Appendix D
Munitions and Explosives of Concern SWMUs 8 and 9 Corrective Action Plan

Jacobs

Woodbine Facility, Camden County, Georgia

Munitions and Explosives of Concern
Solid Waste Management Units 8 and 9 Corrective Action Plan

Revision 3

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Union Carbide Corporation

Munitions and Explosives of Concern
Solid Waste Management Units 8 and 9 Corrective Action Plan

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Acronyms and Abbreviations

°F	degrees Fahrenheit
3R	Recognize, Retreat, and Report
BCS	Bayer CropScience
bgs	below ground surface
CAP	Corrective Action Plan
CS	orthochlorobenzalmalononitrile
DGM	digital geophysical mapping
DLP	decision logic process
DU	decision unit
EC	environmental covenant
GA EPD	Georgia Environmental Protection Division
HE	high explosive
ICP	Institutional Control Plan
IMWP	Interim Measures Work Plan
Jacobs	Jacobs Engineering Group Inc.
LUC	land use control
MC	munitions constituents
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
mm	millimeter(s)
MPPEH	material potentially presenting an explosive hazard
MRA	Munitions Response Area
O&M	operations and maintenance
PTTF	powder train time fuze
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RTP	Rocket Test Pit
RUZ	Restricted Use Zone
site	UCC Woodbine facility in Camden County, Georgia
SWMU	Solid Waste Management Unit
UCC	Union Carbide Corporation
USACE	U.S. Army Corps of Engineers
UXO	unexploded ordnance

1. Introduction

1.1 Authorization

Jacobs Engineering Group Inc. (Jacobs) was retained by Union Carbide Corporation (UCC), a wholly owned subsidiary of The Dow Chemical Company, to provide a Munitions and Explosives of Concern (MEC) Corrective Action Plan (CAP) that addresses potential risks associated with MEC and material potentially presenting an explosive hazard (MPPEH) at the UCC Woodbine facility in Camden County, Georgia (site) and presents a best practical alternative for managing those potential risks. The corrective action alternatives presented in this CAP are based on findings from the MEC Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (CH2M HILL [CH2M] 2007), Phase I MEC RCRA Facility Investigation (RFI) (CH2M 2009), Phase II MEC RFI (CH2M 2010), Phase III MEC RFI (CH2M 2018), and Woodbine Solid Waste Management Unit (SWMU) 8 Interim Measures corrective actions (Jacobs 2022).

The site (Facility Identification Number: GAD 981235294) is currently regulated under a Hazardous Waste Facility Permit HW-063(D), which provides detailed information regarding post-closure care and corrective action for the closed hazardous waste landfill and the RCRA SWMUs at the facility (Georgia Department of Natural Resources 2017). The MEC CAP addresses those SWMUs (SWMUs 8 and 9) that do not have No Further Action determinations where MEC is a known consideration. This MEC CAP is being provided to Georgia Environmental Protection Division (GA EPD) for review. Once approved, the preferred corrective action set forth in this MEC CAP will be implemented.

1.2 Corrective Action Plan Purpose and Scope

The purpose of this MEC CAP is to:

- Briefly summarize the historical investigation, removal, and management of MEC/MPPEH at the site;
- Explain potential risks and current understanding of the conditions of residual MEC/MPPEH at the site;
- Evaluate corrective action alternatives that address MEC-related risk and discuss the preferred corrective action that would minimize the potential hazards associated with MEC/MPPEH to support current and predicted future land use at the site;
- Pursue a No Further Action determination from GA EPD for MEC/MPPEH at SWMUs 8 and 9 at the site following approval of this CAP and implementation of institutional controls.

1.3 Facility Description and Areas Targeted for Corrective Action

The site is located on a 4,045-acre parcel approximately 11.5 miles due east of the town of Woodbine in Georgia Militia District Number 31, Camden County, Georgia (Figure 1). In 1962, Thiokol Corporation purchased the property, and from 1967 to circa 1975, the facility manufactured and tested "deterrent containing" munitions items, including M651 40-millimeter (mm) orthochlorobenzalmalononitrile (CS or tear gas) rounds, the XM-15 (CS canister cluster), M406 40-mm high explosive (HE) grenades, M49 trip flares, and 81-mm mortars with M301 illuminating projectiles .

This CAP was prepared for SWMUs 8 and 9 (formerly referred to as Munitions Response Areas [MRAs] 1 and 2, respectively) defined as follows:

- **SWMU 8** – Consists of 259.3 acres in the north-central portion of the facility and includes the former 40-mm Test Range and the former 81-mm Mortar Test Range (Figure 2).

- **SWMU 9** – Consists of 111.6 acres located in the eastern portion of the facility formerly used for MEC disposal (Figure 2).

MEC/MPPEH and debris removal activities have been conducted from 1992 through 2020. Further MRA/SWMU history, evolution, and current site conditions are provided in Section 2.

1.4 Report Organization

This CAP is organized into the following sections:

- **Section 1, Introduction** – Presents the purpose, scope, and organization of this document, as well as a brief description of the facility.
- **Section 2, Facility Description** – Provides detail regarding the facility use, site characteristics, investigation information, nature and extent of MEC and munitions debris (MD), current and reasonably anticipated future use, and a summary of facility and MEC-related risks.
- **Section 3, MEC Corrective Action Alternatives** – Provides a description, comparison, and estimated cost of corrective action alternatives, as well as analysis of the proposed corrective action alternative.
- **Section 4, References** – Presents a list of works cited in this document.

2. Facility Description

2.1 Facility Location and Munitions Use History

The site is located on a 4,045-acre parcel approximately 11.5 miles due east of the town of Woodbine in Georgia Militia District Number 31, Camden County, Georgia (Figure 1). The Satilla River and Todd Creek lie north of the facility; the Cumberland River, Floyd Creek, and the former Bayer CropScience (BCS) property are southeast of the facility; and the property west of the facility is undeveloped.

In the early 1940s, a paper company purchased the land for use as a tree farm. In 1962, Thiokol Corporation purchased the property, and from 1967 to circa 1975, the facility manufactured and tested "deterrent containing" munitions items, as detailed in Table 1.

Table 1. MEC Types at UCC Woodbine
Munitions and Explosives of Concern Corrective Action Plan, UCC Woodbine

Type	Function	Use	Fuze
M301 Illumination Projectile for 81-mm mortar	Target Illumination	Projected High Angle Ejection	PTTF
40-mm grenade: M406 (HE) and M651 (CS)	HE, CS	Projected low velocity	HE (always acting)/CS (point detonating)
XM 15 CS Canisters	Pyrotechnic burn	Irritant Smoke	Percussion Cap
M84/M84A1 – Fuze	Delay	81 mm Illumination Projectile	PTTF
M581E1 – Fuze	Impact	M651 (CS) 40-mm grenade	Point Detonating
M49 Trip Flare	Illumination	Provides illumination and warning of infiltrating troops	Pressure Release

Note:
PTTF = Powder Train Time Fuze

In 1976, UCC purchased the property from Thiokol Corporation. A UCC subsidiary operated the facility from 1976 to 1986 as an agricultural chemical formulation and manufacturing facility. In December 1986, UCC sold the manufacturing facility and some of the adjacent land to Rhone-Poulenc, which was later renamed Aventis CropScience, then BCS (CH2M 2007).

UCC retained ownership of the current remaining 4,045 acres (referred to herein as the site). SWMUs 8 and 9 remained as undeveloped private land after the 1976 property sale, with much of the area covered by pine forest and some of the forest harvested for timber. SWMUs 8 and 9 are further described in the following subsections.

2.1.1 SWMU 8 – Former 40-mm Test Area and Former 81-mm Mortar Test Area

SWMU 8 is composed of 259.3 acres in the north-central portion of the facility, is bounded by Todd Creek to the north and SWMU 1 (former landfill) to the west and was formerly referred to as MRA-1. An access road bisects SWMU 8 through the former 81-mm Mortar Test Range and curves north adjacent to the former 40-mm Test Range. The road ends in a clearing identified as a former Rocket Test Pit (RTP).

Historical records and facility inspections indicate the munitions employed in SWMU 8 were M406 40-mm HE grenades, M651 40-mm CS grenades, XM-15 CS cannisters, M49 flares, and 81-mm mortar with M301 illumination projectiles. In addition, fuzes (M84, M84A1, and M581E1) and other components/fragments related to the listed MEC types were encountered at SWMU 8. Range fans for investigation were established based on limited information discovered through past investigation results, interviews, and a systematic approach to executing an RFI used on former U.S. Department of Defense range investigations applying standard surface danger zones for firing 40-mm grenades and 81-mm mortar projectiles (USACE 2001). The former 40-mm Test Range, former 81-mm Mortar Test Range, the RTP, and a buffer zone designated as a protective area where the effect of a detonating munition would not endanger others are all inside what is now the 259.3-acre SWMU 8 (Figure 2).

2.1.2 SWMU 9 – Former MEC Disposal Area

SWMU 9 consists of 111.6 acres located in the eastern portion of the facility (Figure 2) and was formerly referred to as MRA-2. Most of SWMU 9 is heavily vegetated except for an access road traversing the SWMU and an open area in the central portion of SWMU 9. Based on historical records and interviews with personnel, open burning of off-specification MEC reportedly was conducted from 1966 to 1976 in the open area in the central part of SWMU 9. The site was not intended for open detonation; however, burning activities resulted in inadvertent detonations. Based on historical records and interviews, the munitions burned or detonated in SWMU 9 were XM-15 CS cannisters, M49 flares, and 81-mm mortar with M301 illumination projectiles. In addition, fuzes, primers, 40-mm ball assemblies, flare/ordnance and explosive waste mixture, bio waste, and riot control agents (such as CS) were also burned/detonated at SWMU 9. No explosive safety quantity distances are known to have been established for the disposal site, and the estimated boundary of SWMU 9 (Figure 2) represents the assumed maximum estimated kickout radius from detonations in the disposal area. The boundary of SWMU 9 is also supported by the locations where MEC and debris were identified in previous investigations because most items were found in the demolition area at the center of the SWMU or within a distance that would be expected to receive kickouts from the demolition area (CH2M 2009, 2010).

2.2 Facility Characteristics and Physical Description

2.2.1 Site Access and Land Use

The site is currently not being used for industrial, recreational, or residential purposes. It is primarily uninhabited, inaccessible woodlands. SWMUs 8 and 9 are on private land owned by UCC, though a small portion of SWMU 8 is located on BCS property (Figure 2). There is a closed RCRA Hazardous Waste Landfill directly west of the former 40-mm Test Range. Todd Creek, a tributary to the Satilla River, is located to the north. The UCC property is accessible by water and land, although no residential or industrial neighbors (aside from the former BCS facility) are in close proximity to the SWMUs, and general public access by motor vehicle is restricted by locked gates. Access to some culturally significant historical landmarks located outside of SWMUs 8 (former Bellevue plantation home) and 9 (Floyd Family Cemetery) may require travel through the SWMUs.

The site currently has an existing environmental covenant (EC) (recorded in 2011 and included as Attachment 1 to Appendix A), which restricts land use to non-residential and prohibits the extraction or use of groundwater for non-remedial purposes. The proposed future land use for the site is for conservation. Timber has been harvested in the past from the site and may be harvested again in the future.

2.2.2 Ecological Setting

The site is primarily wooded with scattered wetlands south of Todd Creek and tidal marshes to the north. SWMUs 8 and 9 are mostly heavily forested, consisting of either hardwoods or pines. The majority of the pines are planted in rows. Undergrowth in all the forests is moderate to thick brush. During the MEC surface clearance work and digital geophysical mapping (DGM) conducted in 2008, vegetation less than 6 inches in diameter was removed within transects that covered approximately 5 percent of the total area of SWMUs 8 and 9 (CH2M 2009). Since then, the vegetation has grown back to thin-to-moderate levels within these transects. During 2018 to 2020 interim action activities, vegetation was cleared across approximately 55 acres of SWMU 8 by cutting brush greater than 6 inches above the ground surface, chopping vines and tree limbs, and removing small trees less than 4 inches in diameter (Jacobs 2022).

A review of historical records indicated federal or state listed animal species have potential to occur within the site (Jacobs 2018a). Gopher Tortoise have been observed within SWMUs 8 and 9. Though not observed during investigative and removal activities within SWMUs 8 and 9, the eastern indigo snake could occur in this area, as it frequently is a commensal with the gopher tortoise (Jacobs 2022).

2.2.3 Cultural Resources

The site is located within the property of the historic homestead of Charles Floyd and his son, General John Floyd. Remnants of the former plantation home, Bellevue, still stand on the site, and the Floyd Family Cemetery is still visited occasionally by family and visitors. Access to the cemetery is through SWMU 9. From 1927 to 1942, the facility was part of a tract known as the Sea Island Game Preserve at Cabin Bluff and was used as a hunting preserve (CH2M 2018). The property continues to offer protected habitat to a wide variety of wildlife, including a large population of wild boar.

2.2.4 Topography

The site is located in the Atlantic Coastal Plain Physiographic Province on flat uplands on a point known as Floyds Neck. The topography is generally flat with slight depressions and shallow drainage ways. Three adjacent rivers, Todd Creek, Floyd Basin, and Cumberland River have eroded steep banks. The facility grounds contain few natural streams, and stormwater is controlled by culverts located along the roadways. There are several depressions and seasonally flooded areas throughout the upland areas. The elevations of SWMUs 8 and 9 range between 10 and 25 feet above mean sea level.

2.2.5 Geology and Hydrogeology

The site is located in the Barrier Island District of the Atlantic Coastal Plain Physiographic Province (Clark and Zisa 1976). Pleistocene sea levels advanced and retreated several times over the Barrier Island Sequence District, forming a stepped progression of decreasing elevations toward the sea. These former, higher sea levels formed barrier island/salt marsh environments generally similar to the present coast. The former sea levels deposited shoreline complexes parallel to the present shoreline. There has been slight to moderate dissection of these former terraces by streams, leading to the development of marshes in poorly drained low areas.

The site resides on undifferentiated surficial sands (Holocene and Pleistocene), the Satilla Formation (Holocene and Pleistocene), and the Cypresshead Formation (Pliocene). The undifferentiated surficial sands and Satilla Formation cannot be separated due to lithologic similarities and lack of paleontological control likely found at the site (Leeth 1999). These Quaternary sediments are well sorted, fine-to-very-fine quartz sand, with some laterally extensive but discontinuous organic-rich layers that occur at approximately 5 to 10 feet below ground surface (bgs). Pelecypod shells are present but not abundant.

There is no distinct marker at the base of the Quaternary sediments, but a partially cemented, reddish brown, iron-stained sand does occur that is typical of the Satilla Formation. Quaternary sediments are generally 35 to 45 feet thick across Camden County, Georgia, including the site (Leeth1999).

The Cypresshead Formation consists of fine-to-medium sand that grades downward in section to a sandy, clayey silt that is characterized at its base by thin clay and silt interbeds that become calcareous and shelly with depth. Pliocene sediments are differentiated primarily on lithology, specifically, an increase in coarse grain size, an increase in clay content, and a decrease in cementation and iron staining. These sediments range from approximately 35 to 45 feet thick (Leeth1999).

Humate-cemented sandstone is locally prominent, with large boulders of humate sandstone littering the bases of bluffs. Humate is produced by the percolation of naturally occurring weak acids from the organic topsoil above the sands. The bluffs along the south bank of Todd Creek on the northern side of the site afford excellent exposures of barrier island facies of the Satilla Formation (Law 1993). Sediments observed in lithologic samples at the UCC landfill, from the March 2006 direct-push technology investigation and May 2006 monitoring well installation, consist of fine-to-medium, indistinctly bedded quartz sand approximately 40 to 55 feet thick, with minor discontinuous clay beds that typically occur 40 to 55 feet bgs (Jacobs 2020).

Site hydrogeology is influenced primarily by the presence and proximity of water sources (rainfall) and sinks (Todd Creek and ponds) and by the hydraulic conductivity of the unconsolidated sediments (sand) that comprise the surficial aquifer beneath the facility (Jacobs 2020). The surficial aquifer system, consisting of the Satilla/Cypresshead (unconfined water table zone) and Ebenezer (confined upper water-bearing zone and confined lower water-bearing zone) is estimated to be 265 feet thick. Based on literature reviews and investigation activities, the unconfined water table unit of the surficial aquifer system is greater than 100 feet thick.

2.2.6 Climate

The climate at the site is characterized by hot, humid summers and mild winters. Data collected from an observing station located approximately 15 miles north of the site in Brunswick, Georgia, for the period 1930 to 2006 indicate that average annual maximum and minimum temperatures were 78.4 degrees Fahrenheit (°F) and 58.9°F, respectively (SERCC 2007). The average annual precipitation is 52 inches with summer being the wettest season, followed by fall, spring, and winter (SERCC 2007).

2.3 Previous Investigations and Removal Actions

Before 2006, the focus of investigations at the facility primarily was on assessing the nature and extent of environmental impacts, not necessarily munitions-related impacts. Previous RCRA investigations conducted within the boundary of SWMU 8 addressed MEC within the immediate investigation area; however, the nature and extent of MEC were not fully characterized or delineated because it was not a primary study objective.

An MEC RFA indicated additional MEC associated with historical activity was likely present; however, the extent was not defined (CH2M 2007). The purpose of the subsequent Phase I, II, and III MEC RCRA RFIs was to characterize the nature and extent of MEC and MEC-related constituents to better understand the potential risks and to develop and refine the MEC-related institutional controls being implemented at the site (CH2M 2009, 2010, 2018). During these investigations, munitions were identified and destroyed, and MEC-related and other metallic debris was removed. Based on the occurrence of documented historical MEC/MPPEH, potential MEC hazards to current and future site workers and trespassers remained at

SWMU 8 within the former 40-mm Test Range and along the main access road of the former 81-mm Mortar Test Range. An additional removal action (Interim Measures corrective action) was completed from 2018 to 2020 to address surface MEC/MPPEH hazards along the access road of the former 81-mm Mortar Test Range and surface and near-surface MEC/MPPEH hazards within the former 40-mm Test Range. Table 2 summarizes the MEC investigation and removal activities completed at the site.

Table 2. Summary of MEC Investigation and Removal Activities
Munitions and Explosives of Concern Corrective Action Plan, UCC Woodbine

Study	Date	Project Objectives	MEC-Related Activities
RFI – SWMUs 02, 03, 04, 05, 06, and 07 (Law 1993)	1991	Complete soils and groundwater investigation to identify nature and extent of contamination. Included soil sampling at all SWMUs, groundwater wells, and sampling at all SWMUs except SWMU 02 and SWMU 07.	Pre-RFI surface debris removal completed. SWMUs 03, 04, 05, 06, and 07 were swept of visible debris including munitions. Munitions related items were found in SWMUs 03 and 07. Munitions were not discovered in SWMUs 05 and 06.
Phase II RFI (APEX 1996)	1996	Collect additional information to address GA EPD comments to Phase I. Included background soil samples at all SWMUs, limited geophysical investigation at SWMUs 03, 06, and 07, collect subsurface soil samples at SWMUs 03, 04, 06 and 07, install wells at SWMU 03 and sample monitoring wells and 03, 04, 05, 06, and 07, complete test pitting at SWMUs 03, 06, and 07, and identify, remove and deactivate UXO.	Surface MEC removal only at SWMUs 03 and 07. Recommended additional surface/subsurface removal.
Addendum to Phase II RFI (APEX 1997)	1996 and 1997	Address GA EPD comments by re-sampling wells with an improved methodology, complete additional surface MEC removal at SWMU 03, and complete additional soil borings at SWMUs 04 and 06.	Surface and subsurface munitions and debris removal at SWMUs 03 and 07 and UXO avoidance in support of other remediation activities.
RFA (CH2M 2007)	2006 and 2007	Archival review of past uses of MEC at the site and to evaluate the site's suitability for future land use.	Visual site inspection confirmed the presence of surface and subsurface MD.
Phase I MEC RFI (CH2M 2008)	2008	Collect data on the presence of surface MEC and collect geophysical data at SWMUs 1A, 8, and 9 to aid in the characterization of the extent of MEC contamination and to provide data for later investigations.	Surface MEC removal and DGM in transects covering approximately 5% of each of three SWMUs.
Phase II MEC RFI (CH2M 2010)	2009	Conduct intrusive investigation to assess the nature of subsurface geophysical anomalies detected in SWMUs 1A, 8, and 9 during the Phase I MEC RFI.	Subsurface MEC removal in transects covering approximately 5% of each of the three SWMUs.

