FINAL

EXPLOSIVES SAFETY PLAN

MUNITIONS AND EXPLOSIVES OF CONCERN

REMOVAL ACTION AND CONSTRUCTION SUPPORT

CONGAREE RIVER PROJECT

COLUMBIA, SOUTH CAROLINA

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Acronyms

ATF&E	Bureau of Alcohol, Tobacco, Firearms and Explosives
BEM	Buried Explosion Module
BGS	below ground surface
BIP	blown in place
CD	Cultural Debris
CM	Conventional Munitions
CWM	Chemical Weapons Material
DDESB	Department of Defense Explosives Safety Board
DESC	Dominion Energy South Carolina, Inc.
DHEC	Department of Health and Environmental Control
DMM	Discarded Military Munitions
DoD	Department of Defense
EM	Engineering Manual
EMM	Earth Moving Machinery
EOD	explosive ordnance disposal
EZ	exclusion zone
FCA	functional check area
IAW	In Accordance With
IDW	investigation derived waste
ISO	industry standard objects
MCE	Maximum Credible Event
MDAS	Material Documented as Safe
MEC	Munitions and Explosives of Concern
MGFD	munitions with the greatest fragmentation distance
MGP	Manufactured Gas Plant
MPPEH	Material Potentially Presenting an Explosive Hazard
MRS	Munitions Response Site
MSD	Minimum Separation Distance
NEW	Net Explosive Weight
OE	Ordnance and Explosives
PM	Project Manager
PTR	public traffic route

PTRD	Public Transportation Route Distance
QA	Quality Assurance
QC	quality control
QCM	Quality Control Manager
Q-D	Quantity Distance
RCWM	recovered chemical warfare materiel
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SLED	State Law Enforcement Division
SUXOS	Senior Unexploded Ordnance Supervisor
TLM	tar-like materials
TP	Technical Paper
USACE	U.S. Army Corps of Engineers
UXO	Unexploded Ordnance
UXOSO	Unexploded Ordnance Safety Officer
VCC	Voluntary Cleanup Contract

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1. Background

1.1. Site location

The Congaree River Project area is located on the Congaree River in Columbia, South Carolina (SC). The site, also referred to as the "project area", begins directly south of the Gervais Street Bridge, extends approximately 200 feet into the river from the eastern shoreline, and approximately 1,500 feet downriver, towards the Blossom Street Bridge. The munitions and explosives of concern (MEC) intrusive activities will occur on the eastern side of Congaree River between Gervais and Blossom Street Bridges, within the cofferdam and removal areas shown on the figures in Appendix A. Underwater intrusive activities will occur within the cofferdam footprints prior to their installation. See Appendix A for the footprint of the cofferdam locations.

1.2. Site Description

1.2.1. Terrain and Vegetation

The predominant topographic feature within the project area is the Congaree River itself, which is a broad shallow river with numerous bedrock assemblages that are visible above the water level at normal river flows. The river slope in the vicinity of the project area is approximately2.10 feet/mile (U.S. Army Corps of Engineers [USACE], 1977). The river depth varies significantly in the project area due to the variability of the bedrock river bottom elevations.

The project area abuts the eastern shoreline, which rises sharply from the water's edge in most places due to a steep bank that varies in height from approximately 5 to 20 feet depending on location. The ground slopes more gently to the east once the top of the riverbank is reached with an approximate 28 feet increase in land surface elevation. The riverbank is forested in this area with a vegetative cover consisting of various trees and tall native grasses and shrubs. The undergrowth is periodically maintained and trimmed in the vicinity of the wooden scenic overlook and river walkway and is much thicker and overgrown further south. The terrain and vegetation are not anticipated to hinder the field activities at the site.

Current access to the river is provided by a partially paved access road, which extends from the intersection of Senate and Gist Streets to the river.

1.2.2. Soil Condition

The landside Congaree Riverbank soil/sediments are unconsolidated, ranged in particle size from clay to gravels, displayed layering, and were approximately 12 feet to 27 feet thick.

Generally, soil/sediment thickness increased in the downriver direction, and is attributed to down cutting of the granite by the Congaree River. The uppermost soil/sediments were generally found

to range from clays to medium sands. Below this is gray silt that overlies a sand and gravel layer. The Congaree River and project area can be generalized by shoreline (gray silt) and channel (sands and gravel). It is not anticipated that soils and or tar-like materials (TLM) will impact detection equipment results.

1.3. Site History

In 1865, during the Civil War, MEC and other articles of war produced by the Confederacy were dumped into the Congaree River near the Gervais Street Bridge by Union forces under the direction of General Sherman. This activity took place during Sherman's occupation of Columbia.

Archeological investigations, conducted as late as 1980, recovered some Discarded Military Munitions (DMM) from the area as well as some other potentially historically significant artifacts. Specifically, this work was focused in and adjacent to the unnamed tributary that enters the river just south of the Gervais Street Bridge. Several cannonballs were identified during this operation and properly disposed of by Army Explosive Ordnance Disposal (EOD) personnel located at nearby Fort Jackson.

Due to the potential presence of MEC within the project area, an additional reconnaissance and screening of the area in question was conducted as part of the investigative activities. Analysis of the survey data identified concentrations of anomalies with DMM potential in the immediate vicinity of the Senate Street landing and scatters extending into the river. A terrestrial magnetometer investigation of the unnamed tributary below the Gervais Street Bridge was also carried out, and that investigation identified eight additional anomalies with a potential association with ordnance.

In June 2010, the occurrence of a TLM within the Congaree River was reported to the South Carolina Department of Health and Environmental Control (SCDHEC). Preliminary sample results conducted on the material by SCDHEC and Dominion Energy South Carolina, Inc. (DESC) indicated that the TLM had similar chemical and physical characteristics as coal tar, a by-product of Manufactured Gas Operations, which were common in cities from the late 1800s until the 1950s. Additional research found that the most likely source of the TLM was a former Manufactured Gas Plant (MGP) located northeast of the river at 1409 Huger Street that operated from about 1906 until the mid-1950s prior to the existence of environmental regulations and permitting. Later this was the location of the city bus terminal until 2008.

DESC had previously entered into a Voluntary Cleanup Contract (VCC) with South Carolina Department of Health and Environmental Control (SCDHEC) in August 2002 to conduct environmental assessment and cleanup activities at the former Huger Street MGP site. DESC has worked proactively and cooperatively with SCDHEC under its existing VCC to determine the

extent of TLM in the Congaree River and to develop a plan for cleanup.

To address the presence of TLM within the river, a Stakeholder-Developed Modified Removal Action was developed and submitted to SCDHEC in December 2018. Two areas within the river, along the eastern shoreline, were proposed for the removal of TLM impacted sediment. The TLM-impacted sediment varies in thickness from a few inches to approximately 6 feet thick in some areas. The current total estimate of sediment requiring removal is approximately 11,675 cubic yards. The total project area within the river, including cofferdam footprints and removal areas, is estimated to be 5.8 acres. Sediment removal from within the water area will occur after cofferdams are installed, and water has been removed. Intrusive investigations and removal operations of metallic anomalies by unexploded ordnance (UXO) divers will be conducted prior to the installation of the cofferdams.

The removal of MEC/Material Potentially Presenting an Explosive Hazard (MPPEH) from the project area and assisting in the segregation and disposal of impacted TLM sediment removed by DESC covered under this explosive safety plan is intended to protect the public, essential personnel, and the environment.

