GPS position data, motion sensor data, and sounding data. Anomalous data that are obvious system errors or "noise" within the water column, such as air bubbles, suspended particles and fish, and bottom multiples, will be filtered from the final data set. Manual editing will be based on a comparison of data outliers with surrounding data points in addition to field and data file notes.

Automated editing of the data may consist of removing all data points that were not flagged as quality three data points. Data flagged as quality three points are data that have passed the SeaBat processor's brightness and co-linearity quality assessment. The co-linearity test compares each beam bottom detection with returns from surrounding beams and verifies that it is within the range specified. The brightness test compares the brightness of the center bottom detect from each beam with the surrounding beams. Use of these criteria for automated removal of erroneous points (outliers) reduced the number of points that required manual inspection and removal.

Additional manual editing in CARIS can be conducted by means of the Subset editing tool. With subset editing the user can view and edit 3D point clouds of data from any subset area of the survey area. This allows the user to view soundings from multiple survey lines and make informed decisions when choosing to remove points. These points will not be deleted from the original data files; instead, they will be

marked for exclusion from the final dataset used to generate a digital terrain model (DTM). Rejected data points can be viewed, re-evaluated, and/or used in future studies.

Processed and reduced data from CARIS will be imported into Fledermaus Pro software for a final quality control check and data exported for final chart production.

17.2.7 MBE Quality Control (QC)

Tetra Tech's data quality is established at the time of data collection through proper setup and operation of the survey systems and cannot be enhanced during processing, other than to remove invalid data. Survey, data processing, and QC procedures will comply and be documented to be consistent with the applicable guidelines provided in SOP 01 by the USACE.

Data quality can be assessed explicitly; a single data element is compared directly to a standard or known control. Alternatively, quality can be assessed implicitly; combinations of data elements are compared to members of their own set for internal consistency. Additionally, quality can be measured quantitatively (numerically) or qualitatively, requiring interpretation on the part of an operator.

For each step of the setup and operation of the survey system, a series of checks are run on the equipment and data collection software configuration. Where possible, a quantitative measurement of data quality is identified for each data type acquired. Procedures are constructed to measure this quantity as near as practicable to the point of acquisition. These measurements of quality are continually assessed throughout the acquisition and processing phases of the project. Where a quantitative measure of data quality cannot be developed, an interpretive or qualitative method is used to estimate data quality.

Data that fail to meet minimum quality standards will be discarded and re-acquired if necessary (based on completeness as defined in Table 12-1). A number of individual data elements are required to calculate a sounding. These include sounder data, vessel attitude, sound velocity profiler, tide, draft, and position. The failure of any data element to meet minimal quality requirements will result in the dismissal of the entire concurrent data set.

Field methods used for measuring data quality begin with position accuracy. At the completion of each survey line, the ISFL reviews the positions of identifiable features in the on-line HYPACK/HYSWEEP coverage plots. This software allows the user to compare the results of the measured positions for consistency within the lines and against external references. Positions of well-defined features, mapped on overlapping lines, will meet or exceed Special Order USACE Hydrographic Survey standards

(Appendix A). Motion data are also scrutinized in HYSWEEP. These data are more difficult than vessel position to QC because there is only one system and it cannot be checked against itself. Consequently, the heave component of the motion data set is merged with the soundings from the vertical beam. A timing error in either of these systems will result in a residual oscillation in the measured depth. Amplitude errors in the heave record will have a similar effect (residual oscillations in the measured depths, "phantom sand waves/ripples").

Sounding data from the MBE are subject to interpretive and quantitative measurements of data quality. During acquisition, sonar operators monitor data quality on the multi-beam monitor and HYPACK acquisition screens. The general noise level of the soundings and useable swath width is visible on the SeaBat monitor. Custom screens in HYPACK and HYSWEEP allow the operator to view a DTM of average depths, waterfall displays, and individual profiles. These displays require interpretation and are used as the first quality check on multi-beam data.

The data will be viewed again as they are cleaned (flagged for exclusion from the final data set) and edited. In HYSWEEP and CARIS lines can be examined for errors associated with poor horizontal and vertical positioning, motion artifacts and sound velocity. By this time, however, the multibeam data are bundled with all their ancillary data elements: sound velocity profiler (SVP), tide, static draft, squat and settlement, heave, pitch, and roll.

The final quality assessment for the data set is conducted with Fledermaus Pro software. Production line data are compared to a DTM created from a cross line. Differences between the soundings and the surface are tabulated for each beam and evaluated with respect to an accuracy standard, in this case, an USACE Special Order specification. Compliance with the specification must exceed 95 %.

The visualization tools available in the processing software provide clear indications of any problems in the motion sensor data or in the time correlation of the echosounder and motion data. Significant errors related to these types of sensor problems result in identifiable data artifacts. Conducting preliminary processing of the bathymetry data on the vessel in real time will allow any problems to be identified and corrected quickly, thus minimizing the potential of having to recollect data.

Cross lines, 45° to 90° offset from the main survey lines, will be used to validate the survey data. Through comparison of the main lines and cross lines, it is possible to assess the accuracy of the bottom measurements across the usable swath and to determine the accuracy of the patch test installation calibration and the validity of the corrections for changing sound speeds through the water column. A set of QC tools in HYPACK, Fledermaus, and/or CARIS will be used to provide a quantitative analysis of the

correlation between the main and cross lines. These results will be reported relative to the appropriate USACE standards (found in SOP 01).

17.2.8 MBE Data Deliverables

A combination of Fledermaus Pro, ArcMap, and Tetra Tech-developed software will be used to generate final data products and to down-sample the high resolution multi-beam data into a DTM which will be based on a 1-meter grid (or less). The minimum number of points required per grid will be one, ensuring that all data collected would be represented. Any 1 meter grid cell without a sounding will be shown as a hole, or "holiday," in the data set (unless interpolation is requested). Charts displaying the site bathymetry and mapped features will be generated in the project datum at a scale, which will be pertinent for site evaluation. Survey units will be US survey feet.

The data products will include a set of GIS chart layers showing the results of the acoustic and magnetic surveys, as well as target picks and features derived from the geophysical survey data. Charts and supporting data will be provided in hardcopy and electronic forms, as required by the client.

17.3 IN-WATER GEOPHYSICAL SURVEYS

Following the hydrographic survey a series of transects will be mapped using either an underwater MGA or BTEM to determine the density and distribution of metallic items in areas of interest. The preliminary transect layout is shown on Figure 17-1.

17.4 MGA SURVEY

17.4.1 MGA Equipment

The magnetometer towfish will be deployed with a surface towed floatation package and be located approximately 30 feet astern of the vessel. The flotation package is adjustable, and allows tow depths to be varied from the surface to near full water depth. A noise test will be performed during the initial equipment checkout to be sure the layback distance is adequate to exclude any magnetic affect from the survey vessel. Table 17-4 contains a description of the proposed gradiometer and supporting hardware and software system components.

The magnetometer data will be acquired at a rate of 2 to 4 measurements/second resulting in an average sample density of approximately 3 to 4 feet along each transect. The data will be displayed on a computer high-resolution monitor in real-time and will be interfaced with the navigation system. The data

will be stored on a digital acquisition and processing system. Position information from the navigation system will also be archived with the digital magnetic data.

Table 17-4. MGA System Components

System	Manufacturer & Model	Parameters
MGA	Marine Magnetics/SeaQuest	Four sensor 3-D Overhauser gradiometer
Magnetometer (backup)	Marine Magnetics/SeaSpy	Single sensor Overhauser magnetometer
Magnetometer Acquisition	SeaLINK / HyPack	Time and position tagged raw data
Magnetometer Processing	Tetra Tech developed software, and Geosoft Oasis Montaj	Corrected, filtered and gridded data
Magnetometer Layback	Digital Cable Counter and/or USBL	Layback in 0.1-feet increments / 0.2% of slant range
Global Positioning System	Leica 1230 RTK GPS/Applanix POS M/V 320/Wavemaster	Kinematic mode – Horizontal: 1-2 centimeter + 1ppm Vertical: 2 centimeter + 1ppm

17.4.2 MGA Data Processing/Analysis

The magnetic data for each sensor in the array will be corrected for diurnal variations, platform attitude, bias, and the regional geomagnetic field datum using proprietary Tetra Tech software. Multiple magnetic gradients will be calculated (horizontal and vertical) and the gradient data will be also used to calculate the analytic signal for the array platform. The horizontal and vertical gradients, analytic signal, and total magnetic field data for each sensor will be interpolated (i.e., gridded) using Geosoft's Oasis Montaj V7.1.to generate color coded images. These images will be used in conjunction with the MBE data to identify individual anomalies that may be MEC and regions of the site that have a higher probability of containing MEC items. Selection criteria for Individual anomalies will be based upon the results from the IVS. Potential MEC areas may be identified using criteria such as anomaly patterns and amplitude response.

Pre-defined Oasis Montaj scripts are used for all data processing and analysis steps (e.g., import *.xyz file and generate database, calculate gradients, drift correction, interpolate data, contour data) in order to eliminate computer keyboard errors during these processes.

17.4.3 MGA QC

QC of the magnetic data will be done in real-time by observing the quality of the data profiles shown on the computer display. Tetra Tech's data quality is established at the time of data collection through

proper setup and operation of the survey systems, and cannot be enhanced during processing, other than to remove invalid data, or apply data filters.

Data quality can be assessed explicitly; a single data element is compared directly to a standard or known control. Alternatively, quality can be assessed implicitly; combinations of data elements are compared to members of their own set for internal consistency. Additionally, quality can be measured quantitatively (numerically) or qualitatively, requiring interpretation on the part of an operator.

For each step of the setup and operation of the survey system, a series of function checks are run on the equipment and data collection software configuration. Where possible, a quantitative measurement of data quality is identified for each data type acquired. Procedures are constructed to measure this quantity as near as practicable to the point of acquisition.. These measurements of quality are continually assessed throughout the acquisition and processing phases of the project. Where a quantitative measure of data quality cannot be developed, an interpretive or qualitative method is used to estimate data quality.

Data that fail to meet minimum quality standards will be discarded and re-acquired if necessary (based on completeness as defined in Table 12-1). A number of individual data elements are required to calculate a magnetometer reading with its associated position. These include magnetometer data, vessel attitude and position, USBL transponder/responder position, array attitude, depth, altitude, and heading.

The software used for data collection provides a visual display for each individual sensor. During data collection, the relative quality of the data can be assessed by 1) comparing the data from individual sensors in areas of "background" (i.e., no metal or magnetic geology), 2) comparing the sensor responses when the platform travels over ferrous metal, and 3) monitoring the map that displays the location of the vessel, towfish, and survey coverage.

Other measures of data quality include the resurvey of a percentage of the transect length each day (re: Table 12-1) and the use of "cross-lines". Cross-lines involve the collection of data at different angles (e.g., 45° to 90°) compared to the original transect orientation. The cross line and original transect data that are coincident can be compared in terms of the repeatability of the sensor response and used as a quality tool to ensure the geophysical data are of sufficient quality to meet the project objectives.

Trained operators will also be able to identify any data issues resulting from background noise that can result from factors such as having the array too close to magnetic sources on the survey vessel, or the presence of significant geological magnetic interference.

The performance of the sensors and the accuracy of the towfish navigation will be verified on a daily basis using the IVS. The seed items selected for the IVS (Table 12-2) are representative of the types of MEC expected in the survey area. IVS seed items will be located using RTK GPS and/or USBL positioning, prior to data being collected with the geophysical sensor systems. The resulting data will be analyzed to ensure that the performance metrics in Table 12-1 are achieved.

17.4.4 MGA Data Deliverables

The MGA data will be color-coded and displayed on a GIS and/or CAD compatible map. The processed data will also be provided as a digital file (x,y,z^1, z^2.....) in ASCII format with header information for each data channel.

The geophysical team will prepare a detailed map and anomaly target list that depicts the northing and easting of all anomalies (or anomaly cluster areas). Each anomaly (or cluster) will be assigned a unique reference number for tracking and reporting. A Microsoft® Excel compatible target detection list will show significant feature detections with:

1. locations
2. detection method(s)
3. mass of object or relative size
4. estimated depth, and proud
5. data analyst comments.

17.5 TDEMI OPTION (BTEM)

TDEMI methods can be used to locate ferrous and nonferrous metals. Manufactured materials that are metallic produce significant, sharp contrasts with the surrounding natural geologic media. The primary factors that affect the detectability of objects or features with TDEMI methods include volumetric size and orientation of the target, distance from the sensor, and the conductive contrast between the object or feature and the surrounding medium.