Table 2. Summary of MEC Investigation and Removal Activities
Munitions and Explosives of Concern Corrective Action Plan, UCC Woodbine

Study	Date	Project Objectives	MEC-Related Activities
Phase III MEC RFI (CH2M 2018)	2018	Characterize surface soils in SWMUs 1A, 8, and 9, and surface and subsurface soils at the former RTP area for MC that resulted from past testing and detonation of munitions or from the presence of MEC or MPPEH; evaluate potential human health and ecological risks associated with current and future potential exposures to MC in these areas.	Soil and groundwater sampling indicated constituents of concern at SWMUs 8 and 9 are below risk-based screening levels and/or are at concentrations consistent with background concentrations.
SWMU 8 Interim Measures Corrective Actions (Jacobs 2022)	2018 - 2020	Surface and near-surface removal of MEC, MPPEH, MDAS, and debris within the former 40-mm Test Range and former 81-mm Mortar Test Range of SWMU 8. Corrective actions were completed in accordance with the Interim Measures Work Plan for SWMU 8 (Jacobs 2018a).	MEC, MPPEH, MDAS, and metal debris surface clearance of 8.8 acres of the former 81-mm Mortar Test Range and surface/near-surface clearance of 49.6 acres of the former 40-mm Test Range.

Notes:
mm = millimeter
MC = munitions constituents
MDAS = material documented as safe
UXO = unexploded ordnance

In addition to MEC-related RFIs, UCC conducted a voluntary RFI to identify potential impacts to soil and groundwater from past activities (CH2M 2008). The Phase III MEC RFI was conducted to further characterize surface soil within SWMUs 8 and 9 and surface and subsurface soil at the former RTP area within SWMU 8 (CH2M 2018). Surface soil samples were collected across 15 DUs in SWMU 8 and 5 DUs in SWMU 9 using incremental sampling methodology and analyzed for MCs (explosive residues, perchlorate, target analyte list metals and hexavalent chromium), CS-related constituents (2-chlorobensalmalononitrile, o-chlorobenzaldehyde, methyl isobutyl ketone, and quinoline), and dioxins/furans (CH2M 2018). Constituents detected were below both the residential and industrial Regional Screening Levels and do not pose a significant threat to human and ecological receptors, indicating additional soil or groundwater characterization and corrective action is not warranted (CH2M 2018).

Buried drums were identified during the Interim Measures corrective action work completed in SWMU 8. The drums contained a white/gray solid material that was found to consist primarily of CS. In October 2020, approximately 45 to 50 deteriorated drums and associated contents were excavated to the extent practical, placed in overpack containers along with impacted soil, transported to a staging area, and the contents were sampled. Remaining metal pieces of the drums were placed in a roll-off container located adjacent to the drum pit and the roll-off. The overpack and roll-off containers were transported to appropriate offsite disposal facilities. The drum excavation area was 48 feet long by 31 feet wide. Verification soil sample results from the excavation revealed high levels of CS in some locations, as well as exceedances of screening levels for polychlorinated biphenyls. Additional evaluation of the drum removal area is being conducted to determine appropriate actions. The results of the drum removal action and any additional corrective actions will be provided to GA EPD in a separate report.

2.4 Nature and Extent of MEC and MD

As identified in Section 2.3 and summarized in Table 2, several phases of MEC RFIs were performed at SWMUs 8 and 9. The Phase I MEC RFI (CH2M 2008) was conducted in 2008 to collect data on the presence of surface MEC/MPPEH, followed by collection of DGM data to aid in the characterization of potential subsurface MEC/MPPEH and provide data for subsequent intrusive investigations. During the Phase II MEC RFI (CH2M 2010), intrusive investigations were conducted to assess the nature and extent of subsurface anomalies detected at SWMUs 8 and 9 during the Phase I MEC RFI.

The nature and extent of MEC/MPPEH for SWMUs 8 and 9 are detailed in Subsections 2.4.1 and 2.4.2. Tables 3 and 4 detail the munitions items recovered during the Phase I and II MEC RFIs for SWMUs 8 and 9 and the Interim Measures corrective action completed at SWMU 8, as well as other historical investigations undertaken in the 1990s. In total, 1,669 munitions items were removed from SWMU 8 (Table 3), and 4,520 munitions items were removed from SWMU 9 (Table 4).

Table 3. SWMU 8 - Recovered Munitions Items
Munitions and Explosives of Concern Corrective Action Plan, UCC Woodbine

Ordnance Item	1992 RFI (Law 1993)	1996 Phase II RFI (APEX 1996)	1997 Addendum to Phase II RFI (APEX 1997)	2008-2016 Phase I, II, and III MEC RFIs (CH2M 2008, 2010, 2018)	2018-2020 Interim Measures Corrective Action (Jacobs 2022)
Number of Items					
M581E1 Fuze	NA	NA	NA	NA	1
M84A1 Fuze	NA	NA	NA	NA	3
M301 Illumination Projectile for 81-mm Mortar	NA	NA	NA	NA	2
M49 Flare	NA	NA	NA	NA	2
M84 Fuzes	NA	NA	NA	NA	129
XM15 CS Canisters	52	NA	24	NA	1
M651 40-mm CS Grenades	260	NA	26	4	128
M406 40-mm HE Grenades	193	4	49	34	313
TOTAL MEC/MPPEH ITEMS FOR SWMU 8	**505**	**4**	**99**	**38**	**579**
Expended CS Clusters, M406 40-mm HE grenade components/fragments, M651 CS grenade components/fragments, 81-mm mortar components/fragments, counterweights, pusher plates, ballistic windshields	NA	NA	NA	9	435
TOTAL MDAS ITEMS FOR SWMU 8	**NA**	**NA**	**NA**	**9**	**435**
55-gallon Drums containing Riot Control Agents (such as CS)	NA	NA	NA	NA	45-50

Notes:
mm = millimeter
MDAS = Material Documented as Safe
NA = Not assessed

Table 4. SWMU 9 - Recovered Munitions Items
Munitions and Explosives of Concern Corrective Action Plan, UCC Woodbine

Ordnance Item	1992 RFI (Law 1993)	1996 Phase II RFI (APEX 1996)	1997 Addendum to Phase II RFI (APEX 1997)	2008-2016 Phase I, II, and III MEC RFIs (CH2M 2008, 2010, 2018)
Number of Items				
M301 Illumination Projectile for 81-mm Mortar	NA	38	NA	NA
40-mm Ball Assemblies	NA	3,001	NA	NA
M-301 Illumination Projectile for 81-mm Mortar, Component	8	NA	NA	1
M-84 Fuze Components	906	NA	NA	NA
M-49 Trip Flares	200	NA	NA	NA
M71A2 Primers	347	NA	NA	1
XM15 CS Canisters	5	NA	NA	NA
M7A1 Primer	NA	NA	NA	1
M84 Fuze Component	NA	NA	NA	10
M49 Trip Flare Component	NA	NA	NA	2
Mortar primer/initiator	NA	NA	NA	1
TOTAL MUNTIONS ITEMS FOR SWMU 9	**1,466**	**3,039**	**NA**	**15**
55-gallon Drums containing M406 40-mm Grenade Ball Assemblies, Flare/OEW Mixtures, Bio Waste, 81-mm mortars, Riot Control Agents (such as CS) and assorted waste	NA	408	NA	NA
Flare/OEW Mixture/Riot Control Agent	NA	2,635 gallons	NA	NA

Notes:
mm = millimeter
NA = Not assessed

2.4.1 SWMU 8

During the Phase I MEC RFI, DGM was performed as a series of transects placed across each SWMU, as shown on Figure 2. Approximately 5 percent of the total land area of each SWMU was surveyed using DGM. A total of 21 MEC/MPPEH items were discovered on the ground surface during the surface clearance and other investigation activities within SWMU 8 (Figure 3). The surface items were found adjacent to the former RTP and adjacent to and within the suspected 40-mm Test Range fan. The type and locations of the MEC/MPPEH were consistent with the use of the former 40-mm Test Range. Analysis of the Phase I MEC RFI DGM data at SWMU 8 resulted in the selection of 597 geophysical anomalies. The highest concentration of anomalies was found around the former RTP and within the former 40-mm Test Range fan (CH2M 2008). The densities of geophysical targets across SWMU 8 were consistent with historical use of the former 40-mm Test Range and the former 81-mm Mortar Test Range, as the greatest concentration of targets were found in and adjacent to these ranges.

Excavation of the anomalies during the Phase II MEC RFI resulted in the discovery of 26 subsurface MEC/MPPEH items at 20 anomaly locations. Of the items, 16 were classified as MEC and required demolition. All MEC/MPPEH discovered during the Phase II investigation were related to 40-mm grenades and 81-mm mortars consistent with the use of the former 40-mm Test Range and former 81-mm Mortar

Test Range. Two MEC items (40-mm grenades) were located within the former 81-mm Mortar Test Range near the main access road. An MPPEH item (81-mm mortar component) was also removed from the area near the firing point of the former 81-mm Mortar Test Range (CH2M 2010). The remaining MEC/MPPEH items were discovered within or near the former 40-mm Test Range fan or near the firing point (vicinity of former RTP), as shown on Figure 3. Based on the distribution of the MEC/MPPEH, it was concluded that the boundaries of SWMU 8 have been defined. Interim corrective actions were undertaken at SWMU 8 from 2018 to 2020 (Jacobs 2022). The primary objective of the interim corrective actions was to reduce risk associated with the potential hazard posed by MEC and MPPEH to current and future site workers and trespassers within the former 40-mm Test Range and along the main access road within the former 81-mm Mortar Test Range in SWMU 8 based on the occurrence of documented historical MEC and MPPEH in these areas as described.

Specifically, the interim corrective actions undertaken at SWMU 8 consisted of conducting surface and near-surface MEC and MPPEH clearance and removal actions at the former 40-mm Test Range, defined as the area from the firing point (within proximity of the former RTP), downrange to where MEC/MPPEH was identified during the MEC RFIs or has the potential to be identified, plus a 200-foot MEC/MPPEH-free buffer zone and at the former 81-mm Mortar Test Range, defined as the area 50 feet from either side of the main access road edge from the former 81-mm Mortar Test Range firing point to the entrance road for the onsite landfill, on the ground surface or within the ground surface material.

The initial Removal Action Area survey boundary for the former 40-mm Test Range extended 37.77 acres and included the firing point and the 40-mm Test Range fan but was ultimately increased to 49.61 acres. The increase included multiple step-outs and reflected a 200-foot buffer zone free of MEC/MPPEH. The initial Removal Action Area survey boundary established for the former 81-mm Mortar Test Range extended 8.8 acres, which did not change in size. The final interim corrective action areas are shown on Figure 3. A total of 4 MEC and 575 MPPEH items were removed and demolished during the interim corrective action. Of these, only one MPPEH item was discovered during surface clearance within the 81-mm Mortar Test Range Removal Action Area. The single MPPEH item consisted of a 40-mm M406 grenade discovered on the ground surface, which is documented in the Interim Measures Completion Report (Jacobs 2022). The removal action objectives were satisfied and all identified material that could cause a potential risk to current and future site workers and trespassers was removed from the site.

2.4.2 SWMU 9

Seven MPPEH items were discovered on the ground surface during surface clearance and other investigation activities (Phase I MEC RFI) within SWMU 9. The surface items were found within a cleared area near the center of SWMU 9 to the northeast of SWMU 9 (Figure 4). The cleared area coincides with the location of MEC/MPPEH and other MEC-related items previously removed during the 1990s. Analysis of the DGM data at SWMU 9 resulted in the selection of 218 geophysical anomalies. The highest concentration of anomalies was found near the center of SWMU 9 (CH2M 2008).

Excavation of these anomalies during the Phase II MEC RFI resulted in the discovery of eight subsurface MPPEH items. None of the items were classified as MEC, nor did they require demolition. The type and location of both the surface and subsurface MPPEH were consistent with the history of the site's use for munitions demolition in the center of the site, as most items were found in the demolition area or within a distance that would be expected to receive kickouts from the demolition area. The majority of the MPPEH were located in the center of SWMU 9 (Figure 4). Based on distribution of the MPPEH at and near the demolition area, it was concluded that the boundaries of SWMU 9 were defined.

2.5 Summary of Site Risks

2.5.1 Risk Pathways

Risks from exposure to MEC differ greatly from risks associated with exposure to chemicals. Direct (handling) or indirect contact with MEC has the potential to result in injury or death, although the risk of injury or death is greatly dependent on the type and condition of the MEC.

Pathways at the site that affect the risk of exposure to MEC include the following:

- **Site accessibility** – Access to the site is currently restricted through a locked access gate and a fence around most of the perimeter of the property bounded by land. Access to the site via Todd Creek is available, but the waterway has very light boat traffic. SWMU 9 is difficult to access by foot or vehicle, as well, and access via boat is even more difficult due to the extensive salt marshes in the surrounding area. Occasional trespassing by hunters of deer and wild boar does occur at the site; however, the hunting is typically performed from several roads internal to the site without entering the SWMUs, which are densely vegetated. Further, the dense vegetation at the site is prime habitat for rattlesnakes and this fact is well known to the hunters in the area. This is based on reports by site operating personnel who have observed this trespassing, have lived in the area since childhood, and are very familiar with the site and surrounding areas. Potential future changes in site use (conservation easement) could impact the access frequency and controls.
- **Duration of potential contact** – Current activities conducted at the site are related to operations and maintenance (O&M) of the hazardous waste landfill and visiting the Floyd Family Cemetery. Both activities require traversing the SWMUs on established roads; however, time spent in each SWMU is limited, and probability of exposure is limited because areas where these activities occur are free from MEC. Potential future land use may include site visitor and construction activities in and around SWMUs 8 and 9. O&M personnel, visitors, site workers, etc. could be exposed to MEC within work areas or if they left the prescribed access routes to each part of the site.
- **Quantity and type of MEC** –The quantity and type of MEC affects the possibility that a receptor will detonate a MEC item. Smaller items are more likely to be detonated from deliberate contact (picking the item up) or inadvertent contact (accidentally stepping on or kicking the item) than large MEC items that can be recognized and avoided. However, based on the type of MEC found at the SWMUs at the site and the removal actions that have been completed, the likelihood of casual contact with the MEC (stepping on or handling without subjecting it to significant energy, such as striking it with a hard object or applying significant heat) is very low.
- **Depth of MEC versus site use** – The maximum penetrating depth of 40-mm munitions within the site's sandy soils is 6 inches. However, removal activities were completed in areas of DGM anomalies to a depth of greater than 6 inches. Intrusive activities are limited at the site, and the highest risk based on current site use would be from contact with surface MEC.
- **Potential for MEC migration** – MEC items that are currently in the subsurface at the site may migrate to the surface through erosion from wind and rain and exposure due to digging by feral hogs and other wild animals. Because the SWMUs are covered with dense vegetation, the potential for such erosion is low.

2.5.2 Decision Logic Process

To further evaluate and address the remedial action goals for SWMUs 8 and 9, a risk management methodology created by the U.S. Army Corps of Engineers (USACE) for Formerly Used Defense Sites and Military Munitions Response Program sites (USACE 2016) was used at the site. This risk management

methodology, called the decision logic process (DLP), was created to provide information to support risk management decisions upon completion of site characterization, develop remedial action objectives (RAOs), and provide a basis for assessing achievement of RAOs relative to acceptable end states.

A DLP for the site was presented to GA EPD in collaborative meetings on March 26 and May 23, 2018 (Jacobs 2018b). UCC proposed using the DLP to evaluate potential hazards from MEC within SWMUs 8 and 9 at the Woodbine, Georgia, site. GA EPD agreed that the DLP was an appropriate process for assessing MEC hazards at SWMUs 8 and 9.

The DLP is used to differentiate acceptable versus unacceptable site conditions at SWMUs 8 and 9, to establish a systematic approach for developing RAOs, and to assist in developing acceptable response alternatives to meet the RAOs. After site characterization, an evaluation following the DLP approach is conducted to determine whether the conditions are acceptable or unacceptable and to identify unacceptable risks that require remedial action.

The DLP approach employs a series of four matrices that use site-specific information to relate accessibility, munitions sensitivity, and severity of an explosive event if it were to occur, to determine risks. These matrices are as follows:

- **Matrix 1: Likelihood of Encounter** – relates the site characterization data on the amount of MEC potentially present at the site to the current and future land use and also considers site accessibility to determine the likelihood of encountering MEC.
- **Matrix 2: Severity of an Incident** – assesses the likelihood of encounter from Matrix 1 along with the types of MEC potentially present to determine the severity of an unintentional detonation.
- **Matrix 3: Likelihood of Detonation** – relates the sensitivity of the MEC items potentially present to the likelihood for energy to be imparted on an item during an encounter by specific land users.
- **Matrix 4: Acceptable and Unacceptable Site Conditions** – combines the results of the first three categories to differentiate acceptable and unacceptable site conditions.

The DLP matrices were employed to evaluate SWMUs 8 and 9 as follows:

- **Scenario 1:** SWMU 8 following completion of the Interim Measures remedial actions and implementation of institutional controls, as described in the MEC Institutional Control Plan (ICP) (Appendix A)
- **Scenario 2:** SWMU 9 following implementation of institutional controls, as described in the MEC ICP (Appendix A)

Each scenario evaluation includes a summary of the current matrix scoring, current users, future proposed land use, past work summary, current risks, proposed corrective actions to mitigate risks, and the detailed matrix scoring after implementation of proposed corrective actions (as applicable).

UCC prepared an initial draft evaluation of each scenario using the DLP matrix. UCC and GA EPD collaboratively reviewed the initial draft, and comments were received from GA EPD. UCC revised the draft evaluation, which was reviewed again with GA EPD via conference call. GA EPD provided concurrence on the results of the evaluation. Following implementation of the 2018 to 2020 corrective actions as documented in the SWMU 8 Interim Measures Completion Report (Jacobs 2022), Jacobs verified the surface/near-surface removal actions within the former 40-mm Test Range and surface removals within the former 81-mm Mortar Test Range had been completed as described for Scenario 1 and verified the results of the DLP for this scenario. The DLP evaluation summary for each scenario is included in the following subsections, and detailed DLP information for each scenario is included in Appendix B.

2.5.2.1 Scenario 1: SWMU 8

The DLP was first conducted for SWMU 8 based on current and potential future land use and implementing land use controls (LUCs) consisting of installation of warning signage along main access roads and the SWMU perimeter and executing ECs as described in the MEC ICP (Appendix A). The result of this assessment was a determination of unacceptable conditions. The DLP was then conducted considering the same current and future use and LUCs plus completion of a surface/near-surface MEC removal action at the former 40-mm Test Range and a surface MEC removal action along the main access road through the former 81-mm Mortar Test Range. The updated DLP concluded that acceptable conditions would be present for SWMU 8 with appropriate LUCs following a surface/near-surface removal action at the former 40-mm Test Range and a surface removal action along the main access road through the former 81-mm Mortar Test Range (Appendix B). Based on the results of the DLP, UCC prepared the *Interim Measures Work Plan, Removal Action for SWMU 8* (IMWP) (Jacobs 2018a). GA EPD conditionally approved the IMWP on January 8, 2019, which was implemented between 2018 and 2020 and is documented in the Interim Measures Completion Report (Jacobs 2022). Completion of the surface/ near-surface removal action and implementation of LUCs consisting of installation of warning signage along main access roads and the SWMU perimeter and executing an EC, as detailed in the MEC ICP (Appendix A), satisfies the conditions evaluated for Scenario 1 and the acceptable determination.

2.5.2.2 Scenario 2: SWMU 9

The DLP was used to assess the potential risk for SWMU 9 based on current and future land use and implementing LUCs consisting of installation of warning signage along main access roads and the SWMU perimeter and executing an EC, as detailed in the MEC ICP (Appendix A). The results of the DLP indicate acceptable conditions for SWMU 9 with appropriate LUCs.

3. MEC Corrective Action Alternatives

This section presents the project objective that forms the basis of each corrective action alternative and a comparison of each alternative based on comparison criteria selected to achieve the project objective.