1.4. Current and Future Land Use

Current land use for the project area is public recreation and residential (the Congaree River), with adjacent private property along the eastern shoreline. The future land use is expected to be the same (Congaree River waterway).

1.5. Project Area

The site, also referred to as the “project area”, begins directly south of the Gervais Street Bridge, extends approximately 200 feet into the river from the eastern shoreline, and approximately 1,500 feet downriver, towards Blossom Street Bridge. The MEC intrusive activities will occur on the eastern side of Congaree River between Gervais and Blossom Street Bridges, within the cofferdam and removal areas shown on the figures in Appendix A. Underwater intrusive activities will also occur within the cofferdam footprint prior to their installation. See Appendix A for the footprint of the cofferdam location.

1.6. General

This Explosives Safety Plan (ESP) covers the munitions response actions in support of cofferdam installations and removal of impacted sediment within the Congaree River. The area to be swept and intrusively investigated for MEC/MPPEH consists of approximately 5.8 acres within the Congaree River. A shallow dive operation (covered in a separately submitted Dive Operation Plan) will be performed to remove any potential MEC/MPPEH within the cofferdam footprints prior to cofferdam construction needed to dewater the sediment areas containing TLM.

MEC items determined acceptable to move and recovered by the UXO divers will be transported by workboat and moved by hand cart to a placarded vehicle for transport to a designated collection point or to the portable storage magazine for temporary storage. Any MEC deemed not acceptable to move may be rigged by UXO personnel for remote movement using rope or cable that is suitable for moving the MEC remotely. For remote movement of not acceptable to move MEC, non-essential personnel must be separated from the operation by the maximum fragmentation distance horizontal (MFD-H) of 3060 ft for the selected munition with the greatest fragmentation distance (MGFD). This can be mitigated by sandbag engineering controls to reduce the distance to the K328 blast distance of 393 feet. Essential personnel in armored equipment or protected by shielding designed to defeat hazardous fragments must remain outside the K24 blast distance of 29 ft. until the MEC has been repositioned to the location where it will be blown in place. If possible, the explosive disposal operation will be conducted using the required burial depth calculated using the buried explosion module (BEM). This will result in no blast or fragmentation at the surface and a required exclusion zone of only 200 feet to comply with the Department of Defense (DoD) explosive safety requirements for intentional detonations.

Once the cofferdams have been constructed and water removed from within, a surface sweep and intrusive mag and dig process for MEC/MPPEH will be performed prior to excavation of TLM material. The area will be cleared of all surface MEC/MPPEH regardless of size (excluding small arms ammunition .50 caliber and below not visually detectable). Sub-surface ferrous metal anomalies will be investigated to the depth of detection up to three feet below ground surface (BGS). In TLM contaminated areas requiring deeper excavations, the excavation will be performed in three-foot lifts, and the surface of each lift will be inspected by the UXO technicians prior to each successive lift. The Senior Unexploded Ordnance Supervisor (SUXOS) and Unexploded Ordnance Safety Officer (UXOSO) will ensure all essential personnel are fully trained on the associated hazards and fully aware of the safety procedures to be followed when MEC/MPPEH investigation operations commence.

1.7. History and Characterization Data Analysis

Site History and previous characterization data are presented above in Site History section 1.5.

1.8. Selected Munitions Response Actions

In order to support the removal of TLM from the project area a “mag and dig” type removal action has been selected to remove the MEC/MPPEH prior to cofferdam installation and sediment/soil excavation. There will be no underwater removal of sediments prior to dewatering. A shallow wading/dive operation to sweep the area of the cofferdam footprint will be performed prior to cofferdam installation and is covered under a separate dive operations plan. Stand-by construction support will also be performed during sediment/soil excavation.

1.9. Land Use Controls (LUC)

No permanent land use controls are being proposed. Currently, there are signs announcing that no swimming is allowed in the area of the TLM. Prior to field activities, the operations area will be fenced, and signs posted to keep the public out for safety and protection of civil war era antiquities. Temporary fencing to prevent unauthorized access to the site will be put up and maintained during the entire removal action project.

1.10. Reason for Munitions and Explosives of Concern (MEC)

In 1865, during the Civil War, MEC and other articles of war produced by the Confederacy were dumped into the Congaree River near the Gervais Street Bridge by Union forces under the direction of General Sherman.

1.11. Type of MEC

Based on historical information primarily from an Inventory of Stores Captured in Columbia, SC document dated February 17, 1865, MEC/MPPEH items of interest that could potentially be encountered are identified below. The historical list contained a more general nomenclature than that used in the DoD Fragmentation database of today. The list below is taken directly in name from the 1865 document.

- Case shot, fixed, 12 pounder gun
- Fuse-shell, fixed, 12 pounder gun
- Grape, 12 pounder gun
- Canister, fixed, 12 pounder gun
- Shot, fixed, 6 pounder gun
- Case, fixed, 6 pounder gun
- Fuse-shell, fixed, 6 pounder gun
- Canister, fixed, 6 pounder gun
- Shot, fixed, 24 pounder gun
- Shell, fixed, 24 pounder gun
- Canister, fixed, 24 pounder gun
- Shell, fixed, 8 inch
- Shot and shell, not fixed, 8 inch
- Shot and shell, not fixed, 8 inch
- Shot and shell, not fixed, 10 inch

2. Maps

Figure A-1 in appendix A shows a map of the site in relation to the surrounding area. Figure A- 3 shows the proposed magazine location in regard to MEC clearance within the river. Figure A-2 is a map that shows the area with the Quantity Distance (Q-D) arcs that will be used during the MEC removal action in the area.

3. Explosive Safety Quantity -Distance

3.1. Munitions with Greatest Fragmentation Distance (MGFD)

According to historical information for Columbia, SC inventory, a variety of other munitions were identified as having been used or stored at the site. No information found to date associates any other munitions with the project site. Therefore, the 10 in "cannonball" shell has been selected as the MGFD for the project. Table 3-1 shows the maximum fragmentation distance and safe underwater overpressure distances for the selected MGFD. Q-D arcs are shown in Appendix A on Figure A-3. See Appendix B for Fragmentation Data Sheets.

Table 3-1. MGFD Table for Congaree River TLM Remediation Project

MGFD Type	Munitions Item	HFD (feet)	MFD-H (feet)	Safe Underwater Overpressure Distances in Feet at Specific Depths[2/]				
				1≥	5 ft	10 ft	15 ft	20 ft[3/]
Primary	10 Inch Cannonball Shell	237 [1/]	3060 [1/]	312	990	1,080	1,170	1,259

Notes:
1/ From Fragmentation Data Review Form, updated June 5, 2020
2/ From Chief of Naval Operations Interim Guidance 2014. For swimmers 1 foot deep or less, the safe distance = (13000/50)*(NEW$^{1/3}$). For swimmers/divers deeper than 1 foot, the safe distance = 15*(DOB*NEW$^{1/5}$)+900. Where DOB = Depth of blast, NEW = net explosive weight
3/ Estimated maximum depth of Congaree River within the Cofferdam Footprint.