The depth of investigation using TDEMI methods is related to the coil separation and/or size, coil orientation, and the frequency or time duration of the transmitted signal. In general, the use of lower frequencies will result in greater depth penetration and reduced spatial resolution of conductive and magnetic objects and features.

17.5.1 Principles of Operation

The proposed TDEMI instrumentation operates on a principle commonly referred to as time-domain. TDEMI refers to a system in which a coil generates a pulsed (i.e., time based) primary magnetic field into the Earth that induces eddy currents in conductive materials. The decay of these eddy currents produces a secondary magnetic field measured by the same coil. If the secondary field is measured at a relatively long time after termination of the primary pulse, the current induced in the relatively non-conductive ground will fully dissipate, while the current in the conductive media (fabricated metallic objects) will continue to produce a secondary magnetic field. The measured response is reported in units of mV. Electromagnetic data are generally acquired over a predetermined grid at a line and station interval consistent with the anticipated size of the items or features of interest. These data provide a spatial distribution of the instrument response over the surveyed area.

17.5.2 Instrumentation

If the TDEMI option is applicable and available, Tetra Tech will utilize an in-house designed BTEM. The array is 4 meters wide and contains three EM61-MK2 coils (1 meter x 0.5 meter) spaced 0.5 meters apart. The array is designed to glide along the bottom, to obtain the strongest signal and therefore the greatest depth of detection of metallic items. BTEM signal response falls off, as the sixth power of the distance, so standoff distance from the items of interest must be minimized to detect smaller items.

To further increase the detection range, the Geonics EM61-MK2 Time-Domain Metal Detector (EM61-MK2 HP) used in the BTEM can be operated in high power mode. The high power modification provides an eight-fold increase in the amount of signal transmitted by a standard transmitter coil, which can result in improvements in the signal-to-noise ratio. High Power mode will be tested on site, but may not be utilized, or may only be utilized in some areas, depending on testing results.

The EM61-MK2 is relatively insensitive (compared to the MGA) to nearby cultural interferences such as large metal structures, power lines, etc., and has the ability to record digital data at 0.0625 second intervals, which, using a 1 meter per second speed (2 knots), translates into a spatial sample density of approximately 0.07 meter (0.23 feet) along track. At 1.5 meters per second (3 knots) the spatial sample density is approximately 0.1 meter (0.33 feet) along track.

The EM61-MK2 HP can measure multiple time gates (216, 366, 660, and 1,266 microseconds) to provide a more complete measurement of the response decay rate.

17.5.3 TDEMI Option (BTEM) Data Collection

The BTEM will be towed on or near the bottom using predefined, parallel one-dimensional (1-D) transects that coincide with the transects used for the hydrographic surveys. In areas of the site where there are features such as depressions and debris, as determined by the hydrographic survey, the location and orientation of the pre-defined transects may be modified to allow for the safe collection of BTEM data.

17.5.4 TDEMI Option (BTEM) Data Processing/Analysis

Data from the TDEMI array (BTEM) is processed and analyzed by a combination of software developed by Geonics and Geosoft. TDEMI data is converted from binary to ASCII format and merged with the position data using Geonics' DAT61 v2.37 software. The data is then imported to Geosoft Oasis Montaj v7.1 and the data is corrected for instrument latency and drift.

Prior to interpretation, color-coded images of all the TDEMI (BTEM) sensor information are generated using Oasis Montaj's gridding algorithm. These images will be used in conjunction with the MBE data to identify individual anomalies that may be MEC and regions of the site that have a higher probability of containing MEC items. Selection criteria for individual anomalies will be based upon the results from the IVS. Potential MEC areas may be identified using criteria such as anomaly patterns and amplitude response.

Pre-defined Oasis Montaj scripts are used for all data processing and analysis steps (e.g., import *.xyz file and generate database, sum data channels, drift correction, interpolate data, contour data) in order to eliminate computer keyboard errors during these processes

17.5.5 TDEMI Option (BTEM) Data QA/QC

QA/QC of the electromagnetic data will be done in real-time by observing the quality of the data profiles displayed on the computer display. Tetra Tech's data quality is established at the time of data collection through proper setup and operation of the survey systems, and cannot be enhanced during processing, other than to remove invalid data, or apply data filters.

Data quality can be assessed explicitly; a single data element is compared directly to a standard or known control. Alternatively, quality can be assessed implicitly; combinations of data elements are compared to members of their own set for internal consistency. Additionally, quality can be measured quantitatively (numerically) or qualitatively, requiring interpretation on the part of an operator.

For each step of the setup and operation of the survey system, a series of function checks are run on the equipment and data collection software configuration. Where possible, a quantitative measurement of data quality is identified for each data type acquired. Procedures are constructed to measure this quantity as near as practicable to the point of acquisition. These measurements of quality are continually assessed throughout the acquisition and processing phases of the project. Where a quantitative measure of data quality cannot be developed, an interpretive or qualitative method is used to estimate data quality.

Data that fail to meet minimum quality standards will be discarded and re-acquired if necessary (based on completeness as defined in Table 12-1). A number of individual data elements are required to calculate a TDEMI reading with its associated position. These include electromagnetic data, vessel attitude and position, USBL transponder/responder position, array attitude, depth, altitude, and heading. The failure of any data element to meet minimal quality requirements will result reliance on a back-up system, interpolation or if necessary, in the dismissal of the entire concurrent data set (TDEMI readings).

The software used for data collection will provide visual indications of any problems with individual sensors, both by showing any anomalies in the individual sensor time series, and through comparison with the data from the other sensors.

Trained operators will also be able to identify any data issues resulting from background noise that can result from factors such as having the array too close to electromagnetic sources on the survey vessel.

The performance of the sensors and the accuracy of the tow body navigation will be verified using the IVS seeded targets in an area that has been surveyed to ensure there is a minimum of background signals from either natural sources or fabricated debris. These targets will be selected to have magnetic signatures representative of the types of MEC expected in the survey area. The IVS seeded targets will be laid out using USBL with RTK GPS positioning, then surveyed in multiple directions with the BTEM system. Any differences between the measured and surveyed positions for IVS seed items will be analyzed to determine if the DQOs have been achieved.

The final quality assessment for the data set is conducted after filters have been applied and data have been gridded.

QC lines, cross lines, 45° to 90° offset from the main survey lines and/or repeated lines (resurvey of a section of a line), will be used to validate the survey data. Through comparison of the main lines and QC lines, it is possible to assess the accuracy of the TDEMI measurements

17.5.6 BTEM Data Deliverables

The BTEM data will be color-coded and displayed on a GIS and/or CAD compatible map. The processed data will also be provided as a digital file (x,y,z1, z2.....) in ASCII format with header information for each data channel.

The geophysical team will prepare a detailed map and anomaly target list that depicts the northing and easting of all anomalies (or anomaly cluster areas). Each anomaly (or cluster) will be assigned a unique reference number for tracking and reporting. A Microsoft® Excel compatible target detection list will show significant feature detections with:

1. locations
2. detection method(s)
3. relative size
4. estimated depth, and proud
5. data analyst comments.

17.5.7 Programmatic Geophysical Data QC Overview

Field personnel, data processors, and data interpreters implement our QC Program in a consistent, systematic fashion. Our geophysics QC Program includes a battery of pre-project tests, and once the project has started, a test regimen is applied for each acquisition session. The test regimen includes functional checks to ensure the position and proper functioning of geophysical sensor instrumentation prior to and at the end of each data acquisition session. Processing checks to ensure the data collected are of sufficient quality and quantity to meet the project objectives, and interpretation checks to ensure the processed data are representative of the site conditions complete the test regimen.

Pre-project tests include functional checks to ensure the position and geophysical sensor instrumentation is operating within their defined parameters. Operational and test procedures will conform to the manufacturer's standard instructions. QC of the instruments' data will be achieved daily by field testing, checking the sensor and navigation system against a known target to ensure that they are operating properly. All geophysical instruments and equipment used to gather and generate field data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of the results are consistent with the manufacturer's specifications. Calibration, repair, or replacement records will be

filed and maintained by the field geophysicist and may be subject to audit by the QA manager. Data processing QC is required to assure data quality. Potential data problems include source data errors, data entry errors, data editing errors, and user errors. All data will be reviewed to identify and correct any of these errors should they occur. A portion of each data file will contain overlap (reacquisition of a survey line, a cross line, or a diagonal line) such that drift and repeatability can be monitored.

SAP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Exclusion Areas	Matrix	Approximate Depth (bgs)	Survey Methodology	Degree of Investigation	SOP Name[1]
Consecutively numbered transects beginning with No. 1. Transects will typically be oriented parallel to bottom contours. The same transects will be used for MBE and geophysical survey (See Figure 17-1)	Areas with rock outcrops or other obstacles; areas where water is too shallow for safe survey operations	Sediments; non-intrusive	NA	MBE, MGA and/or BTEM	100% of transect area shown on Figure 17-1 for all surveys	Procedures in UFP-SAP; SOP 01,
Cross lines for QC of MBE data at a rate of 1 cross line per 10 sampling transects This will also apply to BTEM data, if used	Areas with rock outcrops or other obstacles; areas where water is too shallow for safe survey operations	Sediments; non-intrusive	NA	MBE and BTEM	Transects 45° – 90° rotation from sampling transects NOTE: If sampling transects cross at angles within this range they may serve as the QC transects.	Procedures in UFP-SAP; SOP 01,
Re-mapping of transects for QC of MGA data at a minimum rate of 5 % of the linear sampling transect length	Areas with rock outcrops or other obstacles; areas where water is too shallow for safe survey operations	Sediments; non-intrusive	NA	MGA	Overlying sampling transects	Procedures in UFP-SAP; SOP 01,

bgs – below ground surface
(1) SOPs can be found in Appendix A of the MEC UFP-SAP.

SAP Worksheet #19 -- Analytical SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

☑ **Worksheet Not Applicable**

No laboratory samples are proposed for collection/analysis during this MEC investigation.

SAP Worksheet #20 -- Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Characterization Procedure	Number of Units	Field Duplicates/Repeat Data Collection	Number of Seed Items	Quality Control
lake bottom	MBE	Cross Lines for QC of MBE data at a rate of 1 cross line per 20 sampling transects.	Not Applicable	NA, IVS	Survey cross lines (typically at 45° or 90° to MBE study transects) to perform direct comparison of co-incident points where transects cross. If a point to surface comparison conducted between the survey and the cross line does not meet the specified USACE Hydrographic survey standards, the survey team will reprocess and analyze the MBE and attitude sensor data to determine the root of the problem. If the failure cannot be resolved through reprocessing, the data will be rejected and recollected if necessary to meet completeness criteria or eliminate large gaps in the data set.
sediment	MGA	Repeat transects for QC of magnetometer at a minimum rate of 5% of the linear transect length.	Not Applicable	NA, IVS	Resurvey transects to perform a direct comparison to field data collected during MGA survey. If the location of targets varies by more than 1 meter, the survey team will reprocess and analyze the MGA and attitude sensor data to determine the root cause. If the failure cannot be resolved through reprocessing, the data will be rejected and recollected if necessary to meet completeness criteria or eliminate large gaps in the data set.

Matrix	Characterization Procedure	Number of Units	Field Duplicates/Repeat Data Collection	Number of Seed Items	Quality Control
sediment	TDEMI Array (BTEM)	Cross Lines for QC of TDEMI data at a rate of 1 cross line per 20 sampling transects.	Not Applicable	NA, IVS	Survey cross lines (typically at 45° or 90° to BTEM study transects) to perform direct comparison of co-incident points. If the signal at the intersections varies by more than 6 millivolts when flight altitude varies by less 0.5 meters, the survey team will reprocess and analyze the BTEM data to determine the root of the problem. If the failure cannot be resolved through reprocessing, the data will be rejected and recollected if necessary to meet completeness criteria or eliminate large gaps in the data set.

SAP Worksheet #21 -- Project SOP References Table

(UFP-QAPP Manual Section 3.1.2)

Reference Number	Title	Originating Organization of SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP 01	Hydrographic Surveying Engineering Manual (EM 1110-2-1003 and appendices)	USACE	Various system components	N	
SOP 02	Data Processing for MGA and BTEM	Tetra Tech	NA	N	

Note: SOPs are contained in Appendix A of this UFP-SAP.