3.1 Project Objective

Based on the site history, types and quantity of MEC, inherent risk of munitions found, removal activities completed, current and future land use, and the locations of SWMUs 8 and 9 in relation to the site boundaries and features, the primary objective of this MEC CAP is to evaluate corrective action alternatives and provide a recommendation that is protective of human health based on the risk pathways discussed in Section 2.5.1.

3.2 Corrective Action Alternative Descriptions

Three alternatives were selected for evaluation based on their ability to satisfy the project objective:

- Alternative 1 – No Action
- Alternative 2 – Implement Institutional Controls
- Alternative 3 – Additional Surface and Subsurface MEC Clearance and Implement Institutional Controls

Each alternative is discussed in detail in the following subsections.

3.2.1 Alternative 1 – No Action

No additional investigative or remedial activities would be completed within SWMUs 8 and 9. No additional institutional controls would be implemented beyond the existing EC (Camden County Clerk Book 1562 Page 00627, filed March 29, 2011) restricting land use to non-residential.

3.2.2 Alternative 2 – Implement Institutional Controls

This alternative consists of implementing institutional controls as defined in the MEC ICP (Appendix A), which consists of LUCs and restrictions implemented through ECs for SWMUs 8 and 9. The restrictions would be placed on Restricted Use Zones (RUZs) that are composed of the entirety of SWMUs 8 and 9 (Figure 5) and would include the following requirements:

- Access to the RUZ is restricted to persons who have completed, or are escorted by someone who has completed, Department of Defense 3R (Recognize, Retreat, and Report) Training for MEC awareness and avoidance. 3R Training is the minimum requirement for all activities (surface and subsurface) within the RUZ.
- Any land disturbance activity that may result in the release or exposure to MEC, or create a new exposure pathway to MEC, is prohibited, except with the support of a Qualified Unexploded Ordnance (UXO)Technician, defined as a person meeting the minimum qualification standards for personnel performing UXO-related operations as defined in Department of Defense Explosives Safety Board Technical Paper 18, Revision 1, Minimum Qualifications for Personnel Conducting Munitions and Explosives of Concern-Related Activities (24 June 2020) or any subsequent version thereof. Technical support from a Qualified UXO Technician is required prior to and during any construction activities, which include subsurface excavation, digging, drilling, or any other disturbance of the subsurface. The type of support provided by a Qualified UXO Technician will depend on the activity to be performed,

which may include locating surface UXO by visual means; locating subsurface UXO using magnetometers; classifying UXO; and assisting with transport, storage, and disposal of UXO. This requirement also applies to any subsurface excavation following initial authorized construction activities, such as subsurface utility construction actions.

- Permanent warning signage will be installed and maintained at a vehicular access point to the RUZ and along roads and boundaries of the RUZ (Figure 5). Signs will be installed at a spacing of 100 meters and approximately 5 feet above grade and will display verbiage warning of potential MEC and responsible party contact information, as indicated on the example sign (Figure 6). Signage spacing will be reduced to 50 meters in areas of tall, dense vegetation to allow for increased visibility. If new roadways and access points are established through the RUZ, installation of additional signage will be required.

The MEC ICP (Appendix A) was developed based on historical information, site visits, interviews with personnel, and the findings of the investigation and removal activities. Based on the Phase I and II MEC RFIs and the SWMU 8 Interim Measures corrective actions, the current extent of surface and subsurface MEC has been delineated.

3.2.3 Alternative 3 – Additional Surface and Subsurface MEC Clearance and Implement Institutional Controls

With this corrective action, all actions outlined in Alternative 2 plus a surface and near-surface clearance (intrusive investigation to a maximum depth of 3 feet bgs) would be conducted across the following areas:

- 200.9 acres of SWMU 8 where Interim Measures corrective actions were not completed from 2018 through 2020 (Figure 3).
- 111.6 acres comprising SWMU 9 (Figure 4).

This alternative would require work to be completed in the same manner and sequence as the surface/near-surface removal actions completed during the Interim Measures corrective actions (Jacobs 2022), generally described as follows:

- Conduct a land survey to establish action area boundaries.
- Implement wildlife protection measures – assessment of the action area by a wildlife biologist before each vegetation reduction event, removal action activity, and pre- and post-demolition activity.
- Reduce vegetation – cutting brush more than 6 inches above ground surface, chopping vines and tree limbs, and removing small trees less than 4 inches in diameter using manual and mechanized methods.
- Establish a grid system – survey and stake grid corners to establish the location of the sensors during dynamic surveying and to position the collected data.
- Sweep and clear ground surface (instrument-assisted) – visual sweeps and surface clearance to locate MEC, MPPEH, and MD.
- Conduct a DGM detection survey, including instrument verification and quality control seeding.
- Reacquire targets – survey and mark target locations.
- Conduct intrusive investigation – use combination of hand tools and mini-excavator, as necessary, to remove MEC from the subsurface.
- Demolish MEC and MPPEH and waste disposal.

3.3 Comparison of Corrective Action Alternatives

This section presents a detailed evaluation of the three corrective action alternatives based on the following comparison criteria:

- Effectiveness
- Implementability
- Cost

Several categories under each criterion were considered, and the alternatives were compared and ranked against each other in the following sections.

3.3.1 Effectiveness

Effectiveness is measured by an alternative's ability to achieve the following goals:

- **Protect human health, including the health of workers during implementation** – includes consideration of the net reduction of residual MEC or likelihood of exposure to MEC by considering the expected depth of residual MEC, potential exposure pathways between humans and MEC, and potential for an individual to interact with MEC once exposure occurs.
- **Provide short-term effectiveness** – includes consideration of the time necessary to complete each action and whether site conditions would pose an unacceptable risk before the action is complete.
- **Provide long-term effectiveness and permanence** – includes consideration of the magnitude of residual risk and adequacy and reliability of post-corrective action site controls.

Alternative 3 would remove the MEC to the extent practical from the entire SWMU 8 and 9 areas, while both Alternatives 2 and 3 would prevent the completion of exposure pathways between humans and any potentially remaining MEC hazards by providing the following:

- Notification/warning to workers, visitors, and inadvertent public trespassers that they are entering an area where MEC may be present (SWMU 8 and 9 RUZ).
- Guidelines for appropriate training for the identification of MEC and MPPEH for activities within the RUZ.
- Guidelines for appropriate training and oversight of activities such as construction of utilities, roadways, buildings, and/or other structures.
- Requirements for maintaining institutional controls and updating them if development occurs within the RUZ.

Alternative 3 is considered to be protective of human health and has the best long-term effectiveness of the three alternatives because it removes MEC hazards in the surface and near surface over a larger area; however, it will take multiple years to implement the removal action, and therefore, the short-term effectiveness is considered the same as Alternative 2. Site characterization data and the DLP determined the current potential for MEC encounter is intermittent and unlikely based on the current and future land use and that only a minimal amount of MEC may remain following previous removal actions.

Alternative 2 is protective of human health and is effective in both the short and long term. It would not remove additional possible MEC hazards, but the LUCs defined in the ICP were classified by the DLP as acceptable.

Alternative 1 is considered to be the least effective because it would not prevent the completion of exposure pathways between humans and potential MEC hazards. It does not require implementation of the ICP, which was necessary to achieve an acceptable classification by the DLP assessment.

3.3.2 Implementability

Implementability describes whether an alternative could be physically and administratively implemented. Categories used for this criterion are as follows:

- **Technical Feasibility** – includes consideration of reliability of the corrective action with regard to implementation, ease of field implementation, ease of undertaking future actions related to the initial corrective action, and the ability to monitor the effectiveness of the action.
- **Administrative Feasibility** – includes consideration of the ease in which a corrective action could be implemented in terms of acquiring installation permits and coordinating services to support the corrective action.
- **Availability of Services and Materials** – includes consideration of availability of goods and services needed to support the implementation of the corrective action alternatives. Examples include the availability of specialized personnel and equipment, explosives for demolition, a suitable MD scrap recycling facility, and the ability of existing infrastructure to allow personnel and materials to the project site.
- **State and Community Acceptance** – includes consideration of the likelihood of state and community acceptance of the corrective action alternative.

Alternative 1 ranked as the most technically and administratively feasible alternative because it would not include additional site activities nor implementation of additional institutional controls. However, it would likely be the least acceptable alternative to stakeholders and the community given the current and potential future land uses.

Alternative 2 is implementable and feasible from a technical and administrative perspective because implementing institutional controls is straightforward and simple to monitor. Alternative 2 is expected to be the most acceptable action to regulatory stakeholders because it mitigates potential contact with MEC hazards through institutional controls that will continue to stay in place in the event of a land use change.

Alternative 3 is implementable but it involves much greater effort for permitting, construction, and potential risks to workers involved in MEC identification and disposal. In addition, it requires extensive vegetation removal that could result in the destruction of habitat for protected and endangered species observed within the SWMUs. Stakeholder acceptance of this alternative is expected to be high.

3.3.3 Cost

Cost estimates for the alternatives were developed based on subcontractor estimates and actual costs for performing work during the Interim Measures corrective action. A rough order of magnitude summary of costs associated with each alternative is provided in Tables 5 and 6.

Alternative 1 has no cost associated with it. There are no additional actions required under this alternative.

Alternative 2 costs are estimated to be $306,000 and include implementation of the ICP consisting primarily of administrative costs for filing the necessary ECs and purchase and installation of warning signs.

Alternative 3 has the highest cost at approximately $19,600,000 and is several orders of magnitude higher than Alternative 2. Costs consist of implementation of the ICP (same as Alternative 2) and the surface and near-surface MEC clearance of 312.5 acres of forested land. Costs for the clearance work are based on implementation of the SWMU 8 Interim Measures from 2018 to 2020 by the same process.

Table 5. Estimated Capital Costs for Implementation of Alternative 2
Munitions and Explosives of Concern Corrective Action Plan, UCC Woodbine

Description	Total
Work Planning/Project Management	$11,000
Implementation of Institutional Controls	
Field Planning	$11,000
Sign installation including survey	$250,000
Finalize and Execute Environmental Covenants	$6,000
Subtotal of Professional Services	**$278,000**
Contingency (10%)	$28,000
Total	**$306,000**

Table 6. Estimated Capital Costs for Implementation of Alternative 3
Munitions and Explosives of Concern Corrective Action Plan, UCC Woodbine

Description	Total
Work Planning/Project Management	**$850,000**
Surface and Near-surface Removal Field Work	
Field Planning including biological surveys	$115,000
Initial Biological Surveys, Vegetation Clearing and Survey Services	$6,090,000
Digital Geophysical Mapping	$4,300,000
Intrusive Investigation	$6,000,000
Implementation of ICP - Sign Installation and Recording EC	$278,000
Demo Activities	**$60,000**
Reporting	**$120,000**
Subtotal of Professional Services	$17,800,000
Contingency (10%)	$1,780,000
Total	**$19,600,000**

O&M would be the same for Alternatives 2 and 3 and would consist of routine inspections of the signage, as discussed in the MEC ICP (Appendix A). Average annual maintenance costs are estimated to be approximately $12,000.

3.4 Proposed Corrective Action Alternative

The proposed corrective action alternative is Alternative 2, Implementation of MEC Institutional Controls. Alternative 2 is effective at protecting against potential exposure to potential MEC hazards, is ranked as acceptable by the DLP, and is expected to be acceptable to most stakeholders. Alternative 2 ranks the highest in short-term effectiveness because the risk to workers implementing Alternative 3 is significantly higher due to intentional direct contact with MEC. It ranks higher than Alternative 3 in terms of implementability due to the large effort and time required for the removal action. Costs for Alternative 2 are higher than Alternative 1 but substantially lower than Alternative 3.

Alternative 1 was not selected because it is not expected to be acceptable to most stakeholders. Additional LUCs would be needed to achieve an acceptable ranking by the DLP.

Alternative 3 was not selected because of the extremely high cost compared to Alternative 2 without a corresponding significant reduction in risk of potential exposure to MEC. Even after completion of MEC clearance activities, it cannot be guaranteed that all MEC hazards will be eliminated; therefore, Alternative 3 requires the same institutional controls as Alternative 2 to achieve an acceptable ranking by the DLP. MEC clearance activities also involve additional risk to workers performing the investigation and disposal activities, as well as possible risk to endangered and protected species.

4. References

Apex Environmental (APEX). 1996. *Report of the Phase II RCRA Facility Investigation*. September.

Apex Environmental (APEX). 1997. *Addendum to Report of the Phase II RCRA Facility Investigation – Union Carbide Corporation, Woodbine, Georgia Facility*. June 12.

CH2M HILL Engineers, Inc. (CH2M). 2007. *Final Munitions and Explosives of Concern RCRA Facility Assessment – Union Carbide Corporation, Woodbine, Georgia Facility*. November.

CH2M HILL Engineers, Inc. (CH2M). 2008. *Focused Field Investigation Report, Union Carbide Corporation, Woodbine, Georgia*. August.

CH2M HILL Engineers, Inc. (CH2M). 2009. *Final Results of Phase I Munitions and Explosives of Concern RCRA Facility Investigation – Union Carbide Corporation, Woodbine Georgia Facility*. March

CH2M HILL Engineers, Inc. (CH2M). 2010. *Final Results of Phase II Munitions and Explosives of Concern RCRA Facility Investigation – Union Carbide Corporation, Woodbine Georgia Facility*. March.

CH2M HILL Engineers, Inc. (CH2M). 2018. *Phase III Munitions and Explosives of Concern RCRA Facility Investigation Report – Union Carbide Corporation Woodbine Facility, Camden County, Georgia*. June.

Clark, W.Z. and A.C. Zisa. 1976. *Physiographic map of Georgia*, Map SM-4 (reprinted, 1988). Georgia Geologic Survey, Atlanta, Georgia.

Department of Defense Explosives Safety Board. 2020. *Minimum Qualifications for Personnel Conducting Munitions and Explosives of Concern-Related Activities.* Technical Paper 18, Revision 1. June 24.

Georgia Department of Natural Resources. 2017. *Amendment to Hazardous Waste Facility Permit, Permit No. HW-063(D)*. June.

Jacobs Engineering Group Inc. (Jacobs). 2018a. *Interim Measure Work Plan, Removal Action for Solid Waste Management Unit (SWMU) 8*. December.

Jacobs Engineering Group Inc. (Jacobs). 2018b. *Woodbine, Discussion of Decision Logic Process for MEC Areas.* March.

Jacobs Engineering Group Inc. (Jacobs). 2020. *Post-Closure Care and Corrective Action Permit HW-063(D) Application Renewal, UCC Woodbine, Camden County, Georgia Facility*. December.

Jacobs Engineering Group Inc. (Jacobs). 2022. *Solid Waste Management Unit 8 Interim Measure Completion Report - Union Carbide Corporation Woodbine Facility, Camden County, Georgia*. June.

Law Engineering and Environmental Services (Law). 1993. *RCRA Facility Investigation Report.* Prepared for UCC.

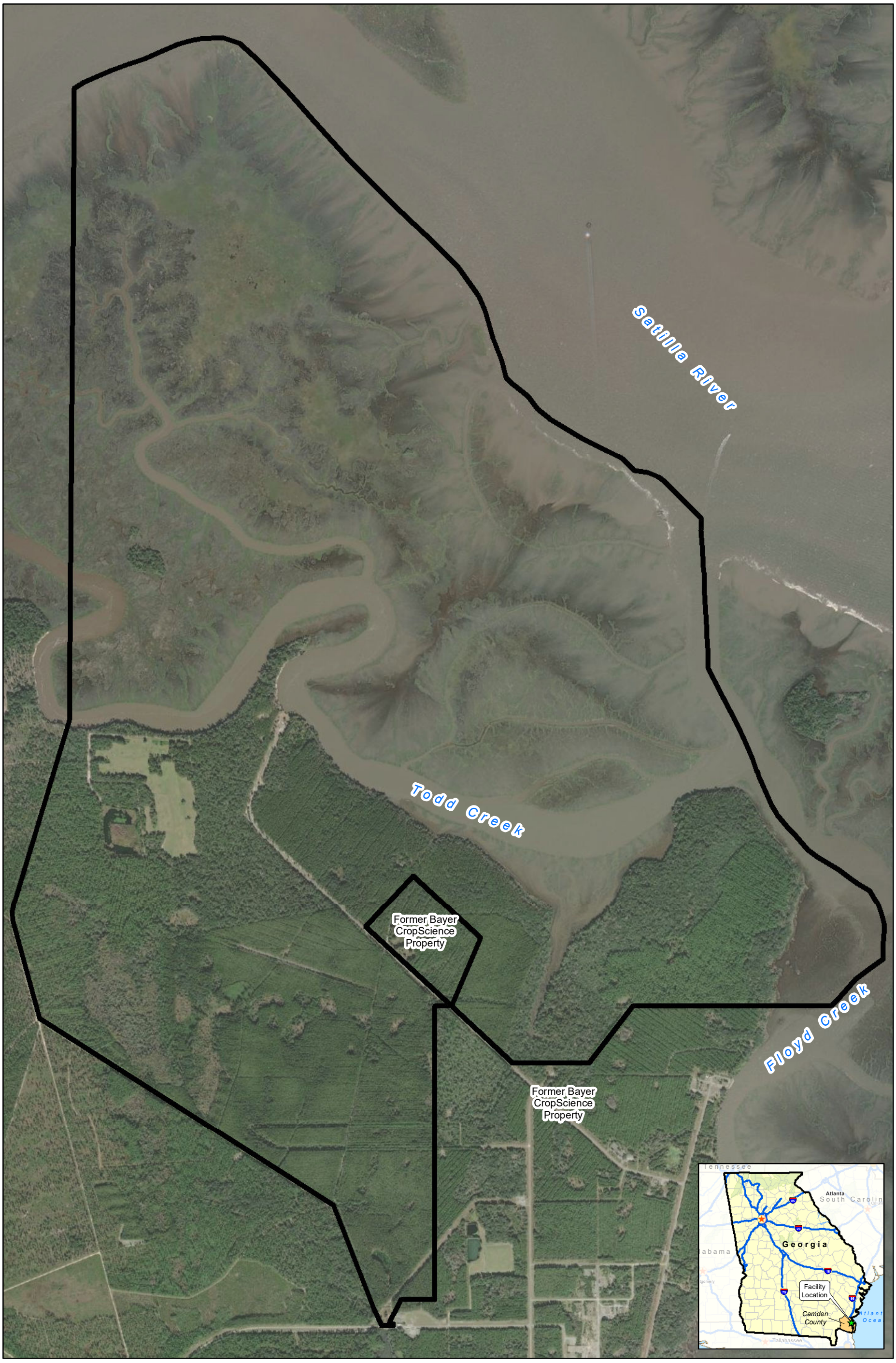
Leeth, D.C. 1999. *Hydrogeology of the surficial aquifer in the vicinity of a former landfill, Naval Submarine Base Kings Bay, Camden County, Georgia*. U.S. Geological Survey Water Resources Investigations Report 98-4246, 28 pp.

Southeast Regional Climate Center (SERCC), University of North Carolina at Chapel Hill. http://radar.meas.ncsu.edu/. Data for Station 091340 (Brunswick) accessed October 11, 2007, at http://radar.meas.ncsu.edu/cgi-bin/sercc/cliMAIN.pl?ga1340.

U.S. Army Corp of Engineers (USACE). 2001. *Army Range Inventory, Appendix E of Data Collector Instructions*. September.

U.S. Army Corp of Engineers (USACE). 2016. *Decision Logic to Assess Risks Associated with Explosive Hazards and to Develop Remedial Action Objectives for Munitions Response Sites*. December.

Figures



LEGEND

Property Boundary

N

0 800 1,600 3,200

Feet

Notes:

1. ESRI Aerial from ArcGIS Online, Dated 11/18/2020
2. Property boundary based on survey completed September 21, 2017 by Geomatics Corporation.