3.2. MEC Area(s)

The exclusion zones (EZ) required for the public/non-essential personnel will be applied during all MEC intrusive, movement, and disposal operations. The minimum separation distance (MSD) for the project is presented in Table 3-1. Preliminary site work such as surveying, laying grid lanes, and anomaly avoidance does not require the establishment of an MSD for Q-D purposes. Essential personnel are defined as those on-site contractor and personnel required to participate in the MEC removal, along with those approved and authorized visitors. All other personnel are non-essential personnel. The outer boundaries of the MSD arcs are depicted on the Q-D map in

Figure A-3. The team separation distance at this site will be the K40 overpressure distance shown in Table 6-1. Positive control of the EZ based on the MSD will be maintained at all times that MEC operations are being conducted. Prior to beginning MEC operations, the contractor will ensure that there are no non-essential personnel within the EZ, and the contractor will ensure that the EZ remains clear of non-essential personnel throughout the MEC operations.

Only UXO-qualified personnel (see Department of Defense Explosives Safety Board [DDESB] Technical Paper [TP]-18 for definitions) will perform MEC intrusive investigation, construction support, and removal activities. Activities will be accomplished in accordance with the procedures detailed in the current USACE Engineering Manual (EM) 385-1-97. "Explosives Safety and Health Requirements Manual". The UXO personnel will clear all excavation, construction, and laydown locations to ensure no intentional physical contact with MEC during removal/excavation operations.

Any occupied buildings or public roadways in the EZ areas during MEC operations will be evacuated and/or roadways blocked to prevent non-essential personnel from entering during the conduct of MEC operations. In addition, spotters will be used to stop work when non-essential personnel enters the EZ during the conduct of MEC operations.

3.3. Demolition Explosives

3.3.1. Delivery on As-Needed Basis

Donor explosives will be provided by a local vendor on an as-needed basis. MEC that is deemed acceptable to move will be transported to a portable storage magazine for temporary storage, MEC that is deemed not acceptable to move will be marked and guarded until disposal is accomplished

3.3.2. Explosive Storage Magazines

Due to the fact that on-going explosives needs might be present on the project, an on-site magazine to store recovered MEC will be utilized on this project. MEC will be stored in the un-barricaded type II ATF&E explosives magazine as hazard class/division (C/D) 1.1. The UXO contractor will maintain/control the sited explosive storage magazine.

Positioning of the magazine will be in accordance with (IAW) DESR 6055.09, DA PAM 385-64, and Section 55.206 of ATFP 5400.7. The closest occupied structure relative to the explosives magazine is 700 ft, and the nearest public road is 850 ft. The Magazine will be secured by the erection of a temporary fence that will be 8 to 10 ft in height and has one locked entry point. The maximum Net Explosive Weight (NEW) that will be stored will be less than 31 lbs. IAW DESR 6055.09 Section V3.E3.1.2.1.1.5.1, it has been determined that the Public Transportation Route Distance (PTRD) for the proposed magazine location has no public road access. The traffic for

the area of the magazine is less than 400 car/rail passengers per day, and less than 80 ship passengers per day. The PTRD is, therefore, no Minimum Fragment Distance (MFD) is required for public traffic route (PTR) distance (DA PAM 385-64 Section 5-5, and DESR 6055.09 Section V.3.E3.1.3).

Inhabited Building Distance exclusion for the magazine is 200 ft; this is based on a NEW of less than 31 lbs IAW DESR 6055.09 table V3. E3.T2.

Demolition areas planned for this project are to be located within the fenced open area to be located far enough away from the road and inhabited buildings as not to include them within required EZ (EZ distance based on NEW of the MEC and donor charge and engineering control being used) of the demolition area.

3.4. Blow-in-place

If a MEC is deemed unacceptable-to-move, it will be blown in place (BIP) on land or remotely moved for in water removal operations. Underwater BIP procedures will not be conducted. All explosive disposal activities will be performed by DDESB TP-18, "Minimum Qualifications for UXO Technicians and Personnel" revision 1, 24 June 2020 qualified UXO personnel within the munitions response site (MRS). Please see table 3-1 for minimum separation distances for BIP procedures.

If it is determined that an item is acceptable to move, then the MEC/MPPEH will be consolidated on land and a consolidated demolition shot will be performed IAW TP-18 as stated above. The SUXOS and UXOSO must agree in writing that MEC is deemed acceptable to move.

3.5. Collection Points

Collection points are those areas used to temporarily accumulate MEC pending destruction at a later time using consolidated shots. The maximum NEW at a collection point will be limited such that the K40 overpressure distance for the total NEW does not exceed the HFD for the area (see Table 3-1, footnote 1). If multiple collection points are used, they must be separated by the K11 overpressure distance for the NEW of MEC at each collection point.

3.6. In-Grid Consolidated Shots

If determined acceptable to move by the SUXOS and UXOSO, consolidating multiple MEC within the MRS is anticipated for this project. U.S. Army Engineering and Support Center, publication "Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites", dated March 2000 will be used, and a copy of this guidance will be available on site. The maximum NEW for a consolidated shot will be limited such that the K328 overpressure distance for the total NEW (including donor charges) does not exceed the MFD-H for the intentional detonation." The preferred explosive disposal method is to use the BEM to

determine the required burial depth so that no blast or fragmentation reaches the surface.

3.7. Maximum Credible Event (MCE)

This section is not applicable to this project; no explosive soil, chemical weapons material (CWM), or explosives-contaminated facilities are expected.

4. Start Date

The start date for field activities will be coordinated with SCDHEC and DESC.

5. MEC Migration

MEC migration potential within the Congaree River is not expected to be significant. To facilitate removal operations, given the seasonal time constraints for work within the river, MEC clearance of the cofferdam footprints may be completed in advance of contractor mobilization for the construction and removal activities.

6. Detection Equipment and Response Techniques

6.1. Removal Depth

The removal depths for MRS 1 and 2 land/water subsurface clearance of MEC/ MPPEH, and any ferrous metal items is two feet for underwater and three feet for land. However, anomaly signals on land will be followed until they are resolved or one foot below the maximum required excavation depth.

6.2. Detection Equipment

The handheld detectors that will be used for this project include Schondstedt or Ceia magnetometers for land and an all metals electromagnetic (EM) detector (White's) for underwater investigations. The handheld magnetometers have similar detection characteristics and can be expected to consistently detect the MEC items shown in Table 1-1 at their expected depths. The underwater EM detectors have a shorter detection range; however, they will still reliably detect a 10-inch cannonball at depths greater than 4 feet.

6.3. Analog Mag and Flag using Hand Held Detectors

The handheld detectors that will be utilized will be the Schondstedt or Ceia, and an all metals detector (Whites Spectrum XLT or similar).

6.4. Sweep Procedures

Each UXO Technician will demonstrate proficiency with the handheld geophysical device before site activities begin by locating industry standard objects (ISOs) buried in the functional check

area (FCA). The site will be divided into grids, and search lanes will be used to sweep for surface MEC and mag, and dig procedures detailed in the work plan will be conducted to investigate subsurface targets detected by the handheld detectors. See the work plan for more information on sweep and mag and dig procedures.

6.5. Exclusion Zone Control

Positive control of the EZ will be maintained at all times when MEC operations are being conducted. Prior to beginning MEC operations, the UXOSO will ensure that there are no non-essential personnel within the EZ, and the UXO contractor field staff will ensure that the EZ remains clear of non-essential personnel throughout the MEC operations. This will include barricading access roads and entry control points as necessary and displaying appropriate signage indicating explosive operations at barricade points, and posting safety observers to facilitate the halting of traffic and pedestrians. Tables 6-1a and 6-1b provide required Ezs for the MGFD on the surface and underwater.