SAP Worksheet #22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity[1]	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[2]	Comments
RESON Seabat(s) 7125 or R2Sonic 2024	Field Operation Verification	Initial with equipment install and then as indicated by the software	Acceptable variation from conditions observed during initial patch test as registered and determined by the software	Recalibrate, adjust or repair	ISFL	NA	
Applanix POS MV 320/ Wavemaster	Field Operation Verification	Daily	Consistent results over IVS	Recalibrate, adjust or repair	ISFL	NA	
HYPACK Inc.	Field Operation Verification	Daily	Consistent results over IVS	Recalibrate, adjust or repair	ISFL	NA	
IVS 3D	Field Operation Verification	Daily	Consistent results over IVS	Recalibrate, adjust or repair	ISFL	NA	
Leica 1230 RTK GPS/Applanix POS (M/V) Wavemaster	Field Operation Verification	Daily	Checks against known control points ± 0.02 meter	Recalibrate, adjust or repair	ISFL	NA	
SeaBird SBE-19/FSI NXIC	Field Operation Verification	Daily	Cross checks with Microcat at specific depth	Recalibrate, adjust or repair	ISFL	NA	
SeaBird 37 Microcat	Field Operation Verification	Daily	Cross checks with SBE-19/FSI NXIC at specific depths	Recalibrate, adjust or repair	ISFL	NA	
MGA and/or BTEM	Field Operation Verification	Daily	Detection of all ferrous items in IVS	Recalibrate, adjust or repair	ISFL	NA	

1 Activities may include calibration, verification, testing, and maintenance.
2 Manufacturer instructions will be followed for calibration, maintenance and testing.

SAP Worksheet #23 -- Analytical SOP References Table

(UFP-QAPP Manual Section 3.2.1)

☑ **Worksheet Not Applicable**

No laboratory samples are proposed for collection/analysis during this MEC investigation (See Worksheet #21 for project SOPs).

SAP Worksheet #24 -- Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

☑ **Worksheet Not Applicable**

No analytical instrument calibration data will be required to support MEC geophysics surveys/investigations (see Worksheet #22 for geophysical equipment calibrations).

SAP Worksheet #25 -- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.2.3)

☑ **Worksheet Not Applicable**

No analytical instrument equipment maintenance, testing, or inspections will be required to support the MEC investigations. Field instrumentation maintenance, testing, and inspection for geophysics sensors and magnetometers are presented in Worksheet #22.

SAP Worksheet #26 -- MPPEH Handling System

(UFP-QAPP Manual Appendix A)

☑ **Worksheet Not Applicable**

This worksheet is not applicable because this investigation is a SI and no MPPEH will be handled.

SAP Worksheet #27 -- Sample Custody Requirements Table

(UFP-QAPP Manual Section 3.3.3)

☑ **Worksheet Not Applicable**

No samples are proposed for collection/analysis and no MPPEH will be handled during the SI covered by this UFP-SAP.

SAP Worksheet #28 -- Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

☑ **Worksheet Not Applicable**

No analytical laboratory QC sampling will be required for this UFP-SAP to support these MEC investigations.

SAP Worksheet #29 -- Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

Document/Record	Generator	Definable Feature of Work	Frequency of Completion	Where Maintained
UFP-SAP Approval Letters or emails	PM, Illinois EPA	Planning	One time	PF
Verification Email or Worksheet #4– Read UFP-SAP	Navy, Field Personnel	Planning	One time	PF
Explosives Safety Submission (ESS) Determination	PM	Mobilization	One time	SI/PF
Field Checklists	Field Geophysical Personnel	Field surveys (Hydrographic and Geophysical)	Field collection days	SI/PF
Daily Reports	ISFL	Hydrographic and In-water Geophysical Surveys	Field collection days	SI/PF
Medical and OSHA Clearance Letter	HSM, HSO, and PM	All	As needed	PF
Daily Safety Meeting Sign-In	SSO	All	Daily	SI/PF
Medical Data Sheet	All Field Personnel	All	As needed	PF
Field notes/survey logs (detailing equipment and procedure)	ISFL	Field Surveys (Hydrographic and Geophysical)	Field collection days	PF
Raw Hydrographic and Geophysical Survey Data	ISFL	Geophysical and Hydrographic Data Collection	Field collection days	PF/NIRIS
Processed Hydrographic and Geophysical Survey Data	ISFL	Geophysical and Hydrographic Data Collection	Provided at end of project	PF/NIRIS

Document/Record	Generator	Definable Feature of Work	Frequency of Completion	Where Maintained
Assessment findings	Various (see Worksheet #31)	All	As needed	SI/PF
Quality Control Surveillance Report	In-water Survey QC Manager	Hydrographic and In-water Geophysical Surveys	In-water Survey Manager- daily	SI/PF
Daily Quality Control Report	ISFL	Field surveys	Daily	SI/PF
Processed final format files (maps) compatible with ArcView Version 8 or specified GIS platform	Geophysicists and Hydrographers	Geophysical and Hydrographic Surveys	One time	SI/PF/NIRIS
Photographs (may be included in report)	Field Geophysical Personnel	Field surveys	As needed	SI/PF
Field Audit Checklist (if an audit is conducted)	PM	Field surveys	As needed	SI/PF
SI Report	Tetra Tech Personnel	SI project work	One time	SI/PF
Daily Reports	ISFL	Hydrographic and In-water Geophysical Surveys	Field collection days	SI/PF

Notes:
SI – Site Inspection Report
PF – Project File
NIRIS – Naval Installation Restoration Information Solution
OSHA - Occupational Safety and Health Administration

Project documentation will be maintained in the Tetra Tech project file. Processed final format files (maps) compatible with Arcview Version 8 or specified GIS platform will be maintained in the Tetra Tech GIS server and Naval Installation Restoration Information Solution (NIRIS).

SAP Worksheet #30 -- Analytical Services Table

(UFP-QAPP Manual Section 3.5.2.3)

☑ **Worksheet Not Applicable**

No analytical services will be required to support MEC investigations.

SAP Worksheet #31 -- Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment[1]	Person(s) Responsible for Responding to Assessment Findings[1]	Person(s) Responsible for Identifying and Implementing Corrective Actions[1]	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions[1]
Personnel Qualifications	One time for all field personnel	Internal	Tetra Tech	ISFL	ISFL	In-water Survey Manager and/or In-water QC Manager	PM
Site-Specific Training	Once at start of fieldwork and at start of each definable feature of work	Internal	Tetra Tech	ISFL PM	ISFL	ISFL	PM
Visitor Briefing	Initial, then as needed to support operations	Internal	Tetra Tech	Project Safety Officer	SSO	SSO	HSO
Accident/ Incident Reporting	Per event	Internal	Tetra Tech	SSO	HSM, HSO	HSM HSO PM	HSM, HSO
Preventive Maintenance	Daily	Internal	Tetra Tech	ISFL	ISFL	ISFL and/or In-water MBE or GP QC Manager	PM
Communications Equipment Inspection	Daily	Internal	Tetra Tech	ISFL ISFL	ISFL and vessel Captain	In-water Survey Manager and/or In-water QC Manager	PM

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment[1]	Person(s) Responsible for Responding to Assessment Findings[1]	Person(s) Responsible for Identifying and Implementing Corrective Actions[1]	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions[1]
Safety Inspections	Daily (inspection) Weekly (formal surveillance)	Internal	Tetra Tech	SSO	ISFL and vessel captain.	In-water Survey Manager	PM
IVS – Field Oversight	once	Internal	Tetra Tech	ISFL	ISFL	ISFL and/or in-water QC Manager	In-water Survey Manager
Daily field checklists, geophysical	Daily during survey performance	Internal	Tetra Tech	ISFL	ISFL	ISFL and/or In-water QC Manager	In-water Survey Manager
Geophysical Survey – Field Notes Audit	Once during start of fieldwork, and after survey completion	Internal	Tetra Tech	ISFL	ISFL	ISFL and/or In-water QC Manager	In-water Survey Manager
Geophysical Survey – SOP Conformance (SOP 01)	Weekly during survey performance	Internal	Tetra Tech	ISFL	ISFL	ISFL and/or In-water QC Manager	In-water Survey Manager
Geophysical Data – General Appearance Assessment	Daily/after data are processed	Internal	Tetra Tech	ISFL	ISFL	ISFL and/or In-water QC Manager	In-water Survey Manager
Surveying and Mapping Operations	Initial, then Weekly	Internal	Tetra Tech	ISFL	ISFL	ISFL and/or In-water QC Manager	In-water Survey Manager
Data Processing and Interpretation	Weekly	Internal	Tetra Tech	ISFL	ISFL	ISFL and/or in-water QC Manager	In-water Survey Lead

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment[1]	Person(s) Responsible for Responding to Assessment Findings[1]	Person(s) Responsible for Identifying and Implementing Corrective Actions[1]	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions[1]
Field Work Systems Audit	1 per contract year	Internal	Tetra Tech	QAM	Project Geophysicist UXO Manager PM	QAM Project Geophysicist UXO Manager	QAMPM

1 Tetra Tech personnel unless otherwise noted. ISFL support will be provided by Tetra Tech.

SAP Worksheet #32 -- Assessment Findings and Corrective Action Responses

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Timeframe for Response
Personnel Qualifications	e-mail	Ralph Basinski– PM, Tetra Tech	Immediately upon discovery	e-mail	Ralph Basinski– PM, Tetra Tech	Prior to initiation of task
Accident/Incident Reporting	Accident/Incident Report Form	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech Matt Soltis – HSM, Tetra Tech Grey Coppi - HSO, Tetra Tech	Immediately	Dependent upon accident/incident	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech Matt Soltis – HSM, Tetra Tech Grey Coppi - HSO, Tetra Tech	Within 24 hours
Preventive Maintenance	Field Forms	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours	Field Forms	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours
Communications Equipment Inspection	Field Forms	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours	Field Forms	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Timeframe for Response
Safety Inspections	Field Forms	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours	Field Forms	Bob Feldpausch – In-water Survey Manager Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours
IVS – Assessment	Oral	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours	e-mail	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours
Daily Field Checklists, geophysical	Oral and e-mail or fax	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours after assessment	Updated Geophysical Field Checklist and Forms	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 48 hours
Geophysical Survey – Field Notes Audit	Letter/e-mail	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 5 business days of receipt	Complete Field Notes	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 5 business days of receipt
Geophysical Survey – Conformance to SOP 01	Letter/e-mail	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 5 business days of assessment	Justification or clarification of procedure to be provided in letter correspondence	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 5 business days of receipt
Geophysical Data – General Appearance Assessment	e-mail	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours	e-mail	Bob Feldpausch – In-water Survey Manager, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 48 hours

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Timeframe for Response
Surveying and Mapping Operations	Initial via e-mail, then Weekly	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours	Updated e-mail	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 48 hours
Data Processing and Interpretation	Weekly	Internal	Tetra Tech	ISFL	Richard Funk- ISFL, Tetra Tech	Within 48 hours
Surveillance, Inspection, Audit (internal or external	Nonconformance Report (NCR) or Deficiency Notice (DN)	Site QC Manager, internal Navy QC Program QC Manager, Tetra Tech PM; Navy RPM	Within 24 hours	Recommendations on NCR or DN and Follow-on Surveillance and QC Reports	TBD	Within 48 hours
Visitor Briefing	e-mail	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours	Updated e-mail	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours
Site-Specific Training	e-mail	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Upon Completion of Training	Updated e-mail	Richard Funk- ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech	Within 24 hours
Field Work Systems Audit	Letter Report	Ralph Basinski– PM, Tetra Tech Tom Johnston – QAM, Tetra Tech	Within 5 business days of assessment	Letter Report	Ralph Basinski– PM, Tetra Tech Tom Johnston – QAM, Tetra Tech	Within 10 business days of receipt

SAP Worksheet #33 -- QA Management Reports Table

(UFP QAPP Manual Section 4.2)

Type of Report	**Frequency** (daily, weekly monthly, quarterly, annually, etc.)	**Projected Delivery Date(s)**	**Person(s) Responsible for Report Preparation** (title and organizational affiliation)	**Report Recipient(s)** (title and organizational affiliation)
Project monthly progress report	Monthly (written) for duration of the project	Monthly	PM Tetra Tech	Navy RPM NAVFAC
Field Status Reports	Daily (oral or email), during the course of fieldwork	TBD	ISFL Tetra Tech	PM Tetra Tech In-water Survey Manager Tetra Tech
Daily QC Report (Geophysics)	Daily (e-mail)	TBD	ISFL Tetra Tech	PM Tetra Tech In-water Survey Manager Tetra Tech
QC Meeting Minutes	Twice per month, during project performance	TBD	In-water Survey Manager Tetra Tech	PM Tetra Tech
Rework Items List	Twice per month, during project performance	TBD	In-water Survey Manager, Tetra Tech	PM Tetra Tech

Type of Report	**Frequency** (daily, weekly monthly, quarterly, annually, etc.)	**Projected Delivery Date(s)**	**Person(s) Responsible for Report Preparation** (title and organizational affiliation)	**Report Recipient(s)** (title and organizational affiliation)
Project QC Report	Internal draft, draft, and final (Appendix to SI MEC Report)	TBD	PM Tetra Tech In-water Survey Manager Tetra Tech	Navy RPM NAVFAC
Final Project Report	Once/after QA Management Reports and Risk Assessment completed	6 months following completion of field activities	Program QC Manager	Navy RPM
QC Project Checklist	Once at the beginning of each project	At first QC meeting	Program QC Manager	Navy RPM

This worksheet will be modified to include the project delivery dates after fieldwork is scheduled.