Figure 1. Site Location Map
Munitions and Explosives of Concern
Corrective Action Plan
Union Carbide Corporation
UCC Woodbine, Camden County, Georgia

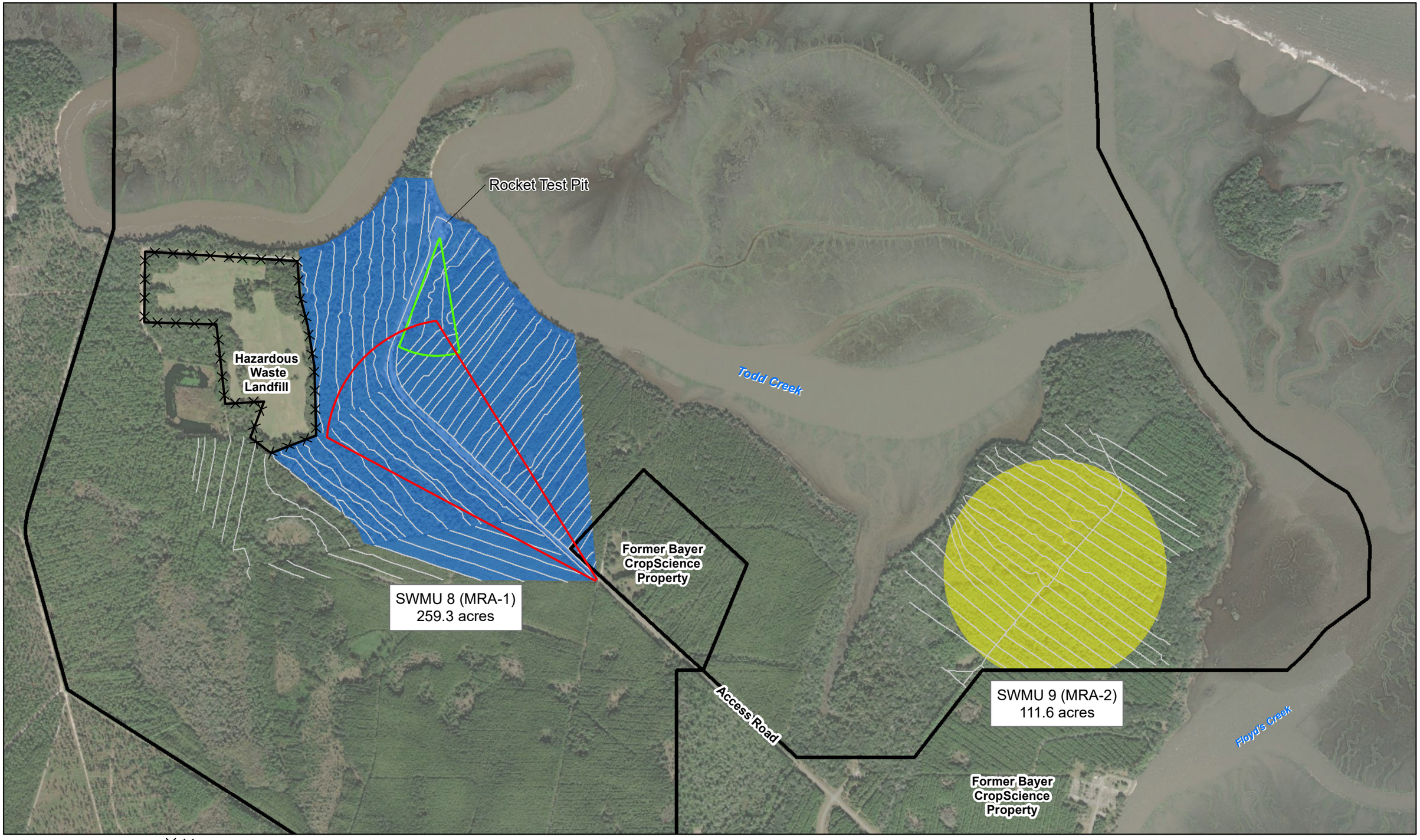


Figure 2. Solid Waste Management Units 8 and 9
Munitions and Explosives of Concern Corrective Action Plan
Union Carbide Corporation
UCC Woodbine, Camden County, Georgia

Jacobs

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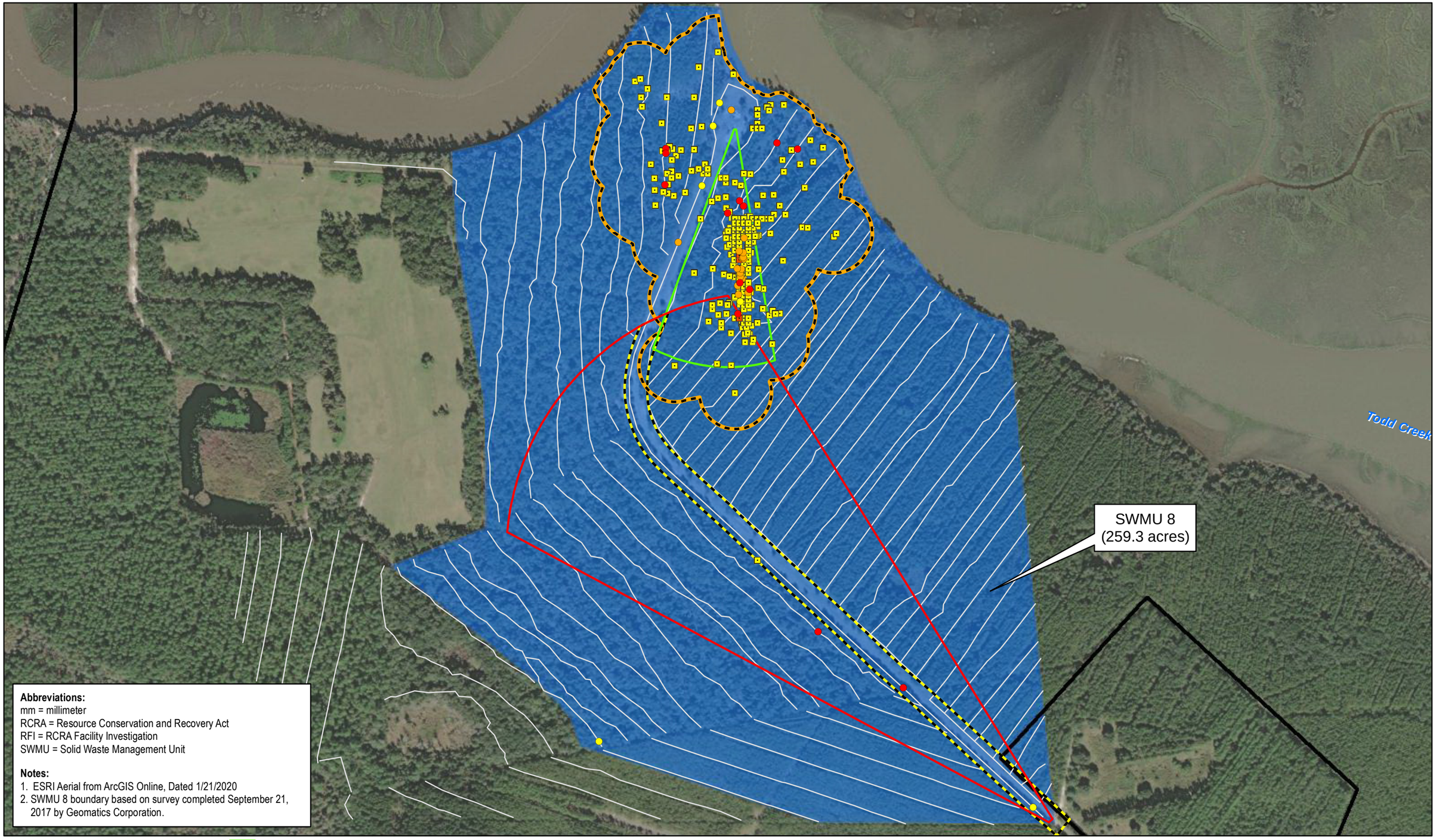

Abbreviations:
mm = millimeter
RCRA = Resource Conservation and Recovery Act
RFI = RCRA Facility Investigation
SWMU = Solid Waste Management Unit

Notes:
1. ESRI Aerial from ArcGIS Online, Dated 1/21/2020
2. SWMU 8 boundary based on survey completed September 21, 2017 by Geomatics Corporation.

- MEC (Interim Measures Corrective Action)
- MPPEH (Interim Measures Corrective Action)
- MEC (Phase I RFI)
- MEC (Phase II RFI)
- MPPEH (Phase II RFI)
- 40-mm Test Range
- 81-mm Mortar Test Range
- Property Boundary
- SWMU 8
- 40-mm Test Range Removal Action Area (49.6 Acres)
- 81-mm Mortar Test Range Removal Action Area (8.8 Acres)
- MEC RFI Phase I & II Transects

N

0 250 500 1,000
Feet

Figure 3. Solid Waste Management Unit 8 Removal Action Results
Munitions and Explosives of Concern Corrective Action Plan
Union Carbide Corporation
UCC Woodbine, Camden County, Georgia

Jacobs

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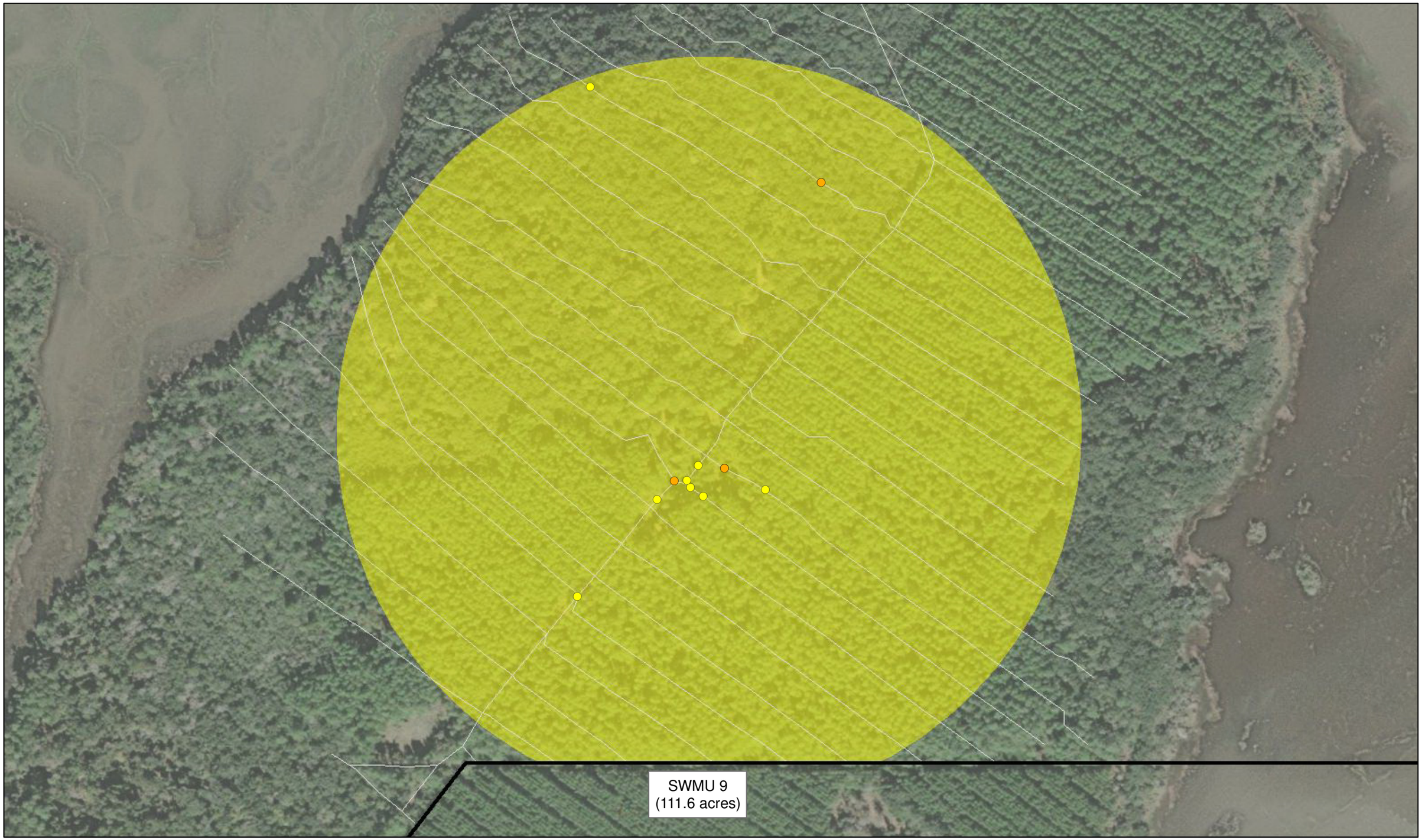


Property Boundary
SWMU 9
MEC RFI Phase I & II Transects
MEC (Phase I RFI)
MPPEH (Phase II RFI)
Former 40-mm Test Range
Former 81-mm Mortar Test Range

Abbreviations:
mm = millimeter
RCRA = Resource Conservation and Recovery Act
RFI = RCRA Facility Investigation
SWMU = Solid Waste Management Unit

Notes:
1. ESRI Aerial from ArcGIS Online, Dated 1/21/2020
2. SWMU 9 boundary based on survey completed September 21, 2017 by Geomatics Corporation.

N

0 150 300 600 Feet

Figure 4. Solid Waste Management Unit 9 Removal Action Results
Munitions and Explosives of Concern Institutional Control Plan
Union Carbide Corporation
UCC Woodbine, Camden County, Georgia

Jacobs

MKE \\dc1vs01\GISProj\D\DowChemicals\Woodbine\MapFiles\2021\Requests\NB\Munitions_Exposives_of_Concern_CP\Fig04_Solid Waste Management Unit 9 Removal Action Results.mxd mpetersh 5/17/2021 1:28:46 PM

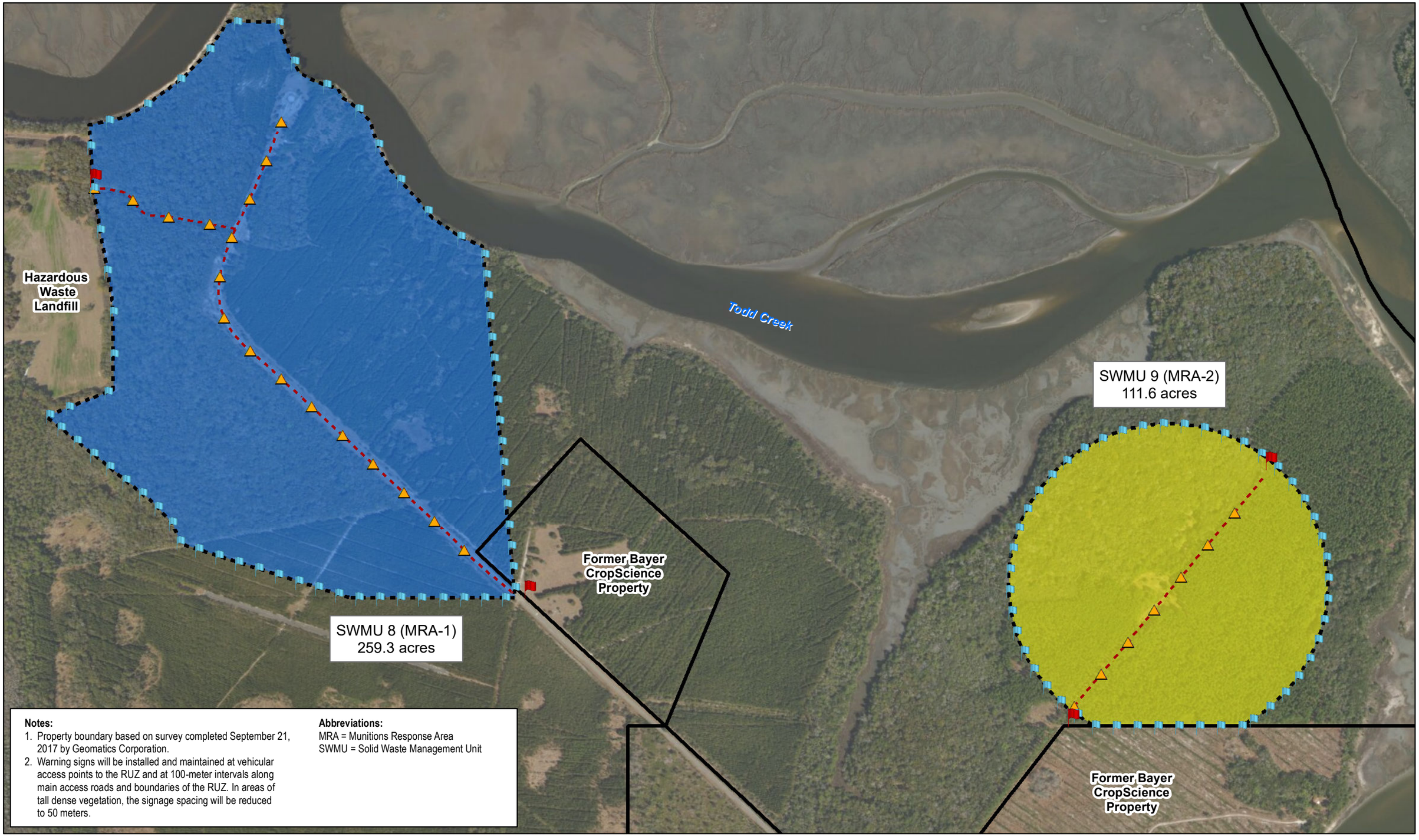


Figure 5. Restricted Use Zone - Proposed Warning Signage Locations
Munitions and Explosives of Concern Corrective Action Plan
Union Carbide Corporation Woodbine
Woodbine, Georgia

Jacobs

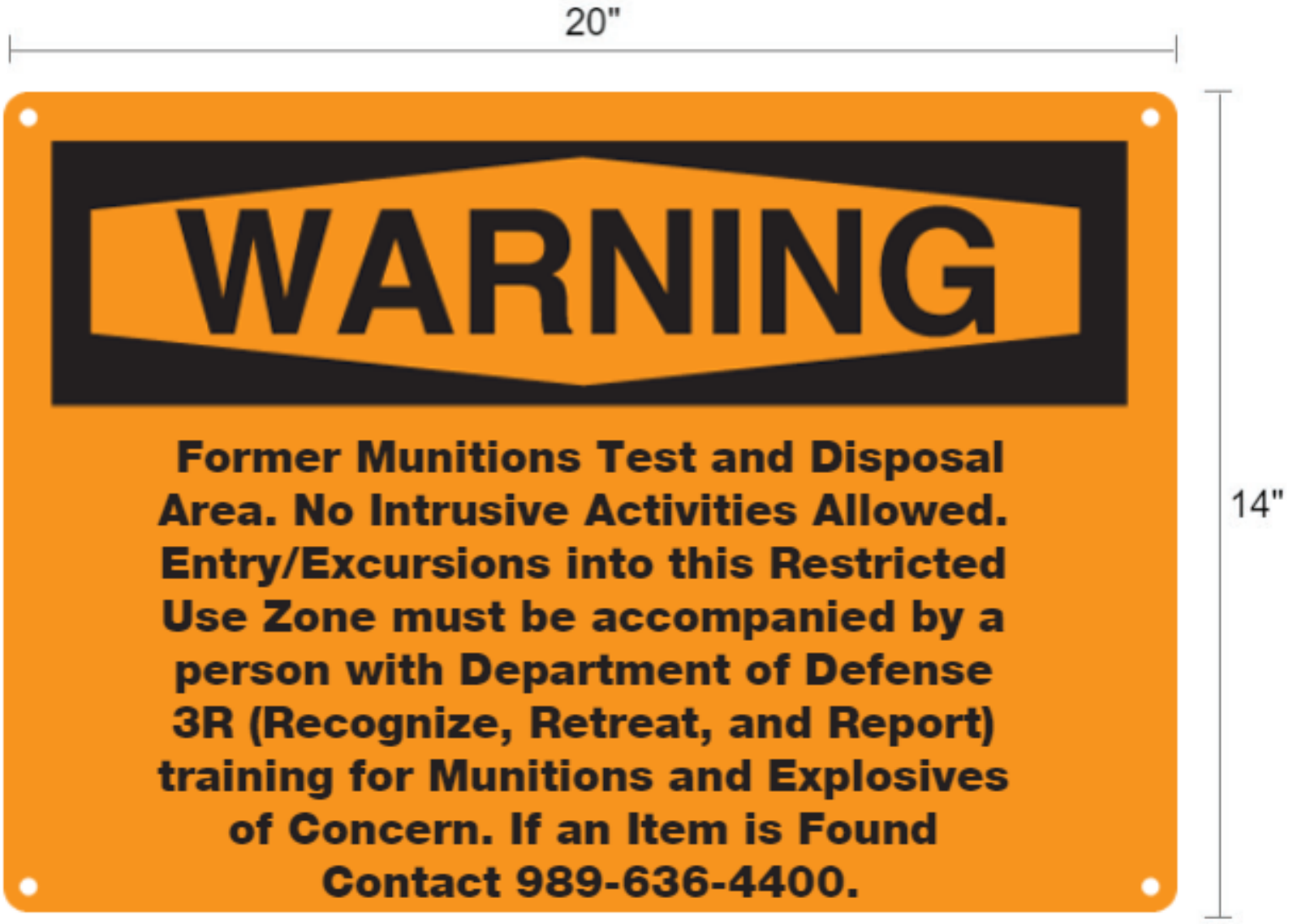


Figure 6. Proposed Warning Signage
Munitions and Explosives of Concern Corrective Action Plan
Union Carbide Corporation
UCC-Woodbine, Camden County, Georgia