Table 6-1a. Surface Exclusion Zones for MGFD

MGFDs		Exclusion Zones (feet)				
	Net Explosive Weight	Fragmentation Effects[2/]		Blast Overpressure Effects[2/]		
Description	(lb.) [1/]	HFD	MFD	K328	K40	K24
10-inch Cannonball Shell	1.172	237	3,060	393	48	29

Notes:
1/ Trinitrotoluene (TNT)-Equivalent Weight
2/ From Fragmentation Data Review Form, updated June 5, 2020.

Table 6-1b. Exclusion Zones for Personnel in Water for MGFD

MGFDs		Exclusion Zones (feet)		
			Blast Overpressure Effects in Water[3/]	
	NEW	No Fragmentation	Swimmers ≤ 1 ft	Swimmers/Divers > 1 ft
Description	(lb.)[1/]	Depth[2/]	$13000*W^{(1/3)}/50$ [4/]	$15*[DOB*W^{(1/5)}]+300*3$ [5/]
10-inch Cannonball Shell	1.172	3	312	990 – 1,259[6/]

Notes:
1/ TNT-Equivalent Weight
2/ From BEM 7.2
3/ Chief of Naval Operations-accepted Navy Underwater Criteria, 2014
4/ Exclusion zone for underwater unintentional detonation for swimmers in the top 1 foot of water, where W=net explosives weight (NEW).
5/ Exclusion Zone for unintentional underwater detonation for divers/dive teams, where W=NEW and DOB=Depth of Blast (underwater depth of munition item being investigated/removed).
6/ Range based on 1-foot DOB to 20-foot DOB (maximum depth of river at cofferdam footprint). A surface EZ will be established using the BEM when water depth is less than the No Fragmentation Depth.

The controlling EZs are shown in table 6-2 below.

Table 6-2. Controlling Exclusion Zones for unitions Response Site

Operation	Sited As	Exposed Sites	Basis[2/]	ESQD (feet)
Manual Operations[1/] (Surficial)	Unintentional Detonation	UXO teams	K40 of the MGFD	29[3]
	Unintentional Detonation	Public and non-essential personnel	HFD of the MGFD	237[3/]
Underwater Operations[1/4]	Unintentional Detonation	Swimmers depth ≤ 1 foot	D=(13,000*W$^{1/3}$)/50	312[5/]
Underwater Operations[1/4]	Unintentional Detonation	Swimmers/diver ≥ 1 foot	S=[15(DOB*W$^{1/5}$) +300]*3	990 – 1,259/
Portable Magazine (31) lb. NEW) Storage of recovered MEC/MPPEH	Aboveground, U.S. Bureau of Alcohol, Tobacco, Firearms (ATF) Type II magazine	Non-essential personnel in structures	Inhabited Building Distance (K40)	200
		Non-essential personnel in the open	Public Traffic Route (K24)	75
MEC Disposal Operations using BEM with 2.5 lb. donor charge	Intentional Detonation	Essential and non-essential personnel	BEM V7.2	Primary 0[5/]

Notes:

1/ Manual operations involve in-water and surface excavation of anomalies with hand tools.

2/ Primary MGFD is the 10 inch Cannonball Shell 4 pounds (lbs.) NEW of black powder equal to 1.720 NEW TNT.

3/ From Fragmentation Data Review Form, updated June 5, 2020.

4/ DOB=Depth of Blast (See Table 6-1b). Range based on 1-foot DOB to 40-foot DOB (maximum depth of bay at high tide is 40 feet). A surface EZ will be established using the BEM when water depth is less than the No Fragmentation Depth, as discussed in Section 6.2.1.

5/ BEM Version 7.2 BEM Printouts are located in Appendix A.

6.6. Operational Risk Management

Munitions response actions involve inherent risks and require evaluation of those risks. Table 6-3 lists risk assessments for the planned project activities using the DoD method for risk assessment.

Table 6-3. Hazard Analysis Matrix for Congaree River Project

Process Step	Hazard	Triggering Event	Initial Risk Index	Hazard Mitigation	Final Risk Index
1	Manual removal of MEC underwater	MEC reacts to movement during removal	C/III/4	UXO technicians	D/III/5
2	Movement and inspection of MEC	MEC reacts to movement and handling during inspection	C/II/3	UXO technicians	D/II/4
3	MEC/MPPEH Transportation	MEC/MPPEH reacts to direct	C/II/2	Item determined acceptable to move. Item packed in sand in a wooden box.	D/II/4

Process Step	Hazard	Triggering Event	Initial Risk Index	Hazard Mitigation	Final Risk Index
		impact or shock		If item is electrically initiated or fuzed, it will be wrapped in aluminum foil and placed in a closed metal container.	
4	MPPEH Processing	MPPEH reacts to impact during processing	C/II/4	MPPEH will be certified and verified as MDAS by two UXO technicians prior to archeological inspection and recycling.	D/II/5
5	MEC/MPPEH Storage	MEC/MPPEH reacts to heat, shock, or friction	C/I/2	ATF Type II HD 1.1 Portable Magazines with fire break utilized for MEC/MPPEH storage.	D/III/5
6	Receipt, handling, holding of donor charges	Donor charges react to heat, shock, or friction	C/II/3	Use of binary explosives, which have no explosive storage requirements or same-day donor charge delivery; detonators stored separately from main charges in ATF-approved day box; demolition operations will not take place if electrical storm <10 miles	D/II/4
7	MEC/MPPEH Disposal using BEM	MEC/MPPEH/ Donor reacts to heat, shock, or friction	C/II/3	Use of BEM to mitigate frag, all demolition operations personnel trained, demolition operations will not take place if electrical storm <10 miles	D/II/4

6.7. Intrusive Investigation

Non-Mechanized MEC removal and identification of anomalies will be performed using the criteria and procedures outlined below. Only DDESB TP-18 qualified personnel will perform intrusive excavation and investigation of anomalies. To gain access to a subsurface anomaly, excavation will be initiated to the side of the anomaly and will not be conducted directly over the anomaly until such time as the depth of the anomaly can be ascertained. Earth Moving Machinery (EMM) excavation of the soil overburden may be performed for anomalies for the purpose of removing overburden. However, the EMM will not be used within 12 inches directly over the anomaly.

Additional excavation will be conducted with care using small hand tools only. A detailed accounting of all MEC located at each site will be made and maintained by the SUXOS. A log entry and photograph will be made for each MEC indicating the item's identification, explosive status, location (x, y, and z measurements), and final disposition. All munitions debris excavated during this investigation will be removed from the dig site and consolidated in appropriate containers for archeological screening and recycling.

6.8. Quality Control and Quality Assurance

The details of the quality control (QC) process that includes three phases of control QC inspections, equipment checks, and blind seeding are located in the project work plan. Upon conclusion of the removal activities in each grid within each area, the UXO Quality Control Specialist (UXOQCS) will conduct a surface and subsurface quality control (QC) inspection. QC inspection results will be submitted to the DESC for submission and review by SCDHEC for Quality Assurance (QA). Any non-conformance to contractual requirements will be documented and reported in writing to the SUXOS, Quality Control Manager (QCM), and Project Manager (PM). The SUXOS will be responsible for the field remediation of the non- conformance.

6.9. Equipment Tests

See section 6.4 Sweep Procedures for information regarding equipment tests.