SAP Worksheet #34 -- Verification (Step I) Process Table - Preparatory and Initial Inspection

(UFP-QAPP Manual Section 5.2.1)

A preparatory phase inspection will be performed prior to beginning each definable feature of work. The purpose of this inspection is to review applicable specifications and verify the necessary resources, conditions, and controls are in place and compliant before start of work activities. An initial phase inspection will be performed at the beginning of each definable feature of work. The purpose of this inspection is to observe/review the application of procedures to ensure their adequacy, ensure adequate resources are applied to the activity and that a clear understanding exists as to the quality control requirements of the definable feature of work. The responsible person will inspect the relevant items from the checklist in the appropriate SOP.

Definable Feature of Work	Description of Verifications	Responsible for Verification (name, organization)
Planning/Site Preparation/mobilization	Project readiness review has been performed by Tetra Tech PM and Navy RPM including UFP-SAP review.	Ralph Basinski- PM, Tetra Tech
	GIS database structure is in place and correct.	Bob Feldpausch - In-water Studies Manager, Tetra Tech
	Site-specific training has been completed (sign in sheets) Personnel meet the training and certification requirements for the project (See Worksheet #7).	Richard Funk – ISFL, Tetra Tech
	Required training is complete (review of plans and SOPs) and personnel understand assigned duties and responsibilities.	Richard Funk – ISFL, Tetra Tech
	Navy RPM has reviewed mobilization and site preparation activities such as equipment setup and checkout, installation of IVS, and grid survey and layout.	Ralph Basinski- PM, Tetra Tech Howard Hickey - RPM, Navy
IVS	IVS has been conducted and verifies that performance criteria have been satisfactorily attained per Worksheet #12. The PM will review the recommendation of the In-water Survey Manager and provide final approval.	Bob Feldpausch - In-water Studies Manager, Tetra Tech

Definable Feature of Work	Description of Verifications	Responsible for Verification (name, organization)
Hydrographic Surveys (MBE) and Marine Gradiometer Array (MGA/BTEM)	Ensure equipment checks and calibrations are performed Ensure equipment is properly setup and deployed per the UFP-SAP and SOPs (altitude, vessel speed, etc.) Ensure proper content and format for field Notes and data files.	Richard Funk – ISFL, Tetra Tech
Hydrographic (MBE) and Marine Geophysical Data (MGA/BTEM) Processing, Analysis and Interpretation	Ensure that processing and analysis are performed per the UFP-SAP and SOPs. Ensure proper content and format for data sets, maps, graphs, and charts. Ensure raw data files are complete. Ensure that all data is backed up at the end of each day.	Richard Funk – ISFL, Tetra Tech
Demobilization	Ensure data collection is complete, all necessary QC has been performed and all data has been transferred to the PM or designee. Ensure that IVS is removed. Ensure equipment is accounted for, properly packed and shipped to storage or vendors.	Richard Funk – ISFL, Tetra Tech Ralph Basinski– PM, Tetra Tech Bob Feldpausch, Tetra Tech
Site Specific Final Report Preparation and approval	Verify that all data and documentation has been acquired for report preparation.	Ralph Basinski– PM, Tetra Tech

SAP Worksheet #35 – Validation (Step IIA and IIB) Process Table (Tier 2) QC Process Summary Table - Follow-Up Inspections

(UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)

Follow-up inspections are conducted to ensure that procedures are being correctly performed, no changed conditions exist which may affect the quality of work, and lessons learned are being applied as identified. The responsible individual will inspect the relevant follow-up items from the checklist in the appropriate SOP at least as often as specified in this worksheet. Worksheet #32 describes actions to be taken in the event that nonconforming conditions are observed during the QC inspections.

Definable Feature of Work	Frequency of Inspection	Supporting QC Document(s)	Responsible for Validation (name, organization)
Site Preparation (including mobilization)	NA/upon completion of SI field work	No follow-up required for Project Readiness. Verify that the UFP-SAP was implemented and carried out as written and that any deviations are documented.	Ralph Basinski-PM, Tetra Tech Howard Hickey-Navy RPM
Site Survey	Daily	Checklist and Field Log books, which document equipment utilization and progress.	Richard Funk-ISFL, Tetra Tech
IVS	Daily	Review data results of IVS.	Richard Funk-ISFL, Tetra Tech
Geophysical Data Collection	Once per day survey is conducted	Daily function tests, which may be documented on checklist, field forms, or via e-mail. Daily reports, general data appearance that document equipment utilized, areas surveyed.	Richard Funk-ISFL, Tetra Tech

Definable Feature of Work	Frequency of Inspection	Supporting QC Document(s)	Responsible for Validation (name, organization)
Geophysical Data Processing and Interpretation	After fieldwork is completed Once per day data is collected	Prior to entering data (field forms and electronic data) from the geophysics investigation into the permanent project database, the ISFL or designated representative will review the data to ensure that all required information is provided. (Geophysical Survey) and SOP 02 (Geophysical Data Processing and Analysis). Verify all data have been transferred correctly and completely during collection. Ensure that data are downloaded and backed up at least once per day to prevent accidental loss of data/field efforts.	Bob Feldpausch, In-water Studies Manager Tetra Tech Mike McGuire, GP QC, Tetra Tech Burr Bridge, MBE QC, Tetra Tech
Demobilization	Once upon completion of each phase of project/site	Verify that all demobilization activities, as applicable to phase of work, have been completed.	Ralph Basinski- PM, Tetra Tech Bob Feldpausch, In-water Studies Manager, Tetra Tech
Site Specific Final Report Preparation and approval	Once upon completion of the project/site activities	Verify that all activities have been documented and reported as applicable to each phase of work, have been included in the report.	Ralph Basinski- PM, Tetra Tech Howard Hickey - Navy RPM

SAP Worksheet #36 -- Analytical Data Validation (Steps IIA and IIB) Summary Table

(UFP-QAPP Manual Section 5.2.2.1)

Step IIa / IIb[1]	Matrix	Analytical Group	Validation Criteria	Data Validator (Title and organization)
IIa	Sediment	Hydrographic Survey (MBE)	Satisfactory rechecks of cross lines by the QC, or ISFL if no QC.	Burr Bridge, MBE QC Manager Tetra Tech
IIa	Sediment	Geophysics Investigation (MGA)	Achievement of goals established for the IVS and consistency in daily rechecks.	Mike McGuire, GP QC Manager Tetra Tech
IIa	Sediment	Geophysics Investigation (BTEM if selected)	Satisfactory rechecks of cross lines by the QC, or ISFL if no QC.	Mike McGuire, GP QC Manager Tetra Tech

1 IIa = compliance with methods, procedures, and contracts (see Table 10, page 117, UFP-QAPP manual, V.1 March 2005). IIb not applicable for MEC investigation.

SAP Worksheet #37 -- Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

DATA USABILITY ASSESSMENT

The usability of the data directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum. The results of these evaluations will be included in the project report. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound technical assessments of these data characteristics:

Certification of Proper Operation of Detection and Positioning Systems

The In-water Studies Manager, acting on behalf of the project team, will prepare a table listing planned calibration and QC checks, their occurrence and the results (acceptable or not acceptable) for each type of metal detector, geophysics instrument, and positioning system equipment that was used on the. Data collected by any improperly operating equipment will be identified. A determination will be made as to whether the affected data adversely affected the ability to meet project objectives. If the project objectives have been adversely impacted, the Tetra Tech PM will consult with the Navy RPM and other project team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

Qualification / Certification of Survey Team

The Tetra Tech PM, acting on behalf of the project team, will prepare a table listing each member of the aqueous geophysics team, which will list required certifications and training and required demonstrations of competency. Any deviations will be identified. Data collected by team members not meeting the required training and demonstrations of competency will be identified. A determination will be made as to whether affected data affected the ability to meet project objectives. If the project objectives have been adversely impacted, the Tetra Tech PM will consult with the Navy RPM and other project team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

Coverage of Areas to be Investigated

A project scientist, identified by the Tetra Tech PM and acting on behalf of the project team, will determine whether data was collected in all areas planned to be investigated as part of the SI. Data gaps

will be identified. The Tetra Tech PM will consult with the project team to determine the extent to which it is necessary to fill these data gaps in the RI phase.

Interpretation of Geophysical Data

A project scientist, acting on behalf of the project team, will analyze the geophysical interpretation and maps to check for completeness of anomaly interpretation (target picking), and whether acceptable anomaly selection criteria were applied in the interpretation of the data. Any deficiencies in anomaly interpretation will be identified, and their impact on the PQOs will be summarized.

Identify the personnel responsible for performing the usability assessment:

The Tetra Tech PM, In-water Studies Manager, and ISFL will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the Navy RPM and Illinois EPA. Either the review will take place in a face-to-face meeting or a teleconference depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

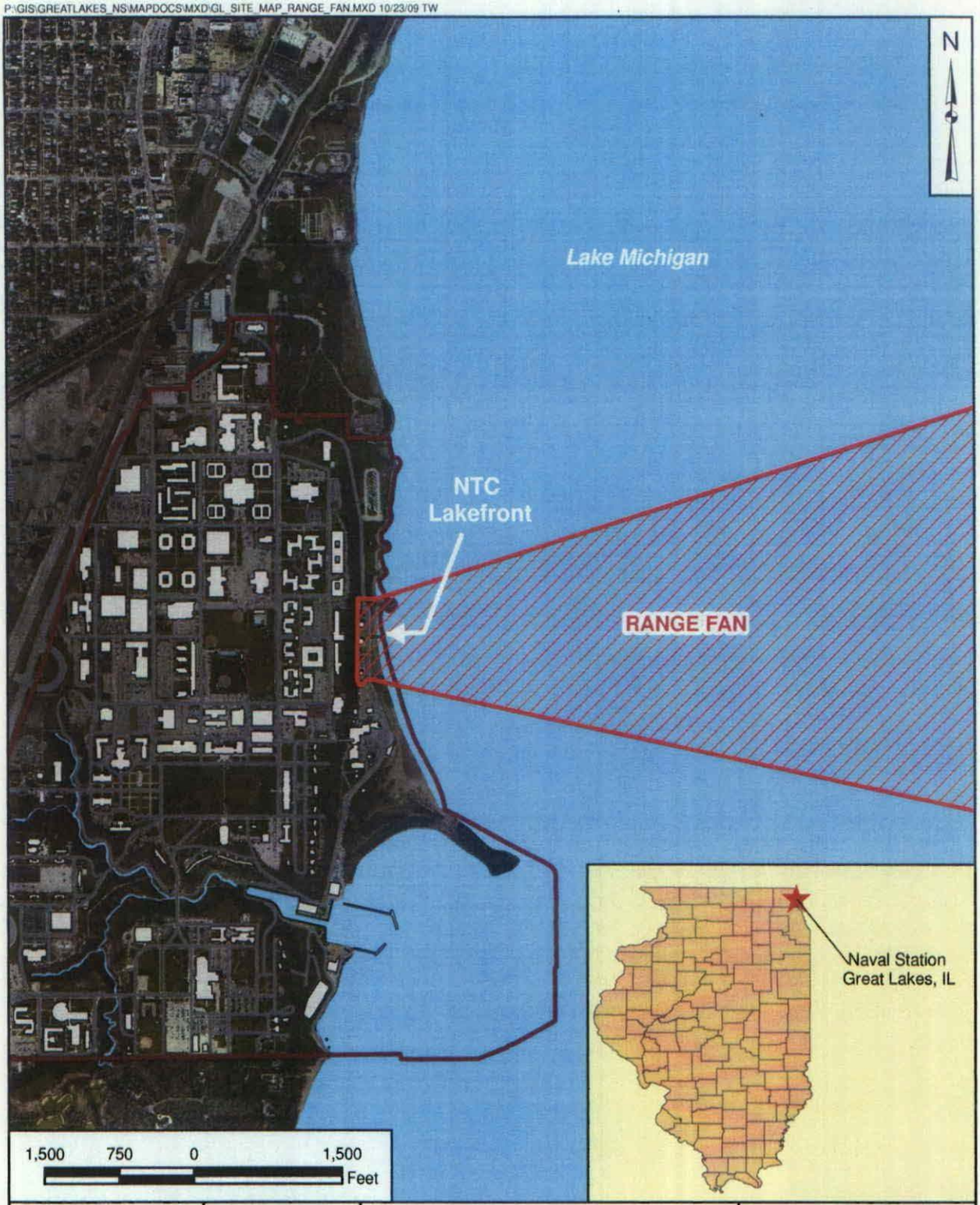
Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented:

Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest re-surveying or other corrective actions, if necessary.