Appendix A
UCC Woodbine MEC Institutional Control Plan

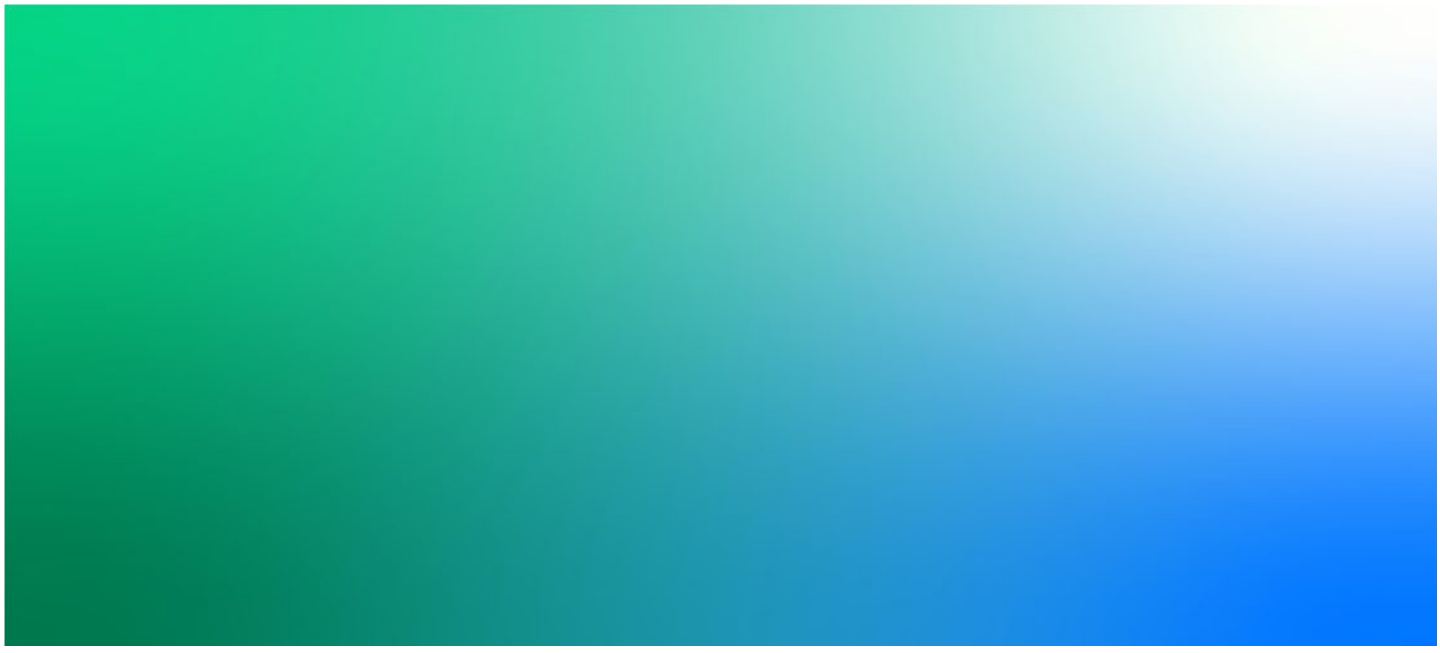
Woodbine Facility, Camden County, Georgia

Munitions and Explosives of Concern
Institutional Control Plan

Revision 3

December 2023

Union Carbide Corporation



Contents

Figures

Attachment

Acronyms and Abbreviations

°F	degrees Fahrenheit
BCS	Bayer CropScience
CH2M	CH2M HILL Engineers, Inc.
COC	constituent of concern
EC	environmental covenant
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
GA EPD	Georgia Environmental Protection Division
ICP	Institutional Control Plan
HHRA	Human Health Risk Assessment
Jacobs	Jacobs Engineering Group Inc.
MEC	munitions and explosives of concern
mm	millimeter(s)
MPPEH	material potentially presenting an explosive hazard
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RUZ	Restricted Use Zone
SWMU	Solid Waste Management Unit
UCC	Union Carbide Corporation
UXO	unexploded ordnance

1. Introduction

This Institutional Control Plan (ICP) was developed for the Union Carbide Corporation (UCC) Woodbine Site (site) (Figure 1) located 5954 Union Carbide Road, Camden County, Georgia to accomplish the following objectives:

- Provide a summary of the site history including types of munitions items historically manufactured and tested at the site and munitions and explosives of concern (MEC) investigations and removal activities completed.
- Detail the institutional controls to be implemented at the site to manage the potential risks posed by residual MEC.
- Outline how the chosen institutional controls should be implemented, maintained, changed, and eventually terminated.

1.1 Site Background

The site is located within the property of the historic homestead of Charles Floyd and his son, General John Floyd. Remnants of the former plantation home, Bellevue, still stand on the site and the Floyd Family Cemetery is still visited annually by family and visitors. From 1927 to 1942, the site was part of a tract known as the Sea Island Game Preserve at Cabin Bluff and was used as a hunting preserve (CH2M 2018). The property continues to offer protected habitat to a wide variety of wildlife including a large population of wild boar.

In the early 1940s, the land was purchased by a paper company for use as a tree farm. In 1962, Thiokol Corporation purchased the property and from 1967 to approximately 1975 the facility manufactured and tested "deterrent containing" munitions items (CH2M 2007), including:

- 40-millimeter (mm) orthochlorobenzalmalononitrile (CS or tear gas) rounds
- XM-15 (CS canister cluster)
- 40-mm high-explosive grenades
- M49 trip flares
- 81-mm mortar-illuminating cartridges
- M84A1 fuzes

Based on historical records, former MEC cleanup efforts, and testimony from a legacy employee (Mr. Lynn), Solid Waste Management Unit (SWMU) 8 was used to test-fire flares within the former 81-mm Mortar Test Range and test-fire grenades within the former 40-mm Test Range. SWMU 9 was also used as a disposal and burn area for munitions (Figure 2) (CH2M 2007).

UCC purchased the property from Thiokol Corporation in 1976 and a UCC subsidiary operated the facility from 1976 to 1986 as an agricultural chemical formulation and manufacturing facility. In December 1986, UCC sold the manufacturing facility and some of the adjacent land to Rhone-Poulenc, which was later renamed Aventis CropScience and then Bayer CropScience (BCS) (CH2M 2007). UCC retained ownership of the current remaining 4,045 acres referred to herein as the site (Figure 1). SWMU 8 remained as undeveloped private land after the 1976 property sale, with much of the area covered by pine forest and some of the forest was harvested for logging.

MEC investigation and mitigation activities began in 1992 within SWMU 8 and SWMU 9 along with soil and groundwater sampling to evaluate human health and ecological risk. During this time, munitions were

identified and destroyed, and debris was removed from the investigation areas. Before 2006, the focus of investigations at the facility had been primarily on assessing the nature and extent of environmental impacts, not necessarily munitions-related impacts. A MEC Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (CH2M 2007) indicated that additional MEC associated with historical activity was likely present within SWMUs 8 and 9; however, the extent was not defined. This same investigation and mitigation work also concluded that surface and subsurface MEC had not been identified outside of the SWMU 9 perimeter (CH2M 2007). UCC conducted a Phase I MEC RCRA Facility Investigation (RFI) (CH2M 2009), a Phase II MEC RFI (CH2M 2010), and a Phase III MEC RFI (CH2M 2018) under the corrective action requirements of the Hazardous and Solid Waste Amendments to RCRA, and Georgia Hazardous Waste Act and requirements of Chapter 391-3-11 of the Georgia Rules. These studies were conducted to evaluate the nature and extent of MEC and MEC-related constituents to better understand the potential risks and to develop and refine the MEC-related institutional controls being implemented at the site. During these investigations, munitions were identified and destroyed, and debris was removed.

The Phase III MEC RFI indicated that soil and groundwater constituents of concern (COCs) at SWMUs 8 and 9 are below risk-based screening levels and/or are at concentrations consistent with background concentrations (CH2M 2018). The Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA), completed as part of the Phase III MEC RFI, concluded that concentrations of COCs at SWMU 8 and SWMU 9 do not pose unacceptable risks to human health or ecological receptors under an industrial land use scenario based on comparison to the Georgia Environmental Protection Division (GA EPD) and U.S. Environmental Protection Agency acceptable risk levels (CH2M 2018). Therefore, no COCs were identified for an industrial land use scenario based on the results of the HHRA or ERA. Based on the results of both the HHRA and ERA, further site characterization of COCs is not warranted for SWMUs 8 and 9 for ecological receptors or under an industrial land use scenario for human receptors.

Additional removal activities (interim corrective actions) were conducted from 2018 to 2020 to identify and remove surface and near surface MEC items within SWMU 8. The primary objective of the interim corrective actions was to reduce risk associated with the potential hazard posed by MEC and material potentially presenting an explosive hazard (MPPEH) to current and future site workers and trespassers within the former 40-mm Test Range and along the main access road within the former 81-mm Mortar Test Range in SWMU 8 (Figure 3). The removal activities met the project quality objectives and all identified material which could cause a potential risk to current and future site workers and trespassers was removed from the site (Jacobs 2022).

1.2 Location

The site is located on a 4,045-acre parcel approximately 11.5 miles due east of the town of Woodbine, in Georgia Militia District Number 31, Camden County, Georgia (Figure 1). The Satilla River and Todd Creek lie to the north of the site; the Cumberland River, Floyd Creek, and the former BCS property are southeast of the facility; and the Sea Island Land Company owns property west of the facility (Figure 1).

Figure 2 shows the locations of SWMU 8 and SWMU 9. SWMU 8 is 259 acres and located south of Todd Creek. SWMU 9 is 111 acres and is located approximately 2,500 feet south, southeast of SWMU 8.

1.3 Topography

The site is located in the Atlantic Coastal Plain Physiographic Province on flat uplands on a point known as Floyds Neck. The topography is generally flat with slight depressions and shallow drainage ways. Three adjacent rivers (Todd Creek, Floyd Creek, and Satilla River) have eroded steep banks. The facility grounds contain few natural streams and stormwater is controlled by ditches and culverts located along the

roadways. There are several depressions and seasonally flooded areas throughout the upland areas. The elevations of the SWMU 8 and SWMU 9 range between 10 and 25 feet above mean sea level.

1.4 Climate

Data collected from an observing station located approximately 15 miles north of the site in Brunswick, Georgia, provide the following climate statistics for the period 1930 to 2006 (Southeast Regional Climate Center 2007):

- The average annual maximum and minimum temperatures were 78.4 degrees Fahrenheit (°F) and 58.9°F, respectively. Maximum temperatures equaled or exceeded 90°F an average of 73.7 days per year and minimum temperatures were less than or equal to 32°F an average of 11.9 days per year.
- The hottest month was July, with an average maximum temperature of 91.9ºF and an average of 22.4 days with temperatures above 90°F. The highest temperature recorded during the reporting period was 106°F.
- The coldest month is January with an average minimum temperature of 42.9°F and an average of 4.9 days with temperatures below 32°F. The lowest temperature recorded during the reporting period was 5°F.
- The average annual precipitation was 52.13 inches. The maximum annual precipitation amount was 79.15 inches, and the minimum annual precipitation amount was 31.92 inches. No snowfall was recorded during the reporting period.
- Summer is the wettest season, with an average season precipitation amount of 18.96 inches, followed by fall (13.72 inches), spring (10.04 inches), then winter (9.41 inches).
- Rainfall amounts greater than or equal to 0.01 inch fell an average of 104 days per year.

1.5 Vegetation

SWMU 8 and SWMU 9 are mostly heavily forested, consisting of either hardwoods or pines. The majority of the pines are planted in rows. Undergrowth in all the forests is moderate to thick brush. During the MEC surface clearance work and digital geophysical mapping conducted in 2008, vegetation less than 6 inches in diameter was removed within transects that covered approximately 5 percent of the total SWMU 8 and SWMU 9 areas (CH2M 2009). Since then, the vegetation has grown back to thin-to-moderate levels within these transects. During 2018 to 2020 interim action activities, vegetation was cleared across approximately 55 acres of SWMU 8 by cutting brush greater than 6 inches above the ground surface, chopping vines and tree limbs, and removing small trees less than 4 inches in diameter (Jacobs 2022).

1.6 Geology

The site is located in the Barrier Island District of the Atlantic Coastal Plain Physiographic Province (Clark and Zisa 1976). Pleistocene sea levels advanced and retreated several times over the Barrier Island Sequence District, forming a stepped progression of decreasing elevations toward the sea. These former, higher sea levels formed barrier island/salt marsh environments generally similar to the present coast. The former sea levels deposited shoreline complexes parallel to the present shoreline. There has been slight to moderate dissection of these former terraces by streams, leading to the development of marshes in poorly drained low areas.

The site resides on undifferentiated surficial sands (Holocene and Pleistocene), the Satilla Formation (Holocene and Pleistocene), and the Cypresshead Formation (Pliocene). The undifferentiated surficial

sands and Satilla Formation cannot be separated due to lithologic similarities and lack of paleontological control likely found at the site (Leeth 1999). These Quaternary sediments are well sorted, fine-to-very-fine quartz sand, with some laterally extensive but discontinuous organic-rich layers that occur at approximately 5 to 10 feet below ground surface. Pelecypod shells are present but not abundant. There is no distinct marker at the base of the Quaternary sediments, but a partially cemented, reddish brown, iron-stained sand does occur that is typical of the Satilla Formation. Quaternary sediments are generally 35 to 45 feet thick across Camden County, Georgia, including the site (Leeth 1999).

The Cypresshead Formation consists of fine-to-medium sand that grades downward in section to a sandy, clayey silt that is characterized at its base by thin clay and silt interbeds that become calcareous and shelly with depth. Pliocene sediments are differentiated primarily on lithology, specifically, an increase in coarse grain size, an increase in clay content, and a decrease in cementation and iron staining. These sediments range from approximately 35 to 45 feet thick (Leeth 1999).

Humate-cemented sandstone is locally prominent, with large boulders of humate sandstone littering the bases of bluffs. Humate is produced by the percolation of naturally occurring weak acids from the organic topsoil above the sands. The bluffs along the south bank of Todd Creek on the northern side of the site affords excellent exposures of barrier island facies of the Satilla Formation (Law Engineering and Environmental Services 1993). Sediments observed in lithologic samples at the UCC landfill, from the March 2006 direct-push technology investigation and May 2006 monitoring well installation, consist of fine-to-medium, indistinctly bedded quartz sand approximately 40 to 55 feet thick, with minor discontinuous clay beds that typically occur 40 to 55 feet below ground surface (CH2M 2008).

2. Institutional Controls

2.1 Possible MEC-Related Risks

Due to the historical use of the property for the manufacturing and testing of munitions items as detailed in Section 1.2, several MEC investigations and removal actions have been completed to reduce MEC-related risk (Jacobs 2022). However, residual MEC may be present at the site. This ICP is being developed to mitigate the risk involved with additional ordnance that may be present due to prior activity involving MEC at the site.

2.1.1 Current Land Use

SWMUs 8 and 9 are on private land owned by UCC, though a small portion of SWMU 8 is located on former BCS property (Figure 2). Much of the area is planted in pines and these areas have been logged in the past and timber may be harvested again in the future. The land is currently not being used for any industrial, recreational, or residential purposes. It is primarily uninhabited, inaccessible woodlands. There is a closed RCRA Hazardous Waste Landfill directly east of the former 40-mm Test Range. Todd Creek, a tributary to the Satilla River, is located to the north. The UCC property is accessible by water and land, although no residential or industrial neighbors (aside from BCS) are in close proximity to the SWMUs and general public access by motor vehicle is restricted by locked gates. Access to some culturally significant historical landmarks located outside of SWMUs 8 and 9 may require travel through the SWMUs.

A review of historical records indicates that federal or state listed animal species have potential to occur within the site (Jacobs 2018). Gopher Tortoise have been observed within SWMUs 8 and 9. Though not observed during investigative and removal activities within SWMUs 8 and 9, the eastern indigo snake could occur in this area as it frequently is a commensal with the gopher tortoise (Jacobs 2022).

Currently, motor vehicle traffic to the site is regulated by locked gates at the entrances to the facility. The site currently has an existing environmental covenant (EC) (recorded in 2011 and included as Attachment 1) which restricts land use to non-residential and prohibits the extraction or use of groundwater for non-remedial purposes.

2.1.2 Future Land Use

The anticipated future land use includes a conservation easement and possible timber harvests.

2.2 Site-Specific Objectives

Based on current and future land use, potential exposure to MEC/MPPEH may occur at SWMUs 8 and 9 from one or more of the following activities:

- Trespassers that may inadvertently access the site
- Visitors and workers that may travel through the Restricted Use Zone (RUZ) via vehicle or on foot
- Construction of utilities, roadways, buildings, or other structures
- Harvesting of timber

UCC conducted an evaluation of the potential risks posed by MEC/MPPEH at SWMUs 8 and 9 as part of the Decision Logic Process (Jacobs 2021). The Decision Logic Process approach employs a series of four matrices that use site-specific information to relate accessibility, munitions sensitivity, and severity of an explosive event if it were to occur, to determine risks. The process was used to assess the types of risks

present based on the potential future land uses and evaluate the types of mitigation methods that could be employed to address those risks. Based on this evaluation, it was determined that land use controls would be effective at achieving an acceptable level of risk reduction in addition to interim measures remedial actions have already completed (Jacobs 2022). The following objectives are identified for the land use controls deemed necessary for the site:

- Provide notification/warning to workers, visitors, and inadvertent public trespassers that they are entering an area where MEC may be present.
- Provide guidelines for appropriate training for the identification of MEC and MPPEH for activities within the RUZ.
- Provide guidelines regarding the type of training and oversight required for site activities.

2.3 Selected Institutional Controls

The selected institutional controls consist of land use controls and restrictions implemented through ECs. The land use controls and restrictions will be applied to the RUZ, which is composed of the entirety of SWMUs 8 and 9, and would include the following:

- Access to the RUZ is restricted to persons who have completed, or are escorted by someone who has completed, Department of Defense 3R (Recognize, Retreat, and Report) Training for MEC awareness and avoidance. 3R Training is the minimum requirement for all activities (surface and subsurface) within the RUZ.
- Any land disturbance activity that may result in the release or exposure to MEC, or create a new exposure pathway to MEC, is prohibited, except with the support of a Qualified Unexploded Ordnance (UXO) Technician, defined as a person meeting the minimum qualification standards for personnel performing UXO-related operations as defined in Department of Defense Explosives Safety Board Technical Paper 18, Revision 1, Minimum Qualifications for Personnel Conducting Munitions and Explosives of Concern-Related Activities (June 24, 2020) or any subsequent version thereof. Technical support from a Qualified UXO Technician is required prior to and during any construction activities, which include subsurface excavation, digging, drilling, or any other disturbance of the subsurface. The type of support provided by a Qualified UXO Technician will depend on the activity to be performed, which may include locating surface UXO by visual means; location of subsurface UXO using magnetometers; classification of UXO; and assisting with transport, storage, and disposal of UXO. This requirement also applies to any subsurface excavation following initial authorized construction activities, such as subsurface utility construction actions.
- Permanent warning signage will be installed and maintained at a vehicular access point to the RUZ and along roads and boundaries of the RUZ (Figure 2). Signs will be installed at a spacing of 100 meters and approximately 5 feet above grade and will display verbiage warning of potential MEC and responsible party contact information as indicated on the example sign included as Figure 4. Signage spacing will be reduced to 50 meters in areas of tall dense vegetation to allow for increased visibility. If new roadways and access points are established through the RUZ, the installation of additional signage will be required.