7. Disposition Techniques

7.1. Demolition Operations

If disposal activities are required, they will be performed by personnel qualified in accordance with DDESB TP-18 and performed within the MRS. The EZs for intentional detonations are shown in Table 3-1, and Q-D Arcs are shown in Figure A-3.

7.1.1. Methods of Disposal

A. If disposal activities are required, they will be performed by qualified UXO personnel within the MRS. The EZs for intentional detonations are shown in Table 3-1, and Q-D Arcs are shown in Figure A-2.

B. MEC will be marked and guarded, if deemed not acceptable to move until disposal is accomplished. MEC that is deemed acceptable to move will be transported to the portable storage magazine for temporary storage or to a designated collection point and guarded until MEC disposal operations are scheduled.

C. All explosive operations will follow the UXO contractor's SOPs for explosive disposal procedures and follow the guidance outlined in TM 60A-1-1-31 and EM 385-1-97, Explosives Safety and Health Requirements Manual. Demolition operations will be performed as needed based magazine capacity, and volume of MEC recovered.

The magazine location chosen for this effort is located within a fenced open area. It has controlled access. All gates are to be locked at all times when not under supervision.

The nearest improved public road is approximately 850 feet away. The nearest inhabited building is 700 feet away.

7.2. Explosive Storage, Accountability, and Transportation

The UXO contractor does not anticipate generating any munitions-based hazardous waste that will require off-site transportation, treatment, storage, or disposal. MEC and/or MPPEH will be destroyed on-site and the resulting scrap will be certified as Material Documented as Safe (MDAS) and turned over to a recycler for smelting before it is released to the public. Non-hazardous cultural debris (CD) and municipal waste generated during this project will be transported to a municipal landfill for disposal.

7.3. Engineering Controls

The primary engineering control for on-site explosive neutralization will be the DDESB BEM calculator (V7.2). Using the BEM calculator will ensure no blast or fragmentation will reach the surface. For MEC deemed unacceptable to move, sandbags will be the primary engineering control following the guidance in (HNC-ED-CS-S-98-7, HNC Safety Advisory dated 7 November 2011, the DDESB Memorandum "Clarifications Regarding Use of Sandbags for Mitigation of Fragmentation and Blast Effects due to Intentional Detonation of Munitions", Nov. 29 2010, and DDESB Memorandum "Revision of DDESB Approval for Use of Sandbag Mitigation of Fragmentation and Blast Effects Resulting from the Intentional Detonation of Munitions", May 22 2014) or Water Mitigation (HNC-ED-CS-S-00-3) may be used to reduce the intentional detonation EZ.

7.4. Scrap Procedures

7.4.1. Inspection and Certification

MPPEH processing procedures will be IAW DoDI 4140.62 and EM 200-1-15. All MPPEH will be assessed and its explosives safety status determined and documented prior to transfer to a third party for disposal recycling or preservation. Prior to release to the public, MPPEH will be documented by authorized and technically qualified personnel as MDAS after a 100% inspection and an independent 100% re-inspection to determine that it is safe from an explosives safety perspective. A DD Form 1348-1A will be completed for all munitions debris and range- related debris to be transferred for final disposition and certified by the USXQCS & SUXOS.

7.4.2. DD Form 1348-1A

Upon completion of all removal activities, the UXO contractor will complete a DD Form 1348-1A IAW EM 200-1-15 that will include the following statement regarding processed MDAS & investigation derived waste (IDW) materials:

"This certifies and verifies that the materials listed have been 100 percent inspected and to the best of our knowledge and belief, are inert / or free of explosive or related material."

7.4.3. Alternative Disposal Techniques

The UXO contractor will not transport any MEC/ MPPEH off-site for disposal. If MEC/MPPEH are required to be demilitarized off-site, the UXO contractor will report this to the DESC on-site representative and implement explosive safety measures to secure the recovered munitions. The UXO contractor in conjunction with DESC will contact the Richland County bomb squad at (803) 576-3000 for assistance. If Richland County Shariff's Department cannot respond, DESC will request Richland County Shariff's Department to contact the South Carolina State Law Enforcement Division (SLED) for assistance with the munition. If SLED cannot support a response, DESC will request SLED to contact U.S. Military EOD to assist with the demilitarization of the item.

8. Environmental, Ecological or Cultural Consideration

Cofferdam construction activities will be conducted around the short-nosed sturgeon spawn season. DESC will determine when the area is safe to work in prior to giving the notice to proceed to the UXO contractor. Ordnance that can be inspected and certified as MDAS will be transferred to the artifact recovery team.

In the event that any environmental, ecological, or cultural considerations arise during project performance, project activities or affected portions of project activities will immediately cease, and the Project SUXOS, PM, DESC, and Government Representatives will be immediately notified. Project activities will not commence in project-affected areas until the contractor is notified to proceed in a manner determined appropriate.

9. Technical Support

9.1. Military Support

No CWM is suspected at this site. However, if suspected CWM is encountered at the project site, all work will immediately cease. All project personnel will withdraw along identified, cleared paths upwind from the discovery. The senior UXO person on site will designate a two-person team to secure the area and prevent unauthorized access. This team will position themselves as far upwind as possible while still maintaining visual contact and control of the area. The senior UXO person on-site following evacuation will immediately notify the PM, who will immediately coordinate with DESC and Government Project Representatives to contact and facilitate military control and EOD response. The contractor will maintain control of the site until control is relinquished to the military. Additionally, local law enforcement will be contacted of the discovery. If the item is recovered chemical warfare materiel (RCWM) or has an unknown liquid filler, the on-site DESC representative will notify the Chemical Warfare Design Center (CWM-DC) at the CEHNC by calling the 24/7 telephone number at 256-895-1180.

9.2. Contractor

All on-site UXO Personnel will meet the required training and minimum experience required by DDESB TP-18.

10. Residual Risk Management

10.1. Land Use Control

No permanent land use controls are being proposed. Temporary fencing to prevent unauthorized access to the site will be put up and maintained during the entire removal action project.

10.2. Long-Term Management

Any long-term management is the responsibility of DESC or other stakeholders related to the project.

11. UXO Safety Education Program

The UXO contractor has not been contracted to perform any UXO Safety education program outside daily safety briefings that are utilized to make other site personnel aware of hazards presented by UXO and the proper procedures in notifying the UXO contractor if evidence of UXO is discovered.

12. Stakeholder Involvement

This project was coordinated with SCDHEC, DESC, and other project stakeholders. All agencies will remain active in the final planning and response stages of the project as required, to include Work Plan review and final approval, progress review and schedule adjustments as required to accommodate construction schedules, EZ establishment, and control support as necessary, unplanned environmental emergency as necessary, and final report review, comment, and acceptance.