Usability Checklist Table			
Phase of Work	**Item to be checked/verified**	**Verified (Yes or No)**	**Comments or Deviations**
Pre-Survey	Qualification of Survey Team evaluated		
	Personnel reviewed and signed-off on relevant UFP-SAP section(s)		
Survey	QC evaluation of survey equipment (tests and checklists satisfactorily completed)		
	IVS met requirements specified in UFP-SAP		
	Conformance to UFP-SAP requirements and procedures for all survey work and rework (including documentation requirements), and all deficiencies documented		
	Coverage of Areas to be Investigated fulfilled and located within accuracy levels required for the SI		
	Interpretation and Summary of Geophysical Data satisfies UFP-SAP requirements		

FIGURES

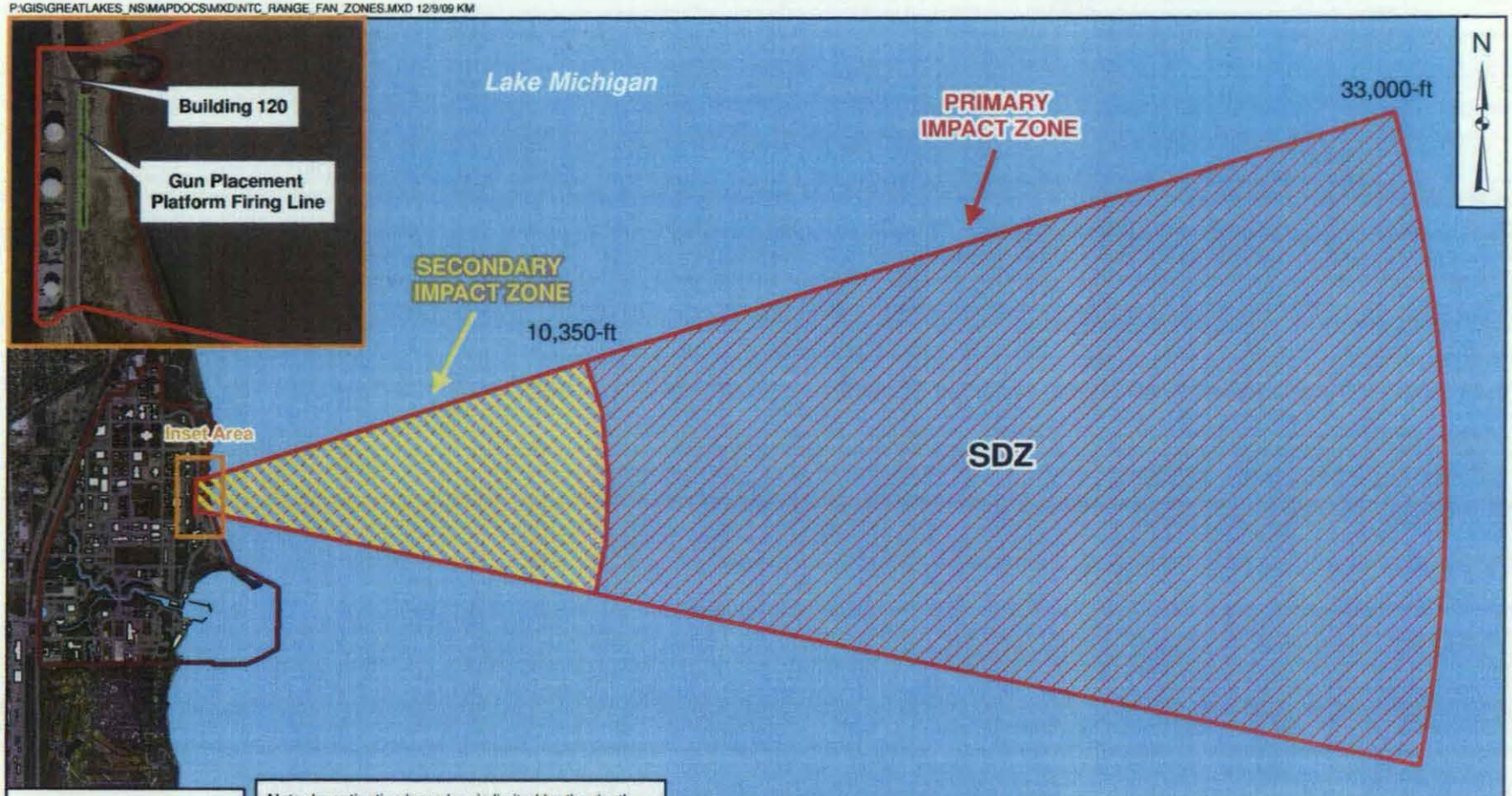
P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\GL_SITE_MAP_RANGE_FAN.MXD 10/23/09 TW



DRAWN BY T.WHEATON	DATE 10/23/09	NAVFAC	SITE LOCATION MAP NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS
CHECKED BY E. LOVE	DATE 10/23/09		
REVISED BY —	DATE —		
SCALE AS NOTED			

CONTRACT NUMBER F274	
OWNER NUMBER —	
APPROVED BY —	DATE —
FIGURE NO. ES-1	REV 0

P:\GIS\GREATLAKES_NS\MAPDOCS\MXD\NTC_RANGE_FAN_ZONES.MXD 12/9/09 KM



Legend

Installation Boundary

Note: Investigation boundary is limited by the depth of Lake Michigan and will not extend beyond the point where water depth is 120 ft deep. Water depth is determined by bathymetry survey.

4,000 0 4,000 Feet

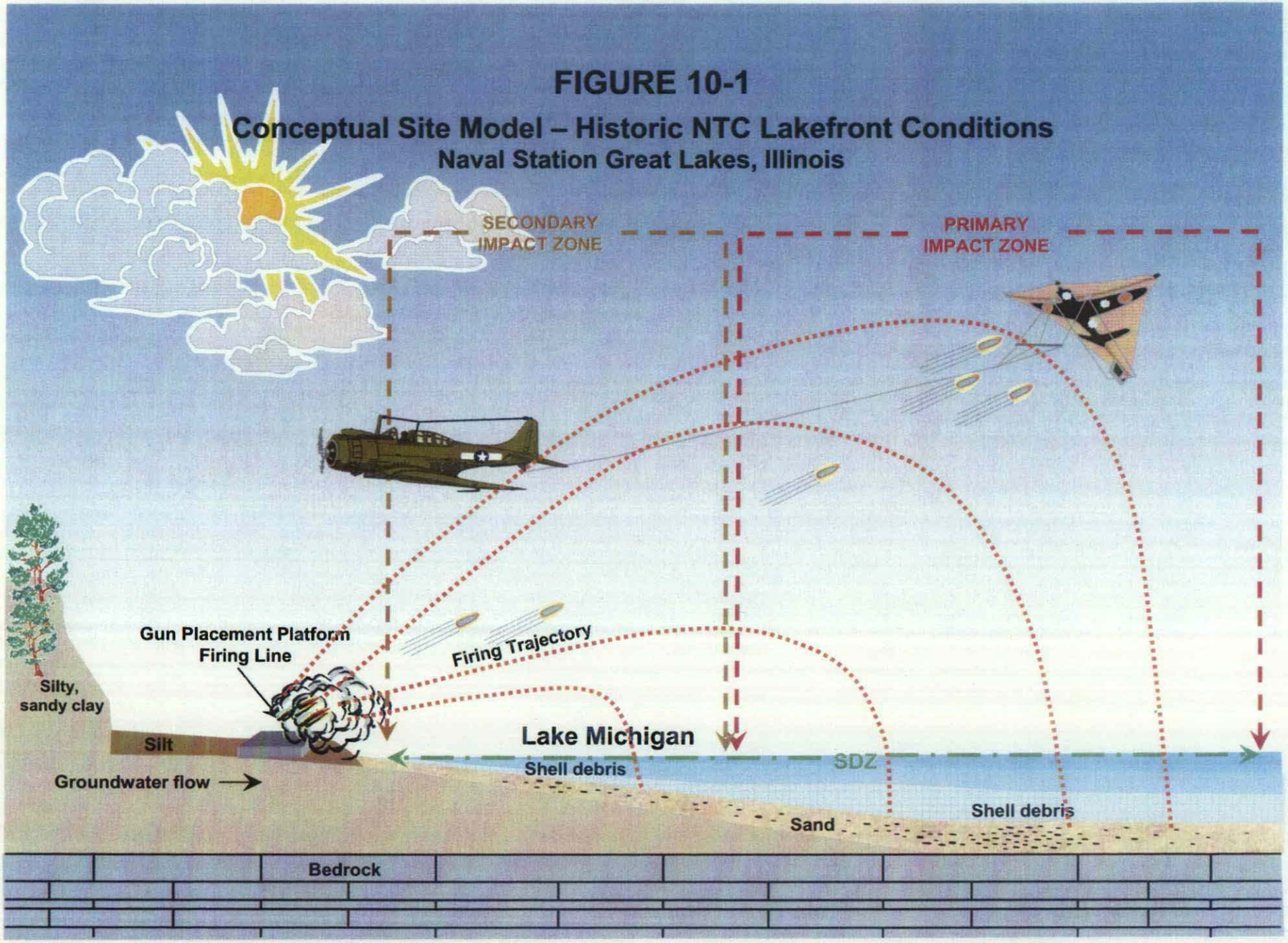
DRAWN BY T. WHEATON	DATE 10/23/09	CONTRACT NUMBER F274
CHECKED BY E. LOVE	DATE 12/9/09	APPROVED BY — DATE —
COST/SCHEDULE AREA		APPROVED BY — DATE —
SCALE AS NOTED	NAVFAC	FIGURE NO. FIGURE ES-2 / REV 0

NTC LAKEFRONT SURFACE DANGER ZONE (SDZ)
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