3. Institutional Control Implementation, Maintenance, Change, and Termination

3.1 Implementation

The institutional controls proposed in Section 2 will be installed/executed following review and approval of the MEC Corrective Action Plan for SWMUs 8 and 9 by GA EPD. The ECs will be executed and recorded with Camden County. Signage will be installed by surveying the locations of the signage to ensure the sign spacing is not more than 100 meters along the RUZ boundary and access roads as shown on Figure 2. Signage spacing will be reduced to 50 meters in areas of tall dense vegetation to allow for increased visibility. A Qualified UXO Technician must accompany the surveyor and sign installer.

3.2 Maintenance

The landowner will be responsible for inspecting and maintaining the signage network on a biennial and as needed basis. Results of biennial inspections and any necessary maintenance will be documented and reported to GA EPD.

3.3 Termination

The institutional controls and this ICP will be reevaluated at the time of completion of additional response actions, change in site use, or change in property owner. Recommendations for modifications or termination of specific institutional controls may be proposed to GA EPD for approval. Changes to these institutional controls cannot be made without the approval of GA EPD.

4. References

CH2M HILL Engineers, Inc. (CH2M). 2007. *Munitions and Explosives of Concern RCRA Facility Assessment, Union Carbide Corporation Woodbine.* Prepared for UCC. Contract No. NA-1022. Purchase Order No. 93130672. October.

CH2M HILL Engineers, Inc. (CH2M). 2008. Hazardous Waste Facility Permit Renewal Application, Permit No. HW-63(D). Prepared for UCC. Woodbine, Georgia. October.

CH2M HILL Engineers, Inc. (CH2M). 2009. *Final Results of Phase I Munitions and Explosives of Concern RCRA Facility Investigation – Union Carbide Corporation, Woodbine Georgia Facility.* March.

CH2M HILL Engineers, Inc. (CH2M). 2010. *Final Results of Phase II Munitions and Explosives of Concern RCRA Facility Investigation – Union Carbide Corporation, Woodbine Georgia Facility.* March.

CH2M HILL Engineers, Inc. (CH2M). 2018. *Phase III Munitions and Explosives of Concern RCRA Facility Investigation Report - Union Carbide Corporation Woodbine Facility, Camden County, Georgia.* June.

Clark, W.Z. and A.C. Zisa. 1976. *Physiographic map of Georgia*, Map SM-4 (reprinted, 1988). Georgia Geologic Survey, Atlanta, Georgia.

Department of Defense Explosives Safety Board. 2020. *Minimum Qualifications for Personnel Conducting Munitions and Explosives of Concern-Related Activities.* Technical Paper 18, Revision 1. June 24.

Jacobs Engineering Group Inc. (Jacobs). 2018. *Interim Measure Work Plan, Removal Action for Solid Waste Management Unit 8*. December.

Jacobs Engineering Group Inc. (Jacobs). 2021. *Munitions and Explosives of Concern Corrective Action Plan for Solid Waste Management Units 8 and 9.* June.

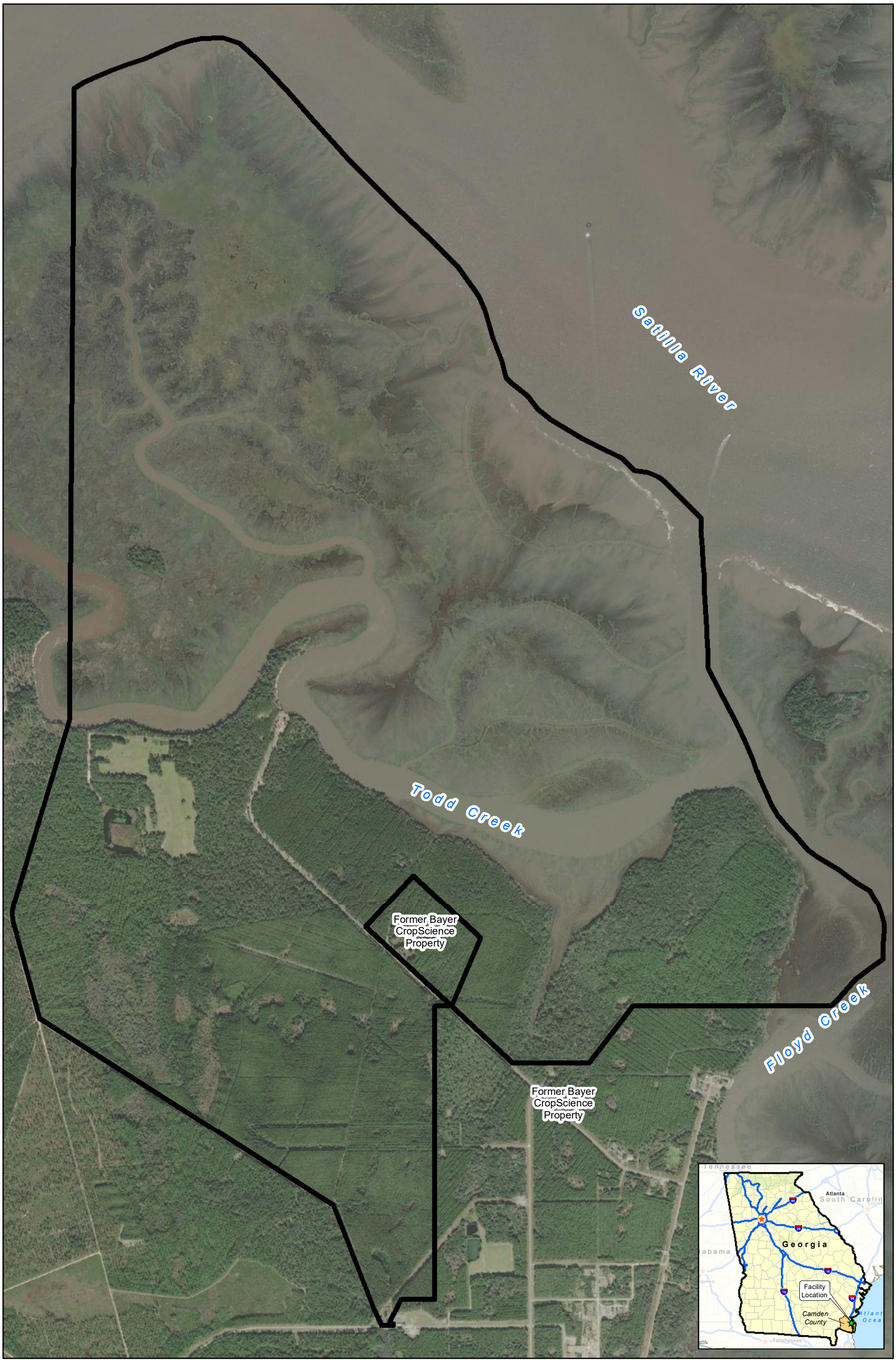
Jacobs Engineering Group Inc. (Jacobs). 2022. *Solid Waste Management Unit 8 Interim Measure Completion Report - Union Carbide Corporation Woodbine Facility, Camden County, Georgia.* June.

Law Engineering and Environmental Services. 1993. *RCRA Facility Investigation Report.* Prepared for UCC.

Leeth, D.C. 1999. *Hydrogeology of the surficial aquifer in the vicinity of a former landfill, Naval Submarine Base Kings Bay, Camden County, Ge*orgia. U.S. Geological Survey Water Resources Investigations Report 98-4246, 28 pp.

Southeast Regional Climate Center, University of North Carolina at Chapel Hill. http://radar.meas.ncsu.edu/. Data for Station 091340 (Brunswick) accessed October 11, 2007, at http://radar.meas.ncsu.edu/cgi-bin/sercc/cliMAIN.pl?ga1340.

Figures



LEGEND

Property Boundary

N

0 800 1,600 3,200

Feet

Notes:

1. ESRI Aerial from ArcGIS Online, Dated 11/18/2020
2. Property boundary based on survey completed September 21, 2017 by Geomatics Corporation.

Figure 1. Site Location Map

Union Carbide Corporation

UCC Woodbine, Camden County, Georgia

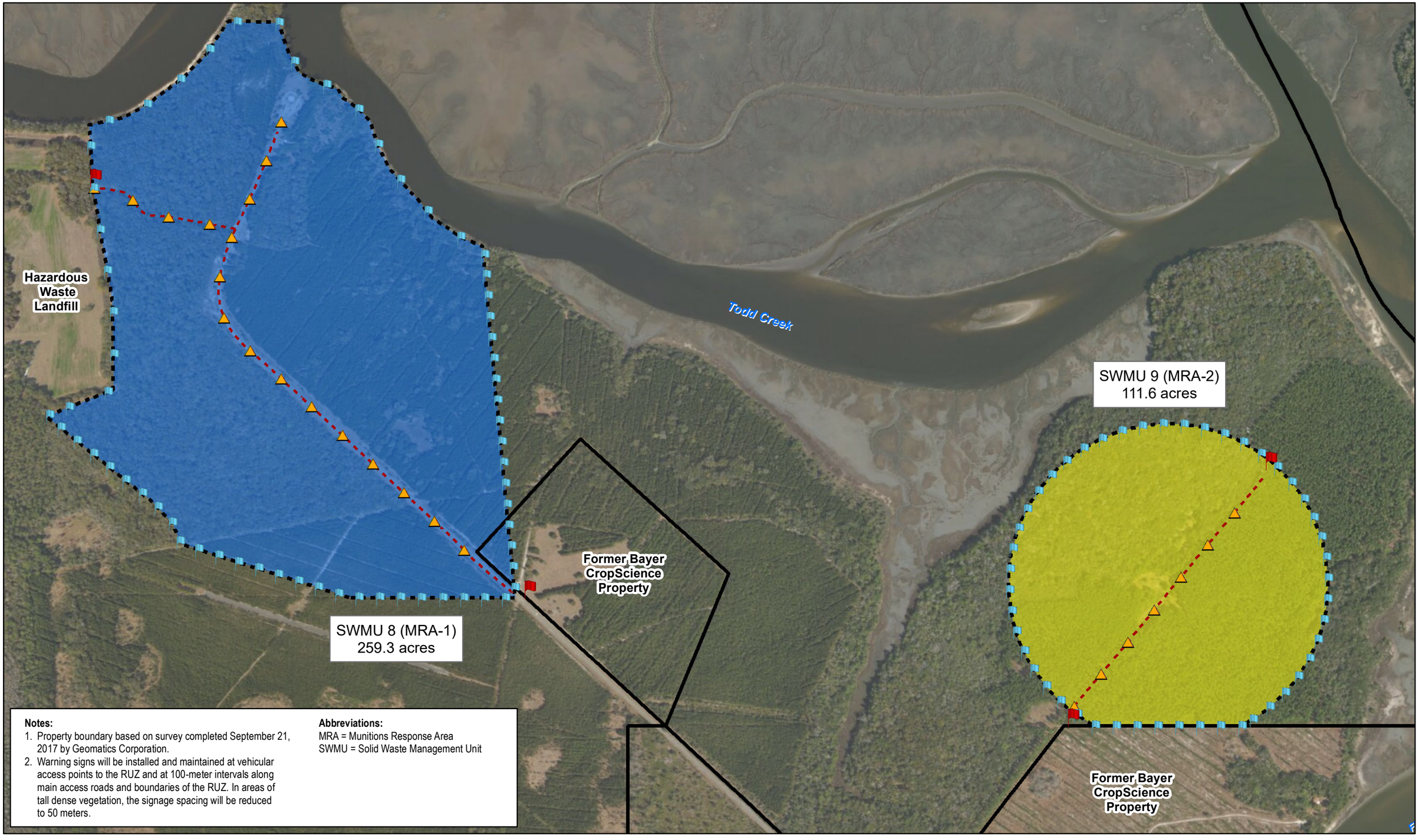
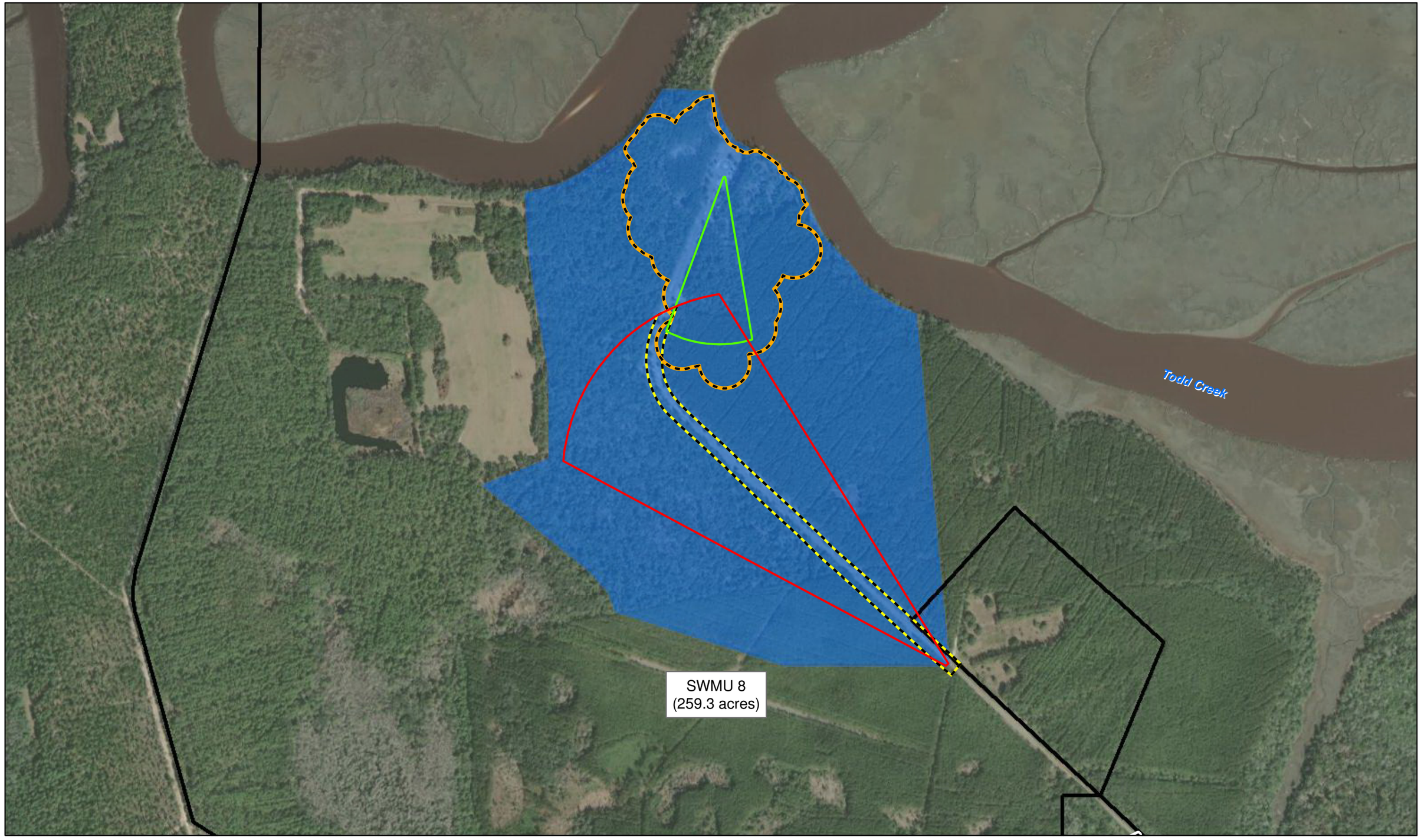


Figure 2. Locations of Solid Waste Management Units 8 and 9
Munitions and Explosives of Concern Institutional Control Plan
Union Carbide Corporation Woodbine
Woodbine, Georgia

Jacobs



40-mm Test Range
81-mm Mortar Test Range
Property Boundary
SWMU 8
40-mm Test Range Removal Action Area (49.6 Acres)
81-mm Mortar Test Range Removal Action Area (8.8 Acres)

N
0 350 700 1,400
Feet

Abbreviations:
mm = millimeter
SWMU = Solid Waste Management Unit

Notes:
1. ESRI Aerial from ArcGIS Online, Dated 1/21/2020
2. SWMU 8 boundary based on survey completed September 21, 2017 by Geomatics Corporation.

Figure 3. Solid Waste Management Unit 8 Features
Munitions and Explosives of Concern Institutional Control Plan
Union Carbide Corporation
UCC-Woodbine, Camden County, Georgia

Jacobs

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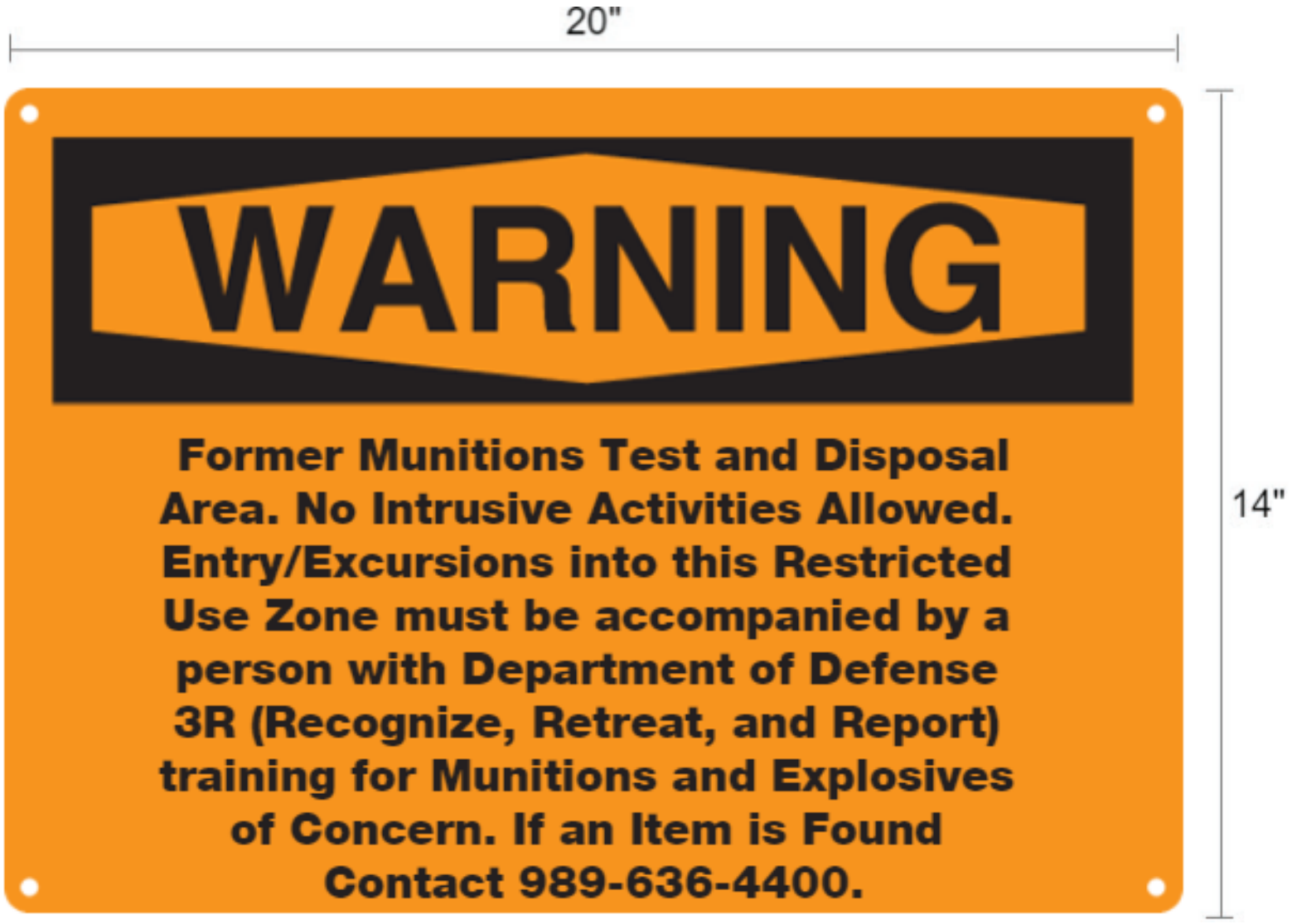