13. Contingencies

Contingency plans for dealing with MEC/MPPEH that requires external state or federal EOD support are detailed in section 7.4.3

Appendix A

Maps

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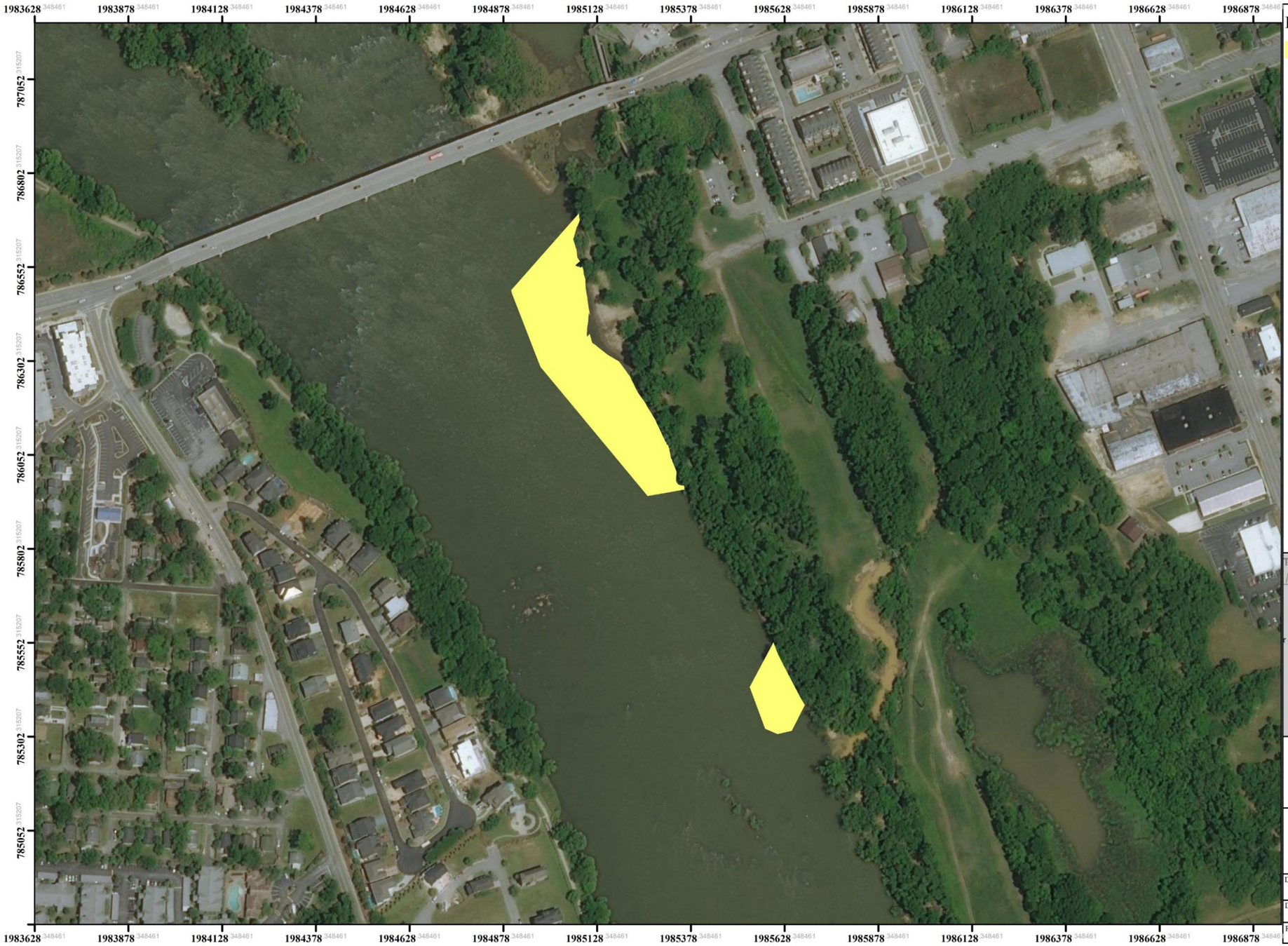

Legend

Extent of Proposed TLM Removal

18°21'

NAD 1983 StatePlane South Carolina (Feet)
Data Provided By:
Apex Companies, LLC

250 125 0 250
Feet

Meters
75 37.5 0 75

Location Map:
Fort Benning, GA

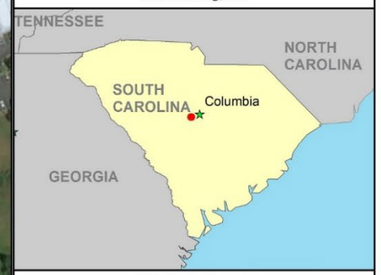

FIGURE A-1
SITE LOCAITON
CONGAREE RIVER PROJECT
COLUMBIA, SOUTH CAROLINA

Prepared For:
Apex Companies, LLC

Prepared By:
TITAN Associates Group inc.

DRAWN	VERIFIED	APPROVED
M. Norris	T. Leonard	
DATE 01/8/2021	FILE A-1 Site Location.mxd	
PAGE # A-1	SCALE 1 inch = 250 feet	

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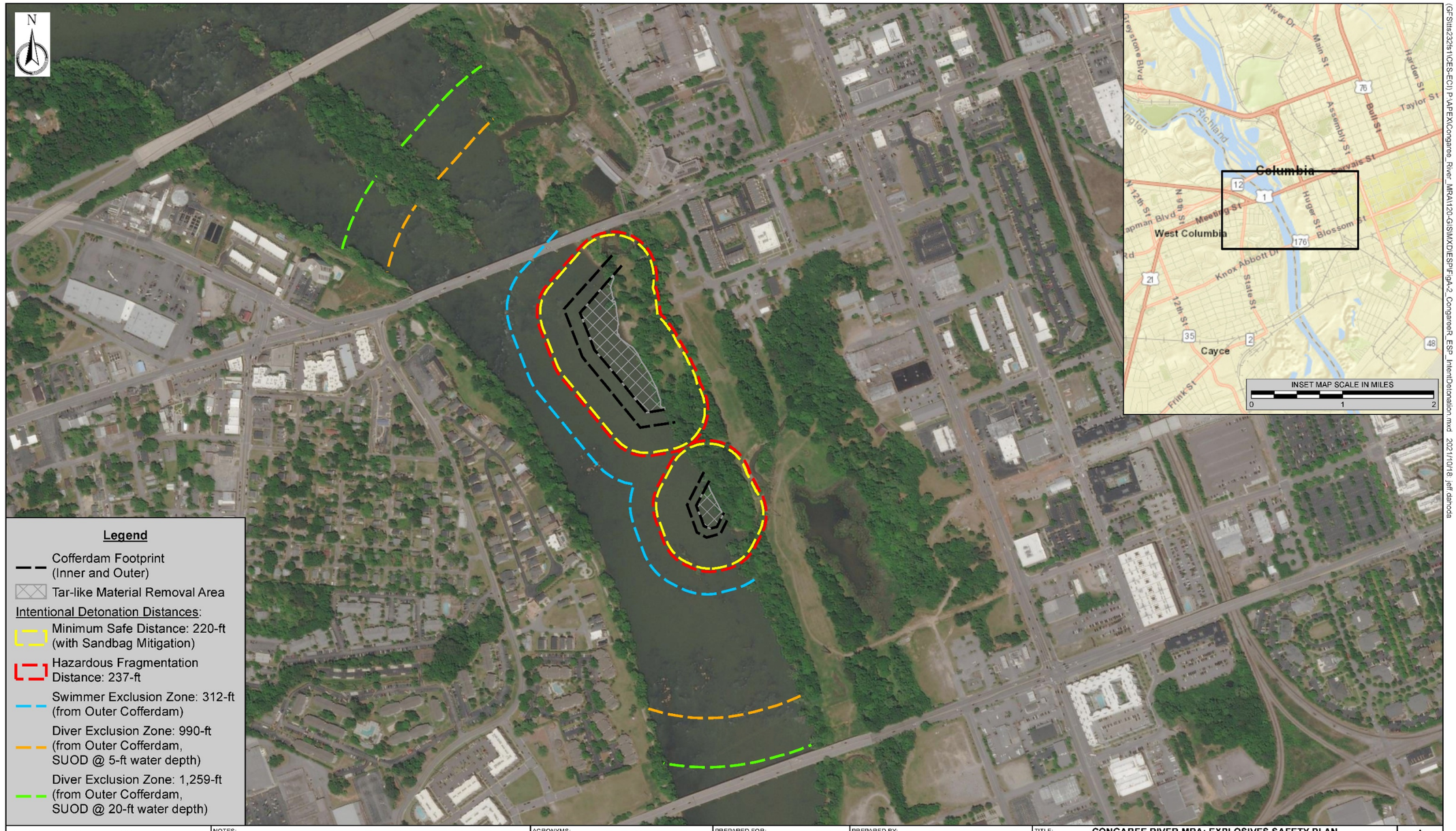