FIGURE 10-1

Conceptual Site Model – Historic NTC Lakefront Conditions

Naval Station Great Lakes, Illinois

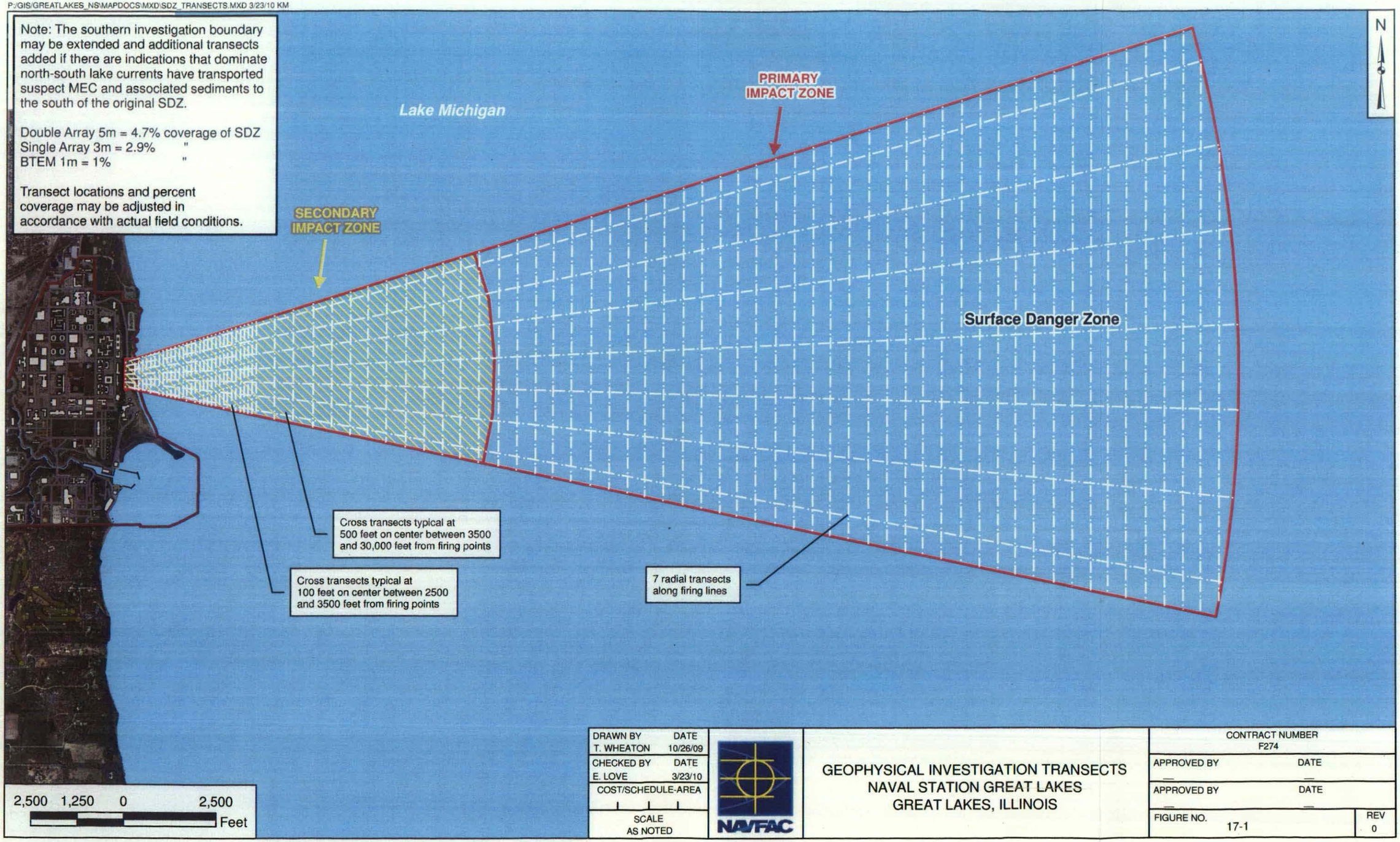


P:/GIS/GREATLAKES_NS\MAPDOCS\MXD\SDZ_TRANSECTS.MXD 3/23/10 KM

Note: The southern investigation boundary may be extended and additional transects added if there are indications that dominate north-south lake currents have transported suspect MEC and associated sediments to the south of the original SDZ.

Double Array 5m = 4.7% coverage of SDZ
Single Array 3m = 2.9% "
BTEM 1m = 1% "

Transect locations and percent coverage may be adjusted in accordance with actual field conditions.



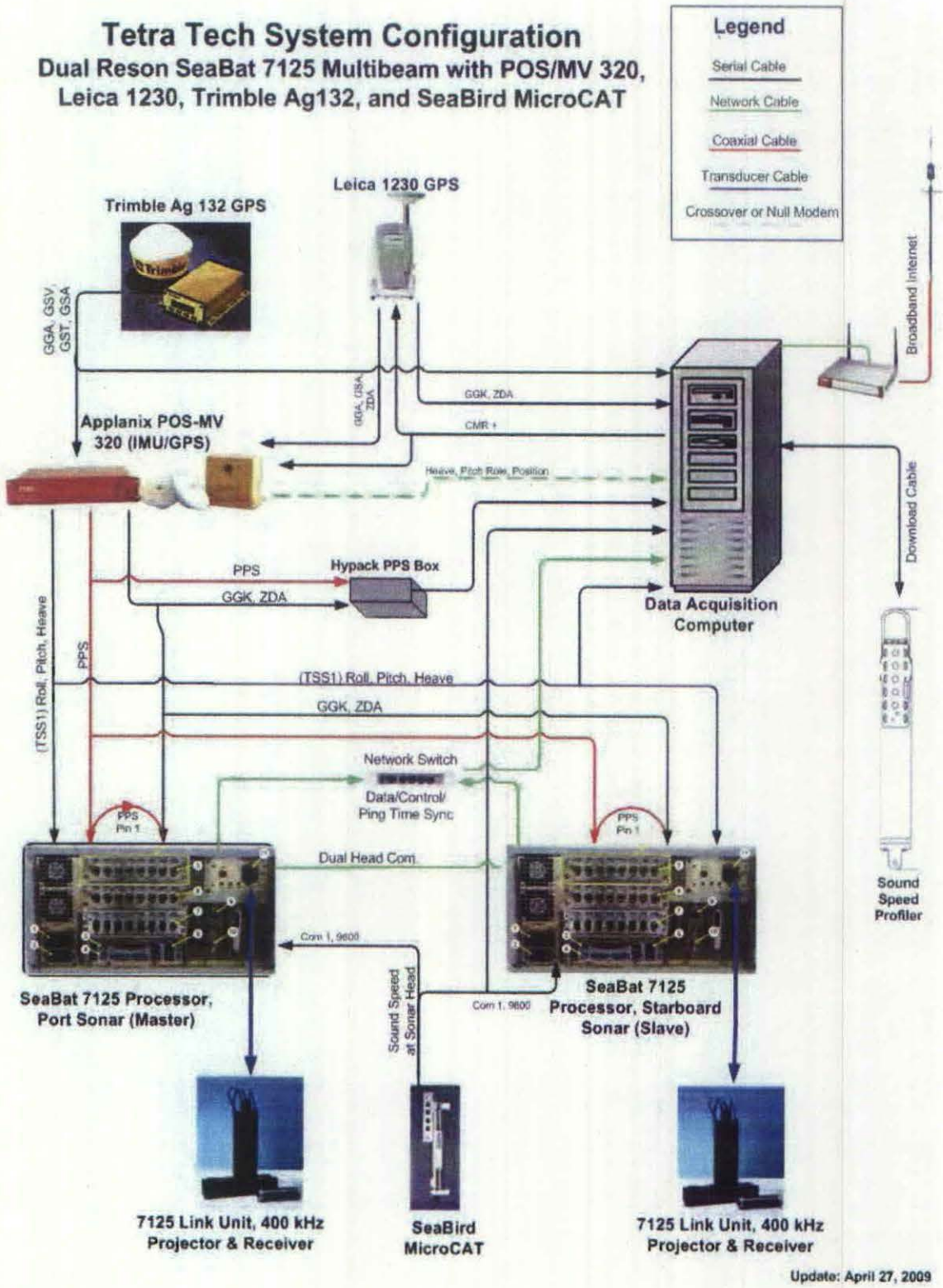
DRAWN BY T. WHEATON	DATE 10/26/09
CHECKED BY E. LOVE	DATE 3/23/10
COST/SCHEDULE-AREA	
SCALE AS NOTED	

NAVFAC

GEOPHYSICAL INVESTIGATION TRANSECTS NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS

CONTRACT NUMBER F274	
APPROVED BY —	DATE —
APPROVED BY —	DATE —
FIGURE NO. 17-1	REV 0

Figure 17-2. MBE System Configuration



APPENDIX A

MEC FIELD STANDARD OPERATING PROCEDURES

SOP 01 USACE ENGINEERING MANUAL – EM1110-2-1003 (HYDROGRAPHIC SURVEYING).

http://140.194.76.129/publications/eng-manuals/em1110-2-1003/toc.htm

(To be provided on CD with hardcopy)

SOP 02 DATA PROCESSING FOR MGA AND BTA

TABLE 1

Summary of Minimum Standards for Hydrographic Surveys

ORDER	Special	1	2	3
Examples of Typical Areas	Harbors, berthing areas, and associated critical channels with minimum underkeel clearances	Harbors, harbor approach channels, recommended tracks and some coastal areas with depths up to 100 m	Areas not described in Special Order and Order 1, or areas up to 200 m water depth	Offshore areas not described in Special Order, and Orders 1 and 2
Horizontal Accuracy (95% Confidence Level)	2 m	5 m + 5% of depth	20 m + 5% of depth	150 m + 5% of depth
Depth Accuracy for Reduced Depths (95% Confidence Level) [1] [2]	a = 0.25 m b = 0.0075	a = 0.5 m b = 0.013	a = 1.0 m b = 0.023	Same as Order 2
100% Bottom Search [3]	Compulsory	Required in selected areas	May be required in selected areas	Not applicable
System Detection Capability	Cubic features > 1 m	Cubic features > 2 m in depths up to 40 m; 10% of depth beyond 40 m	Same as Order 1	Not applicable
Maximum Line Spacing [4]	Not applicable, as 100% search compulsory	3 x average depth or 25 m, whichever is greater	3-4 x average depth or 200 m, whichever is greater	4 x average depth

[1] To calculate the error limits for depth accuracy the corresponding values of a and b listed in Table 1 should be introduced into:

$$\text{Depth Accuracy} = \pm [a^2 + (b * d)^2]^{1/2}$$

where:

a is a constant depth error, i.e. the sum of all constant errors, b*d is the depth dependent error, i.e. the sum of all depth dependent errors where b is a factor of depth dependent error, and d is depth.

[2] The confidence level percentage is the probability that an error will not exceed the specified maximum value.

[3] A method of exploring the seabed which attempts to provide complete coverage of an area for the purpose of detecting all features addressed in this publication.

[4] The line spacing can be expanded if procedures for ensuring an adequate sounding density are used

The rows of Table 1 are explained as follows:

Row 1 "Examples of Typical Areas" gives examples of areas to which an order of survey might typically be applied.

Row 2 " Horizontal Accuracy" lists positioning accuracies to be achieved to meet each order of survey.
Row 3 "Depth Accuracy" specifies parameters to be used to calculate accuracies of reduced depths to be achieved to meet each order of survey.
Row 4 "100% Bottom Search" specifies occasions when full bottom search should be conducted.
Row 5 "System Detection Capability" specifies the detection capabilities of systems used for bottom search.
Row 6 "Maximum Line Spacing" is to be interpreted as either (1) spacing of sounding lines for single beam sounders or
(2) distance between the outer limits of swaths for swath sounding systems.

APPENDIX B

ADDITIONAL TECHNICAL DATA

APPENDIX B-1 REVISED ORDNANCE TECHNICAL DATA SHEETS

APPENDIX B-2 MRP CONCENTRATION AREA RECOMMENDATION

APPENDIX B-1 REVISED ORDNANCE TECHNICAL DATA SHEETS

Appendix B-1 Revised Ordnance Technical Data Sheets

The Ordnance Technical Data Sheets for the 20mm and 30mm ammunition on the PA for the NTC Great Lakes Site were incorrect. The other technical data sheets provided in the PA for the Great Lakes Site are correct and are provided below..

The data sheets provided and the why there are incorrect are summarized below.

Data Sheet	Error
30 MM HEI, M799	Modern system fired from the AH-64 Apache Helicopter—Went into production in 1993
20 MM, HEI, M56 Series	Modern system fired from the M61A1 Vulcan on aircraft like the F/A-18
20 MM, HEI-T, MK 210	Modern system fired from the M242 Bushmaster—came into service in 1972

The correct Technical Data Sheets for the questionable ammunition are provided below. Note: Data was pulled from USN Bomb Disposal School Projectiles and Fuzes Manual, dated June, 1945.

CONFIDENTIAL

INTRODUCTION - Continued

7. Stamped on base or on base plug:

   1. Mark and Mod, size, and type of projectile.
   2. Lot No., year of specification.
   3. Inspector's seal and initial.
   4. Manufacturer's name.
   5. Previously (before 1 July 1944) had weights before and after filling.

8. The serial number of the projectile will also be stamped on the base plug, side of body, and on the windshield if present.

MINOR CALIBER PROJECTILES - INTRODUCTION & IDENTIFICATION

20 mm AMMUNITION

1. General:

Two types of 20 mm weapons are at present in service use in the Navy: the Oerlikon Anti-aircraft Gun, and the Hispano-Suiza Aircraft Gun. These two types of gun differ widely in construction and functioning, and it is emphasized that the ammunition, though somewhat similar in external appearance, IS NOT INTERCHANGEABLE.