Figure 4. Proposed Warning Signage
Union Carbide Corporation
UCC-Woodbine, Camden County, Georgia

Attachment 1
Executed Environmental Covenant

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BOOK PAGE

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FILED
CAMDEN CO. CLERK'S OFFICE

After Recording Return to:

Mark Sjerrill
*see cover

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CAMDEN COUNTY SUPERIOR COURT
WOODBINE, GEORGIA

Georgia Environmental Protection Division
Land Protection Branch
Hazardous Waste Corrective Action Program
2 Martin Luther King Jr. Drive, SE
Suite 1154 East
Atlanta, Georgia 30334

I CERTIFY THAT THIS IS A TRUE & CORRECT COPY OF ORIGINAL
10 PAGES FILED IN THIS OFFICE.
THIS 1ST DAY OF April 2011
Lindsey Hood
DEPUTY CLERK

Environmental Covenant

This instrument is an Environmental Covenant executed pursuant to the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *eq seq.* This Environmental Covenant subjects the Property identified below to the activity and/or use limitations specified in this document. The effective date of the Environmental Covenant shall be the date upon which the fully executed Environmental Covenant has been recorded in accordance with OCGA § 44-16-8(a)

Fee Owner of Property/Grantor:
Union Carbide Corporation
A wholly owned subsidiary of the Dow Chemical Company
P.O. Box 4393
Houston, TX 77210

Grantee/Holder:
Union Carbide Corporation
A wholly owned subsidiary of the Dow Chemical Company
P.O. Box 4393
Houston, TX 77210

Grantee/Entity with Express power to enforce:
State of Georgia
Department of Natural Resources
Environmental Protection Division
2 Martin Luther King, Jr. Drive, SE
Suite 1154 East
Atlanta, Georgia 30334

Parties with interest in the Property: N/A

Property:

The area subject to this Environmental Covenant is 4,011.54 aces entirely within the Union Carbide Corporation (hereinafter "UCC") Woodbine Facility, located at 5954 Union Carbide Road in Woodbine, Camden County, Georgia. The tract of land containing this area (4,011.54 acres) was conveyed on November 1976 from Thiokol Corporation to Union Carbide Corporation recorded in Deed Book 262, Page 227, Camden County Records. The area is located in the 31st G.M.D. District of Camden County, Georgia. The area includes a closed

landfill that is approximately 22-acres in size. The buffer zone around the landfill includes another 36 acres, therefore the combined landfill and buffer total 58.16-acres (hereinafter "RCRA landfill"). A complete legal description of the RCRA landfill is attached as Exhibit A and a map of the area is attached as Exhibit B.

Tax Parcel Number(s):

155 001 of Camden County, Georgia

Name and Location of Administrative Records:

The post-closure care and corrective action at the RCRA landfill that is the subject of this Environmental Covenant is described in the following document:

- Revised Hazardous Waste Facility Permit Renewal Application – Permit No. HW-063(D), dated August 20, 2010, as amended or renewed.

This document is available at the following locations:

Georgia Environmental Protection Division
Land Protection Branch
Hazardous Waste Corrective Action Program
2 Martin Luther King, Jr. Drive, SE
Suite 1154 East
Atlanta, Georgia 30334

Union Carbide Corporation
5954 Union Carbide Road
Woodbine, Georgia 31569

Description of Contamination, Post-Closure Care and Corrective Action:

This property is subject to a Resource Conservation Recovery Act (RCRA) hazardous waste facility permit [HW-063(D)] and has been designated as needing corrective action due to the presence of hazardous waste, hazardous waste constituents, or hazardous constituents regulated under the Georgia Hazardous Waste Management Act, § 12-8-60 *et seq.* (Act) and the Georgia Hazardous Waste Management Rules, 391-3-11 (Rules). Contact the property owner or the Georgia Environmental Protection Division for further information concerning this property.

This Declaration of Covenant is made pursuant to the Georgia Uniform Environmental Covenants Act, O.C.G.A. § 44-16-1, *eq seq* by UCC, its successors and assigns, Camden County Planning and Building Department, and the State of Georgia, Department of Natural Resources, Environmental Protection Division (hereinafter "EPD"), its successors and assigns. This Environmental Covenant is required because the property was used for the disposal of both hazardous and non-hazardous waste. The hazardous waste, hazardous waste constituents, or hazardous constituents disposed of in the landfill are listed in Section II and Table A of Hazardous Waste Facility Permit HW-063(D) (hereinafter "constituents of concern"). Post-closure care and corrective action, as required by Hazardous Waste Facility Permit HW-063(D) Sections II and III, consists of, but is not limited to, the installation and maintenance of engineering controls (clay cap, fencing, maintenance of vegetative cover, and groundwater

monitoring and corrective action system) and institutional controls (limit use to non-residential activities, prohibit groundwater use) to protect human health and the environment.

Grantor, UCC, hereby binds Grantor, its successors and assigns to the activity and use restriction(s) for the area (4,011.54 acres), including the RCRA landfill identified herein and grants such other rights under this Environmental Covenant in favor of Camden County Planning and Building Department and EPD. EPD shall have full right of enforcement and the rights conveyed under this Environmental Covenant pursuant to the Act and Rules. Failure to timely enforce compliance with Environmental Covenant or the use or activity limitation contained herein by any person shall not bar subsequent enforcement by such person and shall not be deemed a waiver of the person's right to take action to enforce any non-compliance. Nothing in this Environmental Covenant shall restrict EPD from excising any authority under applicable law.

UCC makes the following declaration as to limitations, restrictions, and uses to which the area (4,011.54 acres), including the RCRA landfill may be put and specified that such declarations shall constitute covenants to run with the land, pursuant to O.C.G.A § 44-16-5 (a); is perpetual, unless modified or terminated pursuant to the terms of this Covenant pursuant to O.C.G.A § 44-16-9; and shall be binding on all parties and all persons claiming under them, including all current and future owners of any portion of or interest in the RCRA landfill (hereinafter "Owner"). Should a transfer or sale of the area (4,011.54 acres), including the RCRA landfill occur before such time as this Environmental Covenant has been amended or revoked then said Environmental Covenant shall be binding on the transferee(s) or purchaser(s).

The Environmental Covenant shall inure to the benefit of EPD, Camden County Planning and Building Department, UCC and their respective successors and assigns and shall be enforceable by the Director of EPD (hereinafter "Director") or his agents or assigns, UCC or its successors and assigns, Camden County Planning and Building Department or its successors and assigns, and other party(ies) as provided for in O.C.G.A V § 44-16-11 in a court of competent jurisdiction.

Activities and/or Use Limitation(s)

1. Registry. Pursuant to O.C.G.A. § 44-16-12, this Environmental Covenant and any amendment or termination thereof, may be contained in EPD's registry for environmental covenants.

2. Notice. The Owner of the area (4,011.54 acres), including the RCRA landfill must give thirty (30) day advance written notice to EPD of the Owner's intent to convey any interest in the area (4,011.54 acres), including the RCRA landfill. No conveyance of title, easement, lease, or other interest in the area (4,011.54 acres), including the RCRA landfill shall be consummated by the Owner without adequate and complete provision for continued monitoring, operation, and maintenance of the post-closure care and corrective action program. The Owner of the area (4,011.54 acres), including the RCRA landfill must also give thirty (30) day advance written notice to EPD of the Owner's intent to change the use of the RCRA landfill, apply for building permit(s), or propose any site work that would affect the RCRA landfill.

3. Notice of Limitation in Future Conveyances. Each instrument hereafter conveying an interest in the area (4,011.54 acres), including the RCRA landfill subject to this

Environmental Covenant shall contain a notice of the activity and use limitations set forth in the Environmental Covenant and shall provide the recorded location of the Environmental Covenant.

4. Monitoring. The post-closure care and corrective action program detailed in the *Revised Hazardous Waste Facility Permit Renewal Application – Permit No. HW-063(D)* dated August 20, 2010, as amended, must be implemented to ensure compliance with Law and Rules.

5. Periodic Reporting. Semi-annually, the Owner shall submit to EPD a report as specified in Conditions III.H.3. of Hazardous Waste Facility Permit HW-063(D) and the EPD approved post-closure care and corrective action plan, which includes, but is not limited to: groundwater monitoring report results, maintenance and inspection activities, certification of non-residential use of the RCRA landfill, and documentation stating whether or not the activity and use limitation in this Environmental Covenant are being abided by.

6. Activity and Use Limitation(s). The area (4,011.54 acres), including the RCRA landfill shall be used only for non-residential uses, as defined as any real property or portion of a property not currently being used for human habitation or for other purposes with a similar potential for human exposure, at which activities have been or are being conducted that can be categorized in one of the 1987 Standard Industrial Classification (SIC) major groups 01-97 inclusive (except the four-digit codes 4941, 8051, 8059, 8062-3, 8069, 8211, 8221-2, 8351, 8661 and 9223). Non-residential property includes all of the contiguous block(s) and lot(s) controlled by the same owner or operator that are vacant land, or that are used in conjunction with such business; and defined in and allowed under the Camden County's zoning regulations as of the date of this Environmental Covenant. Any residential use on the area (4,011.54 acres), including the RCRA landfill shall be prohibited. Any activity on the area (4,011.54 acres), including the RCRA landfill that may result in the release or exposure to hazardous wastes, hazardous constituents, hazardous waste constituents or the constituents of concern that were contained as part of the post-closure care and corrective action program, or create a new exposure pathway, is prohibited. With exception of work necessary for the maintenance, repair, or replacement of engineering controls, activities that are prohibited in the capped areas include, but are not limited to the following: drilling, digging, placement of any objects or use of any equipment which deforms or stresses the surface beyond its load bearing capability, piercing the surface with a rod, spike or similar item, bulldozing or earthwork.

7. Groundwater Limitation. The use or extraction of groundwater beneath the area (4,011.54 acres), including the RCRA landfill for drinking water or for any other non-remedial purposes shall be prohibited.

8. Permanent Markers. Permanent markers on each side of the RCRA landfill shall be installed and maintained that delineate the restricted area as specified in 40 CFR 261.14(c) and 40 CFR 264.310(b)(6). Disturbance or removal of such markets is prohibited.

9. Right of Access. In addition to any rights already possessed by EPD and/or the Camden County Planning and Building Department, the Owner shall allow authorized representatives of EPD and/or Camden County Planning and Building Department the right to enter the area (4,011.54 acres), including the RCRA landfill at reasonable times for the purpose of evaluating the post-closure care and corrective action program to take samples,

to inspect the RCRA landfill, to inspect records that are related to the post-closure care and corrective action program,and to determine compliance with this Environmental Covenant.

10. Recording of Environmental Covenant and Proof of Notification. Within thirty (30) days after the date of the Director's signature, the Owner shall file this Environmental Covenant with the Recorders of Deeds for each County in the area (4,011.54 acres), including the RCRA landfill is located, and send file stamped copy of this Environmental Covenant to EPD within thirty (30) days of recording. Within that time period, the Owner shall also send a file-stamped copy to each of the following: (1) Camden County Planning and Building Department, (2) each person holding a record of interest in the area (4,011.54 acres), including the RCRA landfill subject to the covenant, (3) each person in possession of the real property subject to the covenant, (4) each municipality, county, consolidated government, or other unit of local government in which real property subject to the covenant is located, and (5) each owner in fee simple whose property abuts the property subject to the Environmental Covenant.

11. Termination or Modification. The Environmental Covenant shall remain in full force and effect in accordance with O.C.G.A. § 44-16-5, unless and until the Director determines that the area (4,011.54 acres), including the RCRA landfill is no longer subject to the post-closure care and corrective action program requirements under Hazardous Waste Facility Permit HW-063(D), whereupon the Environmental Covenant may be amended or revoked in accordance O.C.G.A § 44-16-1 *et seq.*

12. Severability. If any provision of this Environmental Covenant is found to be unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions shall not in any way be affected or impaired.

13. No Property Interest Created in EPD. This Environmental Covenant does not in any way create any interest by EPD in the area (4,011.54 acres), including the RCRA landfill that is subject to the Environmental Covenant. Furthermore, the act of approving this Environmental Covenant does not in any way create any interest by EPD in the RCRA landfill in accordance with O.C.G.A § 44-16-3(b).

Representations and Warranties.

Grantor hereby represents and warrants to the other signatories hereto:

a) That the Grantor has the power and authority to enter into this Environmental Covenant, to grant the rights and interests herein provided and to carry out all obligations hereunder;
b) That the Grantor is the sole owner of the Property and holds fee simple title which is free, clear and unencumbered;
c) That the Grantor has identified all other parties that hold any interest (e.g. encumbrance) in the Property and notified such parties of the Grantor's intention to enter into this Environmental Covenant;
d) That this Environmental Covenant will not materially violate, contravene, or constitute a material default under any other agreement, document or instrument to which Grantor is a party, by which Grantor may be bound or affected;

e) That the Grantor has served each of the people or entities referenced in Activity 10 above with an identical copy of this Environmental Covenant in accordance with O.C.G.A. § 44-16-4(d).
f) That this Environmental Covenant will not materially violate or contravene any zoning law or other law regulating use of the Property; and
g) That this Environmental Covenant does not authorize a use of the Property that is otherwise prohibited by a recorded instrument that has priority over the Environmental Covenant.

Notices.

Any document or communication required to be sent pursuant to the terms of this Environmental Covenant shall be sent to the following persons:

Georgia Environmental Protection Division
Branch Chief
Land Protection Branch
2 Martin Luther King Jr. Drive SE
Suite 1154 East Tower
Atlanta, GA 30334

Union Carbide Corporation
P.O. Box 4393
Houston, TX 77210

Camden County Planning and Building Department
107 Gross Road
Suite 2
Kingsland, GA 31548

Grantor has caused this Environmental Covenant to be executed pursuant to The Georgia Uniform Environmental Covenants Act, on the 27 day of January, 2011.

UNION CARBIDE CORPORATION

Timothy A. King
Authorized Representative for Union Carbide Corporation
Union Carbide Corporation
1254 Enclave Parkway
Houston, TX 77077

Dated: 1/27/11

Peggy A. Given
WITNESS: Peggy A. Given

UNION CARBIDE CORPORATION AS HOLDER

Timothy A. King
Authorized Representative for Union Carbide Corporation
Union Carbide Corporation
1254 Enclave Parkway
Houston, TX 77077

Dated: 1/27/11

Peggy A. Given
WITNESS: Peggy A. Given

CAMDEN COUNTY PLANNING AND BUILDING DEPARTMENT

[Name of Person Acknowledging Receipt]
[Title]

Dated: 3-22-11

WITNESS

Notary CAMDEN COUNTY
EXPIRES 16 MARCH 2015

STATE OF GEORGIA
ENVIRONMENTAL PROTECTION DIVISION

F. Allen Barnes
Director, Georgia Environmental Protection Division

Dated: 3-25-2011

Yolanda P. Fanning
WITNESS

DEBORAH H. MOORE NOTARY PUBLIC DOUGLAS COUNTY GEORGIA EXPIRES APRIL 10, 2013

Deborah H. Moore
Notary 3-25-2011

CLERK'S NOTE: CONTINUE NEXT PAGE

[INDIVIDUAL ACKNOWLEDGMENT]

STATE OF West Virginia
COUNTY OF Kanawha

On this 27th day of January, 2011, I certify that Timothy A. King personally appeared before me, and acknowledged that **he/she** is the individual described herein and who executed the within and foregoing instrument and signed the same at **his/her** free and voluntary act and deed for the uses and purposes therein mentioned.

OFFICIAL SEAL
Notary Public, State Of West Virginia
Iris Jeanne Songer
13 Evergreen Circle
Poca, WV 25159
My Commission Expires July 17, 2016

Iris Jeanne Songer
Notary Public in and for the State of West Virginia, residing at South Charleston
My appointment expires July 17, 2016

[CORPORATE ACKNOWLEDGMENT]

STATE OF West Virginia
COUNTY OF Kanawha

On this 27th day of January, 2011, I certify that Timothy A. King personally appeared before me, acknowledged that **he/she** is the Authorized Representative of the corporation that executed the within and foregoing instrument, and signed said instrument by free and voluntary act and deed of said corporation, for the uses and purposes therein mentioned, and on oath stated that **he/she** was authorized to execute said instrument for said corporation.

OFFICIAL SEAL
Notary Public, State Of West Virginia
Iris Jeanne Songer
13 Evergreen Circle
Poca, WV 25159
My Commission Expires July 17, 2016

Iris Jeanne Songer
Notary Public in and for the State of West Virginia, residing at South Charleston
My appointment expires July 17, 2016

[REPRESENTATIVE ACKNOWLEDGEMENT]

STATE OF _____
COUNTY OF _____

On this _____ day of _____, 20__, I certify that _____ personally appeared before me, acknowledged that **he/she** signed this instrument, on oath stated that **he/she** was authorized to execute this instrument, and acknowledged it as the _____ [type of authority] of _____ [name of party being represented] to be the free and voluntary act and deed of such party for the uses and purposes mentioned in the instrument.

_____
Notary Public in and for the State of Georgia, residing at _____.
My appointment expires _____.

CLERK'S NOTE: CONTINUE NEXT PAGE

EXHIBIT A

Legal Description for the Hazardous Waste Landfill

UCC-Woodbine (Camden County) Georgia

A parcel of land lying in Georgia Militia District 31, Camden County, Georgia containing 58.17 acres more or less, and being more particularly described as follows:

For a POINT OF REFERENCE commence at a point lying on the westerly line of said lands described in Reference Deed Book 262, Page 227, said point being described as the POINT OF BEGINNING of just mentioned lands; Thence South 16°50'37" West, along said westerly line, 171.97 feet; thence South 73°09'23" East, departing said westerly line, 635.80 feet to a 3 inch diameter, 6 foot high, metal fence post and the POINT OF BEGINNING of the herein described lands: Said POINT OF BEGINNING having a Northing of 346438.73 and an Easting of 851886.63, said coordinates expressed in U.S. Survey Feet and being referenced to the Georgia State Plane Coordinate System, East Zone, (1001), North American Datum of 1983, 2007 adjustment. Thence, from said POINT OF BEGINNING,

1. South 88°13'28" East, 804.79 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 346413.79 and Easting of 852691.04;
2. thence South 06°25'21" East, 893.63 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 345525.76 and an Easting of 852791.00;
3. thence North 86°24'59" East, 433.86 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 345552.88 and an Easting of 853224.01;
4. thence South 20°37'29" West, 431.76 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 345148.80 and an Easting of 853071.92;
5. thence South 53°25'54" East, 289.38 feet, to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 344976.39 and an Easting of 853304.34;
6. thence North 68°51'14" East, 542.03 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 345171.93 and an Easting of 853809.87;
7. thence North 01°34'43" West, 780.53 feet to a 2 inch diameter, 6 foot high, metal fence post, having a Northing of 345952.16 and an Easting of 853788.37;
8. thence North 09°24'51" West, 460.73 feet to a 2 inch diameter, 6 foot high, metal fence post, having a Northing of 346406.68 and an Easting of 853713.01;
9. thence North 14°37'48" West, 345.87 feet to a 2 inch diameter, 6 foot high, metal fence post, having a Northing of 346741.34 and an Easting of 853625.65;
10. thence North 04°05'48" West, 381.17 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 347121.54 and an Easting of 853598.42;
11. thence North 86°26'46" West, 1707.03 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 347227.35 and an Easting of 851894.67;
12. thence South 00°35'04" West, 788.67 feet to the point of beginning.