1 INCH = 500 US FEET (SCALE AT 17" X 11")

SCALE IN US FEET
0 500 1,000

NAD 1983 STATE PLANE SOUTH CAROLINA FIPS 3900 US FEET

Creator: JPD / Checked: SMW / Approved: MWD

NOTES:
1) Basemaps from ESRI imagery web mapping service, provider of basemap, aerial, and satellite imagery (Source for Main Map: Maxar, resolution 0.5-m, 04/27/2021. Source for Inset Map: World Street Map).

ACRONYMS:
MRA = Munitions Response Area
SUOD = Safe Underwater Overpressure Distance

PREPARED FOR: APEX

PREPARED BY: TETRA TECH

TITLE: CONGAREE RIVER MRA: EXPLOSIVES SAFETY PLAN

INTENTIONAL DETONATION DISTANCES

A REVISION

PROJECT:	PROJECT NO.:	FIGURE:
CONGAREE RIVER MRA, SC	179-47200023	**Figure A-2**
LOCATION: COLUMBIA, SOUTH CAROLINA	DATE: 10/18/2021	

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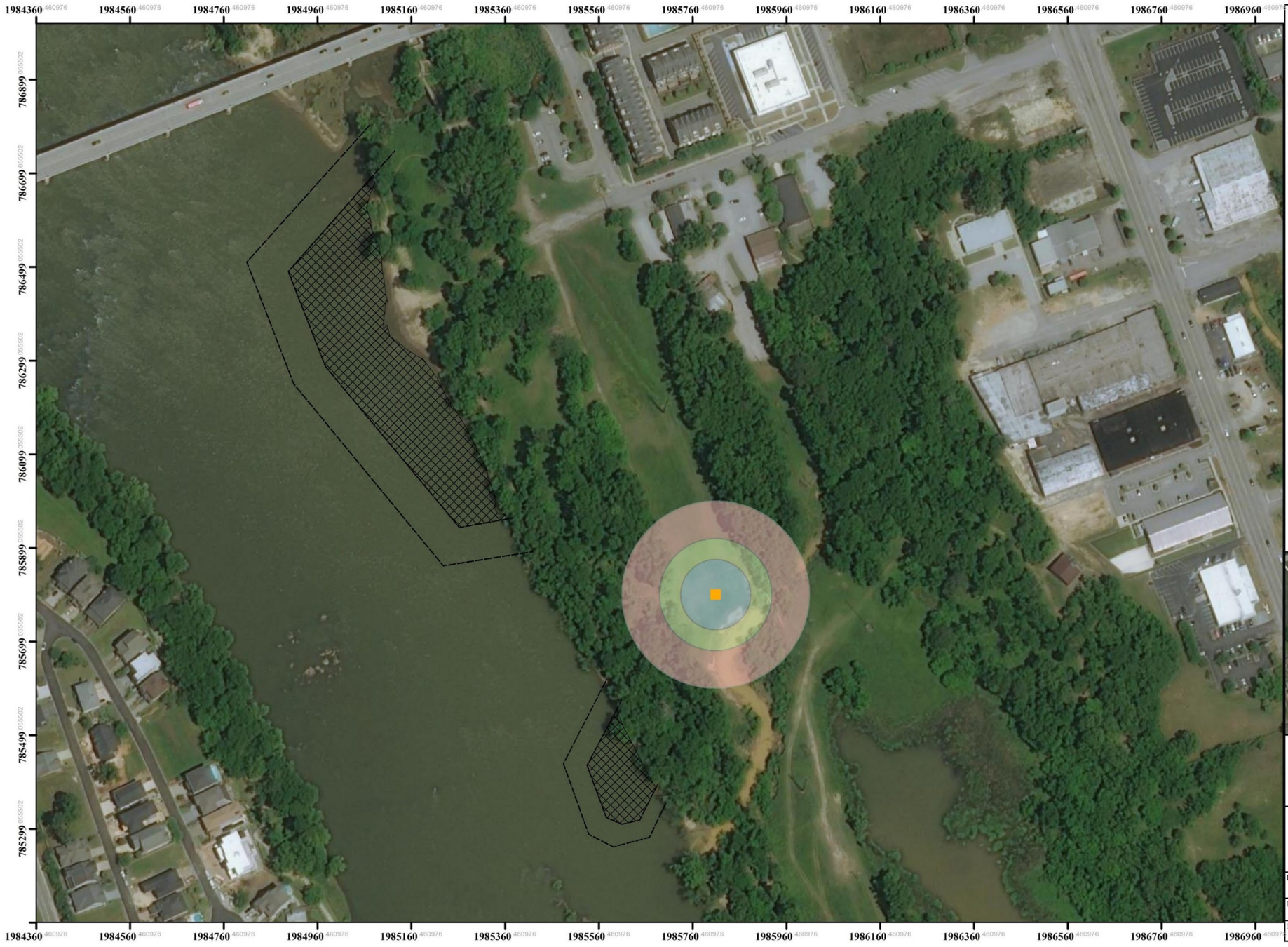

Legend

- Magazine
- Proposed Cofferdam Location
- Extent of Proposed TLM Removal
- PTRD-Low 75 ft (31 Lbs Net Explosive Weight)
- PTRD-Medium 120 ft (31 Lbs Net Explosive Weight)
- IBD/PTRD-High 200 ft (31 Lbs Net Explosive Weight)

18°21'

NAD 1983 StatePlane South Carolina (Feet)
Data Provided By:
Apex Companies, LLC

200 100 0 200
Feet

Meters
60 30 0 60

Location Map:
Fort Benning, GA

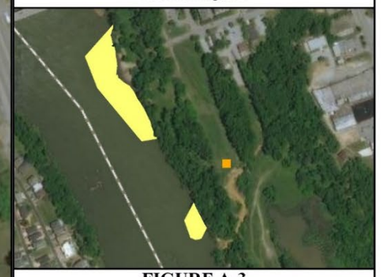

FIGURE A-3
MEC STORAGE MAGAZINE
PROPOSED LOCATION
CONGAREE RIVER PROJECT
COLUMBIA, SOUTH CAROLINA

Prepared For:
Apex Companies, LLC

Prepared By:
ITTAN Associates Group inc.