2. Ammunition for 20 mm Oerlikon A.A. Gun:

The Oerlikon A.A. Gun and its ammunition are of Naval manufacture and design. The ammunition may be distinguished from that designed for the Hispano-Suiza Aircraft Gun by the reduced diameter of the extractor lip at the base of the cartridge case. For identification of individual types of rounds, the body of the projectile is painted a distinctive color, as follows:

Type of Projectile	Filling	Color of Projectile
HE, Mk 3	Tetryl	White
HE, Mk 3	Pentolite	Yellow
HE-I, Mk 3	Tetryl & Incend. Mix	Red
HE-I, Mk 3	Pentolite & Incend. Mix	Light Pink
*HE-T, Mks 4 & 7	Tetryl and Tracer	Light Gray
*HE-T, Mks 4 & 7	Pentolite and Tracer	Blue
AP-T, Mk 9	Tracer	Black
BL & P, Mk 3	Inert Loaded	Dark Green
BL & T, Mk 7	Inert Load and Tracer	Dark Green with Yellow Stripe
Drill	Empty	Seal Brown
HE-I-T		Bright Green

The Mark and Mod, manufacturer's initials or symbol, and lot number are stamped around the body of the projectile.

*When assembled with "Dark Ignition" tracers, a 1/8" bright red band

DATA [redacted]

U.S. NAVY

20 MM A.A.

HE

HE-I

MK-3

OVERALL LENGTH - With Nose Fuze	3.275 in.
Without Nose Fuze	2.625 in.
DIAMETER OF BASE	0.74 in.
DISTANCE - BASE TO BAND	0.374 in.
WIDTH OF BAND	0.16 in.
DIAMETER AT BOURRELET	0.78 in.
TYPE & WEIGHT OF FILLING HE:	.0243 lbs. Tetryl or Pentolite.
TYPE & WEIGHT OF FILLING HE-I:	.0072 lbs. Incendiary Mix; .0171 lbs. Tetryl or Pentolite.
WEIGHT OF LOADED PROJECTILE	0.2714 lbs.
CHARGE/WEIGHT RATIO	8.9%
CARTRIDGE CASE	HE: Mk 2; HE-I: Mks. 2,3,or 4.
PRIMER	HE: Mk 30; HE-I: Mks 30 or 31.
TRACER	None
FUZES WHICH MAY BE USED IN PROJECTILE	Nose: Mk 26 Mods 0 & 1. (P.D.F.)

REMARKS:

(a) The explosive filling of the HE projectile is press-loaded in three equal increments. The HE-I projectile is similarly loaded, but the first increment consists of an incendiary mixture, the other two of HE (either tetryl or pentolite).

(b) This round is also issued BL & P, with an inert filler and a dummy nose cap.

(c) Identification - Marking and Painting:

Projectile Type	Projectile Color
HE (Tetryl)	White
HE (Pentolite)	Yellow
HE-I (Tetryl)	Red
HE-I (Pentolite)	Light Pink
BL & P	Dark Gray Green

DATA

U.S. NAVY

20MM A.A.

HE-T

MK. 4, 7

	Mark 4	Mark 7
OVERALL LENGTH	3.025"	3.025"
Without nose fuze	2.525"	2.525"
DIAMETER OF BASE	0.74"	0.74"
DISTANCE - BASE TO BAND	0.397"	0.397"
WIDTH OF BAND	0.16"	0.16"
DIAMETER AT BOURRELET	0.78"	0.78"
TYPE OF FILLING	Tetryl or Pentolite	
WEIGHT OF FILLING - HE:	.01 lbs.	.01 lbs.
TRACER:	.0173 lbs.	.0147 lbs.
WEIGHT OF LOADED PROJECTILE	.2621 lbs.	.2714 lbs.
CHARGE/WEIGHT RATIO		
CARTRIDGE CASE	Mk 2	Mks 2,3,or 4
PRIMER	Mk 30	Mk 31
TRACER	Integral	Integral
FUZES WHICH MAY BE USED IN PROJECTILE	Nose: Mk 4 projectile - Mk 26 Mods 0 or 2 (P.D.F.)	
	Mk 7 projectile - Mk 26 Mods 0 or 1 (P.D.F.)	
LENGTH OF TRACER CAVITY	1.107"	1.062"
DIAMETER OF TRACER CAVITY	0.51"	0.47"

REMARKS:

(a) The Mk 4 and Mk 7 rounds are identical except for the dimensions of the tracer cavity, which is slightly greater in diameter and length in the Mk 4 than in the Mk 7. This somewhat reduces the tracer filling of the Mk 7.

(b) The Mk 7 round is also issued BL & T with an inert filler in the HE cavity and a dummy nose plug. The tracer cavity contains the standard tracer mixture.

(c) The burster charge of the 20 mm is more sensitive than the usual projectile burster charge. Accordingly, greater caution should be observed in handling.

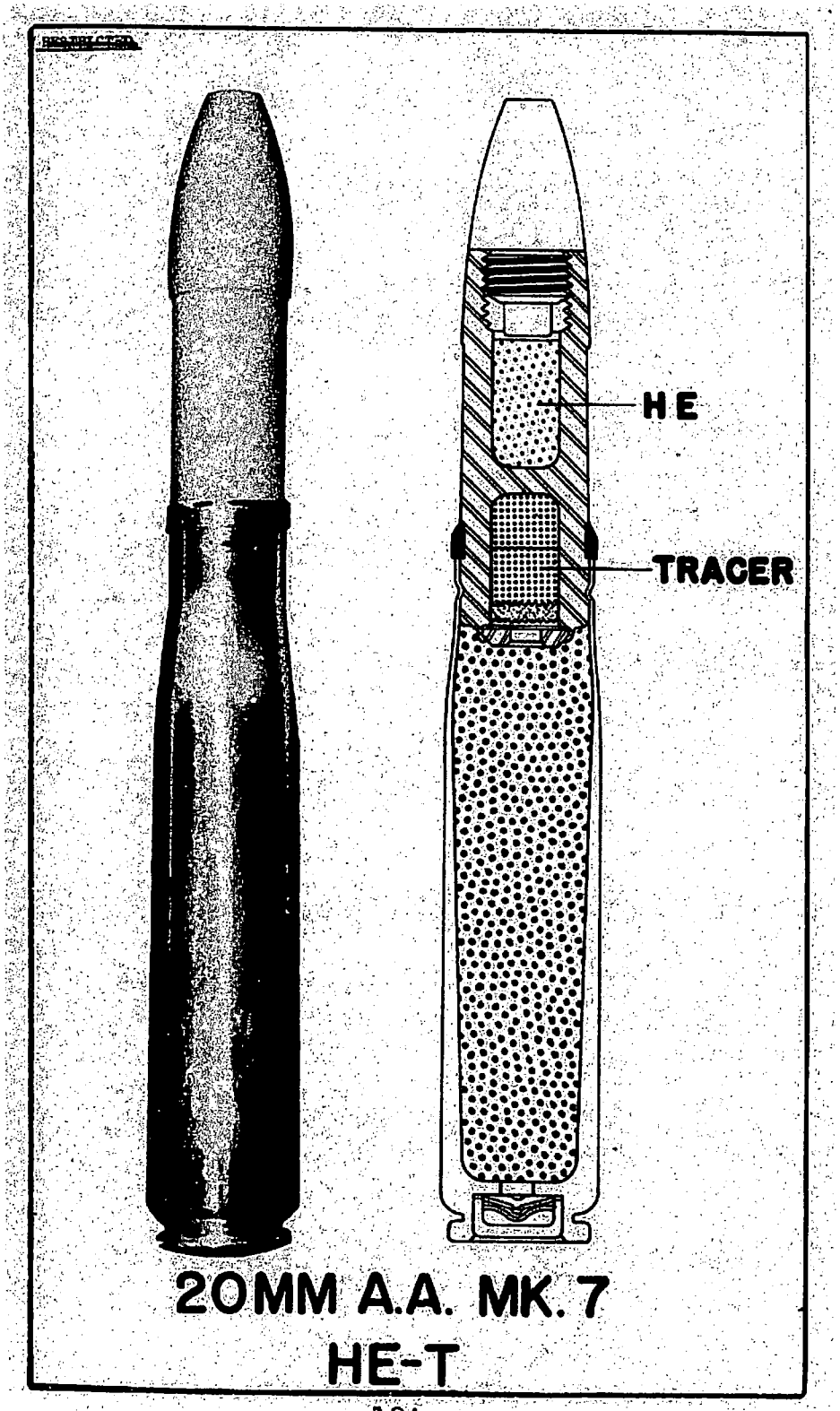
(d) The tracer element in these projectiles is loaded in two increments: (1) First increment is the tracer composition which is pressed in the after compartment by hydraulic pressure; (2) The second increment is the "starter" mixture which is pressed in on top of the tracer composition and is more sensitive than the latter. When the projectile is fired, the heat from the propellant charge ignites the starter which, in turn, sets off the tracer composition.

(e) Identification - Marking and Painting:

Projectile Type	Projectile Color
*HE-T (Tetryl)	Light Gray
*HE-T (Pentolite)	Blue
BL & T	Dark Gray Green, with 1/8" Yellow Band.

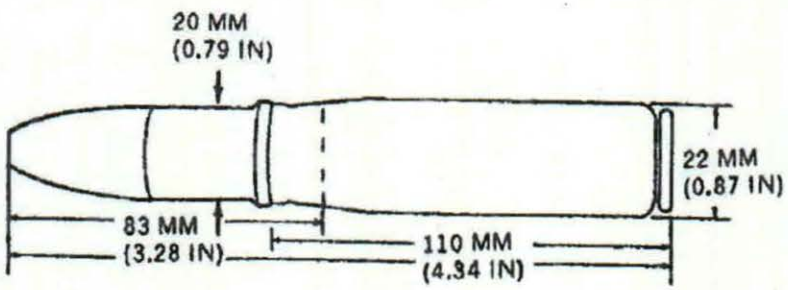
* When assembled with "Dark Ignition" tracers, a 1/8" bright red band will be painted around the projectile midway between the bourrelet and the rotating band.

(f) To eliminate the blinding flash characteristic of standard 20 mm tracers when fired at night, a special "Dark Ignition" tracer has been developed which does not light up until about 100 yds from the gun muzzle. Rounds are designated "HE-T-DI".


HE
TRACER
20MM A.A. MK. 7
HE-T

U.S. PROJECTIL E, 20-MM, AA, MK 3 MOD 0 – 64

ARTILLERY AMMUNITION



APPENDIX B-2 MRP CONCENTRATION AREA RECOMMENDATION

Appendix B-2 MRP Concentration Area Recommendation

To further define areas where the greatest concentration of Munitions and Explosives of Concern (MEC) may exists within the suspect area of concern at the Naval Training Center (NTC) Lakefront Site, a review of the most common types of anti-aircraft (AA) gunnery used while the site was an active training area was conducted. The range of each gun system was used to focus the Munitions Response Program (MRP) efforts in the most likely contaminated areas. Based on this review, a recommendation that the area of concentration start approximately 3,450 yards (10,350 feet) off shore and extend to 10,500 yards (31,500 feet).

The most likely AA guns fired at the Great Lakes NTC Lakefront Site were the 20mm Oerlikon and the Bofors 40mm gun. The Preliminary Assessment (PA) states, "approximately 1,350 sailors a day were instructed on 20- and 40-millimeter guns along the lakefront shooting thousands of shells at cable-drawn targets in the sky over Lake Michigan each day". This supports the theory that the 20mm and 40mm rounds will be the most likely rounds found during MRP operations. According to Wikipedia, these were the most prevalent 20mm and 40mm AA guns employed by the U.S. Navy during the time that NTC Lakefront Site performed AA training (1943 until October 15, 1945). "The [20mm Oerlikon] was fielded on Navy ships starting in 1942, replacing the M2 Browning machine gun, which lacked range and firepower. It became famous in the naval AA role, providing an effective defense at short ranges at which heavier guns had difficulty tracking a target. The gun was eventually abandoned as a major anti-air weapon due to its lack of stopping power against Japanese *kamikaze* attacks. It was largely superseded by the Bofors 40 mm gun." (Wikipedia, 2009). According to NavWeaps.com, "The Bofors weapon was used on almost every US and UK warship of WWII. The Bofors was first installed on U.S. Navy (Navy) vessels in the summer of 1942. Total USA production was about 39,200 weapons. The Gridley class destroyers were the only first-line destroyers in the Navy not to receive this weapon."