DRAWN	VERIFIED	APPROVED
M. Norris	T. Leonard	
DATE 01/08/2021	FILE A-3 Magazine.mxd	
PAGE # A-3	SCALE 1 inch = 200 feet	

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Appendix B

Supporting Explosives Safety Data

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Fragmentation Data Review Form

Database Revision Date 6/5/2020

Category:	Black Powder Rounds
Munition:	10 in Cannonball Shell
Case Material:	Cast Iron, Grey, CL35
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Civil War Era
Munition Case Classification:	Extremely Heavy Cased

DODIC:	
Date Record Created:	11/2/2009
Record Created By:	SDH
Last Date Record Updated:	4/15/2013
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	4
Diameter (in):	9.8500
Cylindrical Case Weight (lb):	93.88430
Maximum Fragment Weight (Intentional) (lb):	3.5556
Design Fragment Weight (95%) (Unintentional) (lb):	0.8186
Critical Fragment Velocity (fps):	1659

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	237
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	3060
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2087

Overpressure Distances

TNT Equivalent (Pressure):	0.43
TNT Equivalent Weight - Pressure (lbs):	1.720
3.5 psi, K18 Distance (ft):	22
2.3 psi; K24 Distance (ft):	29
1.2 psi, K40 Distance (ft):	48
0.0655 psi, K328 Distance (ft):	393

"NOTE: Values shown within this section only address overpressure hazards and do not account for applicable distance values for fragments and debris as required per DoD 6055.09-M."

Sandbag and Water Mitigation Options

TNT Equivalent (Impulse):	0.43
TNT Equivalent Weight - Impulse (lbs):	1.720
Kinetic Energy 10^6 (lb-ft²/s²):	4.8957

Single Sandbag Mitigation

Required Wall & Roof Thickness (in)	36
Expected Max. Throw Distance (ft):	220
Minimum Separation Distance (ft):	220

Double Sandbag Mitigation

Required Wall & Roof Thickness (in)	Not Permitted
Expected Max. Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Water Mitigation

Minimum Separation Distance (ft):	275
Water Containment System:	1100 gal tank

Note: Use Sandbag and Water Mitigation in accordance with all applicable documents and guidance. If a donor charge larger than 32 grams is utilized, the above mitigation options are no longer applicable. Subject matter experts may be contacted to develop site specific mitigation options.

Minimum Thickness to Prevent Perforation (in)

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	12.80	7.40
Mild Steel:	2.21	1.23
Hard Steel:	1.81	1.01
Aluminum:	4.07	2.36
LEXAN:	11.35	7.93
Plexi-glass:	9.75	6.06
Bullet Resist Glass:	9.20	5.43

Item Notes

Distribution Statement D. Distribution authorized to the Department of Defense and U.S. DoD contractors only for Administrative-Operational Use (7 January 2020). Other requests shall be referred to the Department of Defense Explosives Safety Board, 4800 Mark Center Drive, Suite 16E12, Alexandria, VA 22350.

BURIED EXPLOSION MODULE

(Version 7.2)

Note: White cells require input. All other cells are calculated.

Based on DDESB Technical Paper 16, Revision 5
(ENGLISH UNITS)

BURIAL CHARACTERISTIC INPUTS

BURIAL MEDIUM	SOIL TYPE	DEPTH OF BURIAL (ft)
Soil	Dry Sand	6.00

(See TP 16, Revision 5 for soil details)

EXPLOSIVE CHARGE INPUTS

ITEM DESCRIPTION	NUMBER OF ITEMS
10 in Cannonball Shell	5 See Note 6

DONOR CHARGE EXPLOSIVE TYPE	TOTAL WEIGHT OF DONOR CHARGES (lbs)	HORIZONTAL DISTANCE (for pressure calcs)
RDX	2.50	200

VALUES USED IN BEM CALCULATIONS

SINGLE ITEM NEW (lbs)	4.00	TOTAL TNT WEIGHT USED (lbs)	12.25
ITEM DIAMETER (in)	9.850		
SINGLE ITEM MAXIMUM FRAG. WEIGHT (lbs)	3.5556	FRAGMENT WEIGHT USED IN CALCULATIONS (lbs)	3.5556
SINGLE ITEM MAXIMUM FRAG. VELOCITY (ft/s)	1,659	FRAGMENT VELOCITY USED IN CALCULATIONS (ft/s)	1,659

BURIED EXPLOSION MODULE OUTPUTS

CRATER OR CAMOUFLET?

CAMOUFLET See Note 1 See Note 2

CAMOUFLET CAVITY RADIUS (ft): 3

Surface K328 Distance (ft)	756.1	
Buried Equiv. K328 (0.066 psi)	-N/A-	ft
Buried Equiv. K24 (2.3 psi)	-N/A-	ft

NON-ESSENTIAL PERSONNEL DISTANCE (ft): 0

Pressure Values

Distance

	(psi)	(dB)	
Greater of Soil Ejecta and Max. Frag. (0 ft)	-N/A-	-N/A-	See Note 1
User-Entered Horizontal Distance (200 ft)	-N/A-	-N/A-	See Note 1

Note: Provide essential personnel equivalent K24 overpressure distance and protection from all fragments.

WARNING MESSAGES

Note 1: Airblast methodology not applicable (N/A) for Camouflet conditions!
Note 2: Depth too great--no fragments expected

Note 6: The BEM assumes intentional detonation of a single horizontal layer of munitions.

BURIED EXPLOSION MODULE

(Version 7.2)

Note: White cells require input. All other cells are calculated.

Based on DDESB Technical Paper 16, Revision 5
(ENGLISH UNITS)

BURIAL CHARACTERISTIC INPUTS

BURIAL MEDIUM	SOIL TYPE	DEPTH OF BURIAL (ft)
Water	Wet Sand	3.00

(For water burial ignore soil type)

EXPLOSIVE CHARGE INPUTS

ITEM DESCRIPTION	NUMBER OF ITEMS
10 in Cannonball Shell	1

DONOR CHARGE EXPLOSIVE TYPE	TOTAL WEIGHT OF DONOR CHARGES (lbs)	HORIZONTAL DISTANCE (for pressure calcs)
RDX	0.01	

VALUES USED IN BEM CALCULATIONS

SINGLE ITEM NEW (lbs)	4.00	TOTAL TNT WEIGHT USED (lbs)	1.73
ITEM DIAMETER (in)	9.850		
SINGLE ITEM MAXIMUM FRAG. WEIGHT (lbs)	3.5556	FRAGMENT WEIGHT USED IN CALCULATIONS (lbs)	3.5556
SINGLE ITEM MAXIMUM FRAG. VELOCITY (ft/s)	830	FRAGMENT VELOCITY USED IN CALCULATIONS (ft/s)	830

BURIED EXPLOSION MODULE OUTPUTS

FRAGMENT HAZARDS AT SURFACE?

NO FRAGS See Note 2

Surface K328 Distance (ft)	394.1	
Buried Equiv. K328 (0.066 psi)	-N/A-	ft
Buried Equiv. K24 (2.3 psi)	-N/A-	ft

NON-ESSENTIAL PERSONNEL DISTANCE (ft): 0

Note: Provide essential personnel equivalent K24 overpressure distance and protection from all fragments.

Pressure Values

Distance	(psi)	(dB)	
Max Frag Distance (0 ft)	-N/A-	-N/A-	See Note 3
User-Entered Horizontal Distance (ft)	-N/A-	-N/A-	See Note 4

WARNING MESSAGES

Note 2: Water too deep--no fragments expected
Note 3: No overpressure is produced at this depth
Note 4: No overpressure is produced at this depth
Note 5: Scaled Depth Out of Range -- Extrapolated

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