Data on the ranges of these two weapon systems is provided below.

20mm Oerlikon AA Gun Range Data

Elevation	Range
Range @ 10 degrees	3,450 yards (3,154 m)
Range @ 15 degrees	3,950 yards (3,612 m)
Range @ 20 degrees	4,275 yards (3,909 m)
Range @ 25 degrees	4,525 yards (4,138 m)
Range @ 30 degrees	4,650 yards (4,252 m)
Range @ 35 degrees	4,725 yards (4,320 m)
Range @ 40 degrees	4,775 yards (4,366 m)

Range @ 45 degrees	4,800 yards (4,389 m)

Note: Ranges in the table above are simply the ballistic characteristics. Effective range during World War II against aircraft for manually aimed weapons rarely exceeded 1,000 yards (910 m), although gunners were expected to open fire at a 200 or 300 yard (180 or 280 m) greater range to allow aiming corrections. Ammunition used in the 20mm Oerlikon consisted of 20mm: HE MK 3, Mods 1-64, HE MK 3, Mods 1-64, HE-T MK 4, Mods1-28, HE-T MK 7, AP-T MK 9.

The firing rate of the 20mm AA guns was between 250 to 320 rounds per minute.

Bofors 40mm AA Gun Range Data

Elevation	With 1.985 lbs. (0.900 kg) HE Mark 2 Shell	With 1.960 lbs. (0.899 kg) AP M81A1 Shell
Range @ 10 degrees	6,844 yards (6,258 m)	6,466 yards (5,913 m)
Range @ 15 degrees	8,227 yards (7,523 m)	7,580 yards (6,931 m)
Range @ 20 degrees	9,295 yards (8,499 m)	8,389 yards (7,671 m)
Range @ 25 degrees	10,103 yards (9,238 m)	8,959 yards (8,192 m)
Range @ 30 degrees	10,691 yards (9,776 m)	9,358 yards (9,358 m)
Range @ 35 degrees	11,057 yards (10,111 m)	9,568 yards (8,749 m)
Range @ 40 degrees	11,208 yards (10,249 m)	9,618 yards (8,795 m)
Range @ 45 degrees	11,133 yards (10,180 m)	9,492 yards (9.679 m)

Notes: Most USA produced ammunition was set to detonate at 4,000-5,000 yards (3,700-4,570 m) to minimize damage due to "friendly fire." British rounds self-destructed at 3,000-3,500 yards (2,700-3,200 m) but this could be increased to 7,000 yards (6,400 m) in some ammunition types. Ammunition used: 40mm Mk1 and Mk2.

The firing rate of the 40 mm AA gun was 120 rounds per minute per barrel nominal and 140 to 160 rounds per minute when horizontal (gravity assist). Skillful loaders could keep a gun firing for about 24 rounds (six clips) without a pause.

Other AA guns that could have used at the NTC Lakefront Site are the 3-inch, 0.50 caliber AA and the 1.1-inch AA artillery guns. Both of these weapon systems were mentioned in the PA as possibly being used at the NTC Lakefront Site; however, the U.S. Navy did not readily use these guns and there ranges should be used to determine secondary areas of concentration for the MRP efforts. According to Anitaircraft.com, "The 3-inch AA gun was the grandfather of all World War II AA artillery. Shortly after America's entry into the First World War, the caliber of Army antiaircraft guns was set at three inches to take advantage of existing standard cartridges...The 3-inch gun designs continued to be refined during the interwar period with appearance of the more robust M1 and M3 mobile guns and the fixed mount M2 and M4 pieces. By 1930, the M3 was settling in as the standard mobile gun. This allowed a decade of training with the improved weapon before the onset of World War II." During the onset of WW II, there were concerns that the 3-inch gun would not be able to keep pace with modern bombers and the development of an antiaircraft gun capable of dealing with the latest aircraft was put into motion (Brooks, 2009). By 1940 the 3-inch, 0.50 caliber AA gun was relegated to costal defense missions. The 1.1-inch AA artillery gun was used during the early years of WW II but was quickly phased out due to reliability

problems. It was completely phased out of by 1945. The ranges of the 3-inch, 50 caliber and 1.1-inch AA guns are show below.

3-Inch AA Gun Facts

Firing Table Muzzle Velocity: 2,700 feet/second
Breech: Semi-automatic
Maximum Rate of Fire: 25 rounds/minute
Elevation Limits: -5° to 85° (later mounts)
Recoil Type: Hydro-spring
Fire Control Director: M4 or M7 (earlier M1, M2 and M3 could be substituted)
Maximum Effective Slant Range: 9,500 yards
Maximum Effective Horizontal Range: 10,500 yards
Maximum Effective Vertical Range: 10,100 yards
Maximum Effective Fire Control Altitude: 25,000 feet

Actual muzzle velocity was dependent on ammunition used and environmental conditions. Maximum range was limited by a 30-second timed fuze.

Provided by Brooks, 2009.

1.1-inch AA Artillery Gun Range

Range @ 10 degrees	5,300 yards (4,846 m)
Range @ 15 degrees	6,100 yards (5,578 m)
Range @ 20 degrees	6,600 yards (6,035 m)
Range @ 25 degrees	6,900 yards (6,309 m)
Range @ 40.9 degrees	7,400 yards (6,767 m)

Note: 1.1-Inch AA Ammunition used: HE-T MK 1, HE-T/SD MK1, HE-T/SD MK2, Mods 0-1. The firing rate for the 1.1-inch AA gun was roughly 500 rounds per minute (Quad Mount). The self-destruct (SD) munition has explosive filler, which was set off by a "super-quick" fuze.

References

www.NavWeaps.com 2009. http://www.navweaps.com/Weapons/WNUS_4cm-56_mk12.htm

www.battleshipnc.com/physical/armament

World War II Database, http://ww2db.com/weapon.php

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APPENDIX C

EXPLOSIVE SAFETY SUBMISSION DETERMINATION

DEPARTMENT OF THE NAVY
NAVAL ORDNANCE SAFETY AND SECURITY ACTIVITY
FARRAGUT HALL
3817 STRAUSS AVENUE, SUITE 108
INDIAN HEAD, MD 20640-5151

8020
Ser N539/126
29 Jan 10

From: Commanding Officer, Naval Ordnance Safety and Security Activity
To: Commanding Officer, Naval Facilities Engineering Command, Midwest

Subj: EXPLOSIVES SAFETY SUBMISSION DETERMINATION REQUEST TO CONDUCT A SITE INSPECTION OF THE NAVAL TRAINING CENTER LAKEFRONT SITE, NAVAL STATION GREAT LAKES, GREAT LAKES, ILLINOIS

Ref: (a) E-mail NAVFAC MIDWEST Mr. H. Hickey/NOSSA (N539) Mr. D. Murray of 19 Jan 10 (w/encl)
(b) NOSSAINST 8020.15B, Explosives Safety Review, Oversight, and Verification of Munitions Responses, of 26 Jan 09
(c) NAVSEA OP 5, Revision 7

1. As requested by reference (a), the Naval Ordnance Safety and Security Activity (NOSSA) reviewed the subject Explosives Safety Submission (ESS) Determination Request in accordance with references (b) and (c). Based on the information provided, NOSSA has determined that an ESS is not required to conduct a Site Inspection (SI) of the Naval Training Center (NTC) Lakefront Site, Naval Station Great Lakes, Great Lakes, Illinois.

2. As outlined in your request, we understand that the likelihood of encountering Munitions and Explosives of Concern (MEC) and/or Material Potentially Presenting an Explosive Hazard (MPPEH) during the proposed project has been determined to be low and that the following conditions apply:

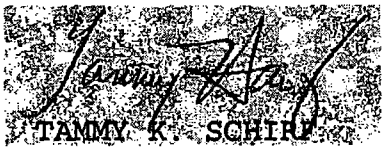
a. An SI will be conducted in the water portion of the NTC Lakefront Site. The first portion of this SI will consist of collecting geophysical data using a multi-beam echo-sounder sonar, a marine gradiometer array, and a bottom-towed time-domain electromagnetic induction array. At no time will any of these instruments come in contact with MEC/MPPEH on the lake bottom and support from an unexploded ordnance (UXO) technician will not be required.

b. The second portion of this SI will consist of collecting sediment samples 0 to 12 inches below the sediment surface using a petite ponar dredge (or equivalent). A UXO technician will ensure there is no intentional physical contact with MEC/MPPEH during sediment sampling operations.

c. The site is outside of all existing explosives safety quantity distance arcs.

3. If lake bottom surface MEC or MPPEH is discovered on the site while employing anomaly avoidance techniques, the item will be avoided and its location and description will be reported to the cognizant Explosive Safety Officer and the Navy Project Manager. An emergency response from the cognizant Explosive Ordnance Disposal detachment will be requested, if appropriate.

4. The NOSSA point of contact for this ESS determination is Mr. Douglas Murray, who can be contacted at DSN 354-5630 or commercial at 301-744-5630.



By direction

Copy to:
CNO (A. Malson; W. Holmes and E. Newbaker)
NAVFAC HQ (R. Sadorra)
NAVFAC MIDWEST (H. Hickey)
NAVSTA GREAT LAKES (S. Nagao)
NOSSA ESSOLANT (B. Sizemore and D. Moore)

REQUEST FOR AN EXPLOSIVES SAFETY SUBMISSION DETERMINATION

Site name/number, Activity, City, State and ZIP code:	Naval Training Center Lakefront Site Naval Station Great Lakes Great lakes, Illinois 60088	Date submitted:	19 January 2010
Project manager: Contact information	Howard Hickey NAVFAC RPM NAVFAC-Midwest 201 Decatur Avenue, Building 1A Great Lakes, Illinois 60088 847- 688-2600 Ext 243 howard.hickey@navy.mil	EOD/UXO contractor: Contact information	Ralph Brooks UXO Program Manager Tetra Tech, Inc. 770-413-0965 Ext 231 ralph.brooks@tetratech.com

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Site history: Briefly describe past MEC or MPPEH use at the site	The Naval Training Center (NTC) Lakefront Site was used as an anti-aircraft (AA) training range from 1942 to 1945 The range consisted of twenty-five gun mounts located on the beachfront which were used to fire at targets towed over Lake Michigan. The range fan associated with this site includes an area of approximately 4,765 acres that extends out from the shoreline over the lake.
MEC or MPPEH known or suspected to be present: Quantity, type/nomenclature, and condition	Approximately 1,350 sailors a day underwent AA training at this site. Several million rounds were fired at cable-drawn targets towed by airplanes over Lake Michigan. The ammunition used included 20-mm, 40-mm and 1.1-inch High Explosive (HE), High Explosive Incendiary (HEI), High Explosive Tracers (HET) and/or HET-Dark Ignition (DI) rounds. The estimated dud rate for these munitions is five to ten percent; hence, several hundred thousand rounds may be present in the Lake Michigan sediment.

Work task/project being proposed: Briefly describe proposed work; identify encumbering ESQD arcs	**Proposed operation**: Site Inspection (SI) o Geophysical Data will be collected in the water portion of the NTC Lakefront Site using the following combination: Multi-beam Echo-sounder Sonar (MBE), Marine Gradiometer Array (MGA), and Bottom-Towed TDEMI Array (BTA). The MBE will first be used to map bathymetry, determine water depths, and to indicate features of interest. The MGA or BTA will then survey the area to detect metal objects and clusters of metal. A UXO escort will not be required during geophysical data collection because the collection methodology will not touch or disturb the lake sediment where MEC may be present. o Sediment samples will be collected, from 0- to 12-inches below sediment surface using a petite ponar dredge (or equivalent) from a specially equipped motor boat. A UXO Technician will also be part of the sediment sampling team to ensure that no MEC are present in the lake-bottom sediment collected for sampling and analysis. o If MEC/MPPEH is discovered on the site during any operation, the item's location and description will be reported to the Navy RPM and the NS Great Lakes Point of Contact. EOD response will be coordinated if needed. o UXO support during the sediment sample operations will be provided by a UXO-qualified technician, as defined in DDESB TP 18. The site is not encumbered by existing Explosive Safety Quantity-Distance (ESQD) arcs. Projected Start Date: March 2010
Likelihood of encountering MEC or MPPEH: Low, medium or high	Likelihood of encountering MEC/MPPEH is low