BOOK PAGE

1562 00636

EXHIBIT B

Survey Plat for the Hazardous Waste Landfill

UCC-Woodbine (Camden County) Georgia

Recorded MAR 2 9 2011

Susan K. Waldron

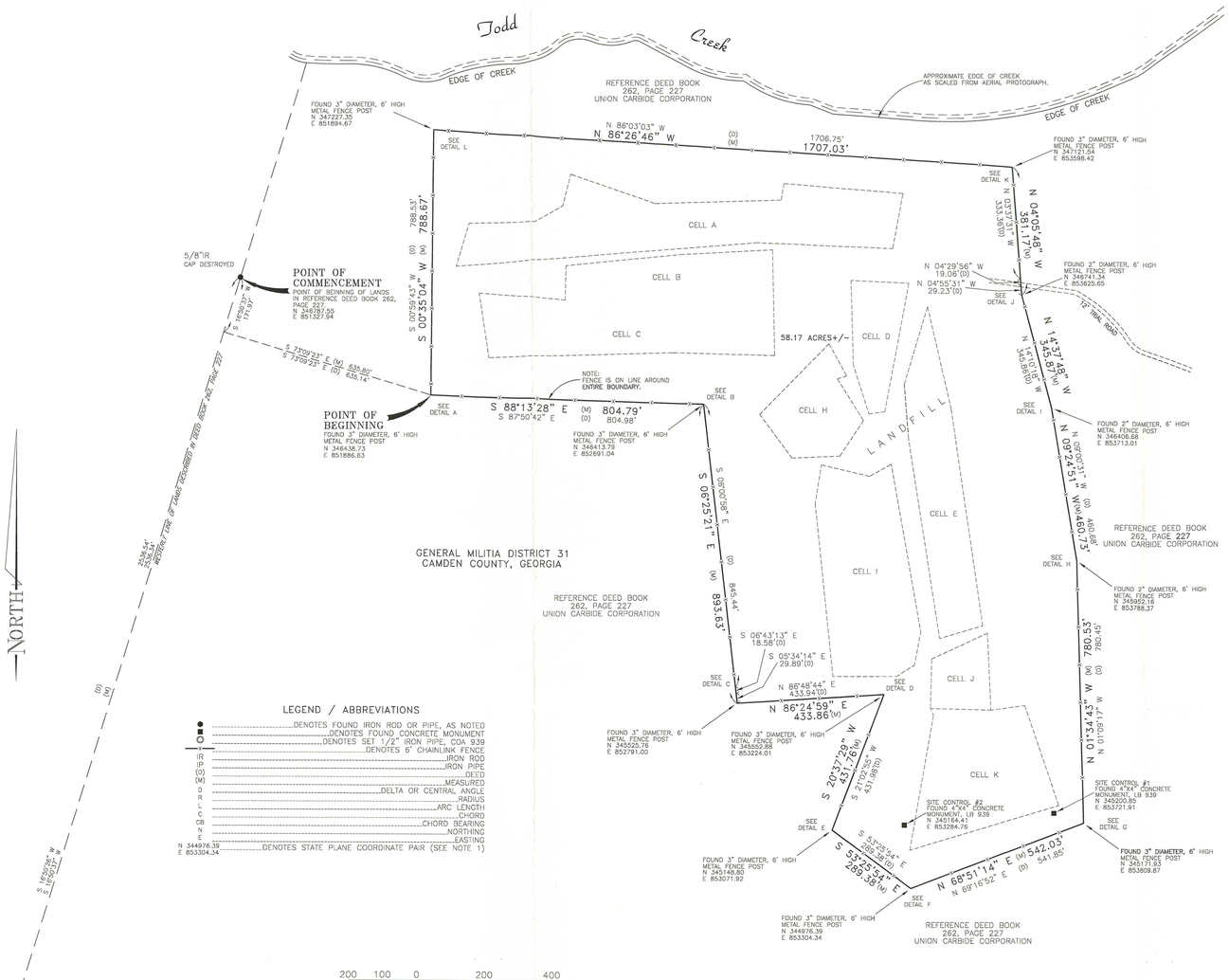
Clerk Superior Court

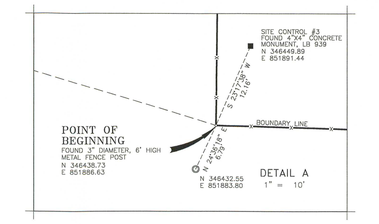
A MAP SHOWING A BOUNDARY SURVEY
OF
THE HAZARDOUS WASTE LANDFILL LOCATED ON
THE UCC–WOODBINE PROPERTY
CAMDEN COUNTY, GEORGIA

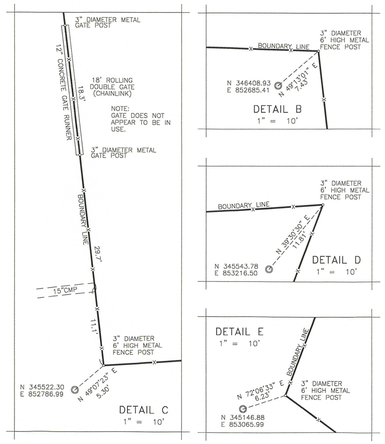
Description:

A parcel of land lying in Georgia Militia District 31, Camden County, Georgia containing 58.17 acres more or less, and being more particularly described as follows:

For a POINT OF REFERENCE commence at a point lying on the westerly line of said lands described in Reference Deed Book 262, Page 227, said point being described as the POINT OF BEGINNING of just mentioned lands; Thence South 16°50'37" West, along said westerly line, 171.97 feet; thence South 73°09'23" East, departing said westerly line, 635.80 feet to a 3 inch diameter, 6 foot high, metal fence post and the POINT OF BEGINNING of the herein described lands; Said POINT OF BEGINNING having a Northing of 346438.73 and an Easting of 851886.63, said coordinates expressed in U.S. Survey Feet and being referenced to the Georgia State Plane Coordinate System, East Zone, (1001), North American Datum of 1983, 2007 adjustment. Thence, from said POINT OF BEGINNING, South 88°13'28" East, 804.79 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 346413.79 and Easting of 852691.04; thence South 06°25'21" East, 893.63 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 345525.76 and an Easting of 852791.00; thence North 86°24'59" East, 433.86 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 345552.88 and an Easting of 853224.01; thence South 20°37'29" West, 431.76 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 345148.80 and an Easting of 853071.92; thence South 53°25'54" East, 289.38 feet, to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 344976.39 and an Easting of 853304.34; thence North 68°51'14" East, 542.03 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 345171.93 and an Easting of 853809.87; thence North 01°34'43" West, 780.53 feet to a 2 inch diameter, 6 foot high, metal fence post, having a Northing of 345952.16 and an Easting of 853788.37; thence North 09°24'51" West, 460.73 feet to a 2 inch diameter, 6 foot high, metal fence post, having a Northing of 346406.68 and an Easting of 853713.01; thence North 14°37'48" West, 345.87 feet to a 2 inch diameter, 6 foot high, metal fence post, having a Northing of 346741.34 and an Easting of 853625.65; thence North 04°05'48" West, 381.17 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 347121.54 and an Easting of 853598.42; thence North 86°26'46" West, 1707.03 feet to a 3 inch diameter, 6 foot high, metal fence post, having a Northing of 347227.35 and an Easting of 851894.67; thence South 00°35'04" West, 788.67 feet to the point of beginning.







NOTES:

1.) BEARINGS AND COORDINATES SHOWN HEREON REFER TO THE GEORGIA STATE PLANE COORDINATE SYSTEM, EAST ZONE (1001), NORTH AMERICAN DATUM OF 1983, 2007 ADJUSTMENT (NAD83/2007) AND ARE EXPRESSED IN U.S. SURVEY FEET.

2.) THIS SURVEY WAS PREPARED WITHOUT THE BENEFIT OF A TITLE ABSTRACT.

3.) THE LOCATION OF THE INTERIOR CELL BOUNDARIES AS SHOWN HEREON WERE NOT LOCATED AS PART OF THIS SURVEY BUT WERE TAKEN FROM PREVIOUS SURVEYS DONE BY THIS FIRM.

4.) NO INTERIOR IMPROVEMENTS WERE LOCATED BY THIS SURVEY.

5.) NO ATTEMPT WAS MADE BY THIS SURVEYOR TO LOCATE ANY JURISDICTIONAL WETLANDS OR ENVIRONMENTALLY SENSITIVE AREAS, IF ANY.

6.) THIS IS A SURFACE SURVEY ONLY. UNDERGROUND IMPROVEMENTS, SUCH AS FOOTERS OR UTILITIES, WERE NOT LOCATED.

7.) INTERIOR AND EXTERIOR PERIMETER TRAIL ROADS ALONG THE FENCE/BOUNDARY ARE NOT SHOWN.

8.) THE FENCE SHOWN HEREON IS 6 FEET ABOVE THE GROUND AND APPROXIMATELY 2 FEET BELOW THE GROUND. ACCORDING TO PERSONNEL ON SITE, THE FENCE WAS ERECTED AFTER THE SURVEY BY HENRY AND ASSOCIATES WAS PERFORMED AND THEREFORE IT IS THIS SURVEYOR'S OPINION THAT THE CORNERS SET FOR THE HENRY SURVEY WERE DESTROYED DUE TO THE TRENCHING FOR THE FENCE INSTALLATION.

9.) THE HORIZONTAL CONTROL POINTS UTILIZED IN THE CALIBRATION FOR THIS SURVEY WERE AS FOLLOWS:
N.G.S. P.I.D. DH4658, N 419349.730, E 842908.420, (NAD83/2007)
N.G.S. P.I.D. AA2804, N 421827.750, E 899222.640, (NAD83/2007)
N.G.S. P.I.D. BG2488, N 247539.430, E 879666.760, (NAD83/2007)
N.G.S. P.I.D. AB4019, N 247772.130, E 819007.760, (NAD83/2007)

10.) THE ERROR OF CLOSURE FOR THE TRAVERSE FROM WHICH THIS SURVEY WAS PERFORMED IS 1:40,000', AND WAS ADJUSTED USING THE COMPASS RULE.

11.) THE ERROR OF CLOSURE FOR THE THE SUBJECT PARCEL SHOWN HEREON IS 1:785,945'.

12.) THE STATE PLANE COORDINATES SHOWN HEREON WERE DERIVED USING GLOBAL POSITION SYSTEMS, REAL TIME KINEMATIC METHOD, UTILIZING A REAL TIME NETWORK BY EGPS SOLUTIONS, INC. THE EQUIPMENT USED WAS TRIMBLE R8 RECEIVERS.

LEGEND / ABBREVIATIONS

●	DENOTES FOUND IRON ROD OR PIPE, AS NOTED
■	DENOTES FOUND CONCRETE MONUMENT
O	DENOTES SET 1/2" IRON PIPE, COA 939
	DENOTES 6' CHAINLINK FENCE
IR	IRON ROD
IP	IRON PIPE
(D)	DEED
(M)	MEASURED
D	DELTA OR CENTRAL ANGLE
R	RADIUS
L	ARC LENGTH
C	CHORD
CB	CHORD BEARING
N	NORTHING
E	EASTING
N 344976.39 E 853304.34	DENOTES STATE PLANE COORDINATE PAIR (SEE NOTE 1)

200 100 0 200 400
SCALE IN FEET
1" = 200'

5/8"IR RLS 1927

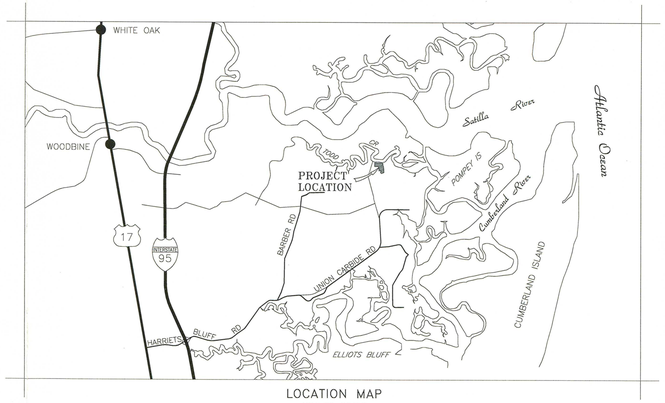
CURVE DATA(M)
D=31°50'05"
R=789.00'(M & D)
L=438.39'(M & D)
C=432.77'(M & D)
CB=S 00°55'34" W(M)
CB=S 00°55'23" W(D)

5/8"IR CAP UNREADABLE

CAUTIONARY NOTICE

1.) THE OWNER OR OPERATOR IS OBLIGATED TO RESTRICT DISTURBANCE OF THE SITE AS SPECIFIED IN 40 CFR, 264 SUBPART G.
2.) THE APPROXIMATE TWENTY ACRES OF LANDFILL CELLS CONTAIN THE FOLLOWING TYPE AND QUANTITY OF WASTE BURRIED LESS THAN TWENTY FEET DEEP:
(a) CELLS A, B, C, F, & G: 2.8–2.9 MILLION POUNDS ALDICARB IN FINE FORM.
(b) CELLS A, B, C, F, & G: 37500 POUNDS ACETONE & METHYLENE CHLORIDE.
(c) CELLS E & I: ALDICARB RESIDUE IN EMPTY BOXES & BAGS.
(d) CELLS D, H, J, & K: NON–HAZARDOUS MATERIAL.

THE ABOVE CAUTIONARY NOTICE WAS TAKEN DIRECTLY FROM A PREVIOUS SURVEY CONDUCTED BY HENRY AND ASSOCIATES, DRAWING No. 0810–0031–01.



LOCATION MAP
–NOT TO SCALE–

CERTIFIED TO:
*UNION CARBIDE CORPORATION

I HEREBY CERTIFY THAT THE ABOVE LAND WAS SURVEYED UNDER MY DIRECT SUPERVISION AND THAT THE IMPROVEMENTS AND CORNERS ARE LOCATED UPON SAME AS SHOWN AND THAT THERE ARE NO ENCROACHMENTS UPON SAID LAND, EXCEPT AS SHOWN.

Pablo Ferrari, Georgia RLS #2820
Not Valid Without The Signature And Original Raised Seal Of A Georgia Registered Land Surveyor

CERTIFICATION TO THE CLERK OF SUPERIOR COURT, CAMDEN COUNTY, GEORGIA:

THIS IS TO CERTIFY THAT TO THE BEST OF MY KNOWLEDGE AND BELIEF, THE PROVISIONS, RELATIVE TO THE ACT CREATED BY GEORGIA CODE SECTION 15–6–67 AMENDED (No. 1366–SENATE BILL No. 7.35), HAVE BEEN MET AND APPROVAL OF THIS PLAT BY THE APPROPRIATE LOCAL GOVERNING AUTHORITY IS NOT NECESSARY FOR RECORDING PURPOSES.

GEOMATICS CORP.
SURVEYING–MAPPING–GPS
2804 N. FIFTH STREET, UNIT 101
ST. AUGUSTINE, FL 32084
PHONE (904) 824–3066 FAX (904) 824–5753
840 SOUTH EDGEWOOD AVENUE, SUITE 221
JACKSONVILLE, FL 32205
PHONE (904) 384–0071
LICENSED BUSINESS
FLORIDA #6979 GEORGIA #939
SOUTH CAROLINA #3387 ALABAMA #794

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Appendix B
Decision Logic Process for SWMUs 8 and 9

Appendix B. Decision Logic Process

1. Introduction

On January 3, 2017, the U.S. Army Corps of Engineers (USACE) promulgated a 2-year trial period for risk management methodology at Formerly Used Defense Sites Military Munitions Response Program projects. The methodology, described as the Decision Logic Process (DLP), was promulgated by USACE to provide information to support risk management decisions upon completion of site characterization, develop remedial action objectives (RAOs), and provide a basis for assessing achievement of RAOs relative to acceptable end states. The DLP is described in the study paper *Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites (MRS)* (USACE 2016), which is attached to a memorandum from USACE titled *Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects* (USACE 2017).

The DLP was presented to the Georgia Environmental Protection Division (GA EPD) in collaborative meetings on March 26, 2018 and May 23, 2018. As outlined during the meetings, the Union Carbide Corporation (UCC) proposed using the DLP to evaluate potential hazards from munitions and explosives of concern (MEC) at Solid Waste Management Unit (SWMU) 8 (consisting of the 40-millimeter [mm] Test Range area and 81-mm Mortar Test Range area), and SWMU 9 (former munitions disposal area) at the Woodbine, Georgia, site. GA EPD agreed that the DLP was an appropriate process for assessing MEC hazards at SWMUs 8 and 9 and to work with UCC to complete the process.

The DLP is used to differentiate acceptable versus unacceptable site conditions at SWMUs 8 and 9, to establish a systematic approach for developing RAOs, and to assist in developing acceptable response alternatives to meet the RAOs. After site characterization, an evaluation following the DLP approach is conducted to determine whether the conditions are acceptable or unacceptable and identify unacceptable risks that require remedial action.

The DLP approach employs a series of four matrices that use site-specific information to relate accessibility, munitions sensitivity, and severity of an explosive event if it were to occur, to determine risks. Based on the available data, the project team (consisting of MEC experts, GA EPD, and UCC) assigns the site to the most applicable category ultimately leading to a classification of either acceptable or unacceptable for each site evaluated. The purpose of each matrix is as follows:

- **Matrix 1: Likelihood of Encounter** – relates the site characterization data on the amount of MEC potentially present at the site to the current and future land use and also considers site accessibility to determine the likelihood of encountering MEC.
- **Matrix 2: Severity of an Incident** – assesses the likelihood of encounter from Matrix 1 along with the types of MEC potentially present to determine the severity of an unintentional detonation.
- **Matrix 3: Likelihood of Detonation** – relates the sensitivity of the MEC items potentially present to the likelihood for energy to be imparted on an item during an encounter by specific land users.
- **Matrix 4: Acceptable and Unacceptable Site Conditions** – combines the results of the first three categories to differentiate acceptable and unacceptable site conditions.

Matrices 1 through 4 are included at the end of this DLP.

The DLP matrices were employed to evaluate SWMUs 8 and 9 as follows:

- Scenario 1: SWMU 8 following completion of the Interim Measures remedial actions and implementation of institutional controls as described in the Institutional Control Plan (Appendix A)
- Scenario 2: SWMU 9 following implementation of institutional controls as described in the Institutional Control Plan (Appendix A)

Each scenario evaluation includes a summary of the current matrix scoring, current uses, future proposed land use, past work summary, current risks, proposed corrective actions to mitigate risks, and the detailed matrix scoring after implementation of proposed corrective actions (as applicable).

UCC prepared an initial draft evaluation of each scenario using the DLP matrix. UCC and GA EPD collaboratively reviewed the initial draft and comments were received from GA EPD. UCC revised the draft evaluation, which was reviewed again with GA EPD on a conference call. GA EPD provided concurrence on the results of the evaluation. Following implementation of the 2018-2020 corrective actions as documented in the SWMU 8 Interim Measures Completion Report (Jacobs 2021), Jacobs verified that the surface/near surface removal actions within the former 40-mm Test Range and surface removals within the former 81-mm Mortar Test Range had been completed as described for Scenario 1 and verified the results for the DLP for this scenario.

2. Scenario 1: SWMU 8 Following Implementation of Surface/Near Surface Removal Action and Additional Land Use Controls

In 2018 to 2020, MEC, material potentially presenting an explosive hazard (MPPEH), material documented as safe, and metal debris surface clearance of 8.8 acres of the former 81-mm Tortar Test Range and surface/near surface clearance of 49.6 acres of the former 40-mm Test Range was completed (Jacobs 2021). Corrective actions were completed in accordance with the *Interim Measures Work Plan for SWMU* 8 (Jacobs 2018) and resulted in the recovery of 4 MEC and 575 MPPEH items.

2.1 Matrix 1 Scoring: Likelihood of Encounter

The scoring for likelihood of encounter for SWMU 8 following the interim measures is classified in the

Matrix (Table B-1) as **Intermittent and Unlikely** based on the current and future land use and amount of MEC present.

The current land use is undeveloped with restricted access through locked gates. Potential encounters with MEC are limited to site workers and possible trespassers. Workers conducting maintenance at the nearby landfill drive on the access road that runs through SWMU 8. These workers have no reason to stop and exit their vehicles, except for a vehicle malfunction, flat tire, or similar issue. If this were to occur, the workers are not expected to walk away from the roadway.

Hunters have been known to occasionally trespass on the site in the past because of the presence of deer and wild hogs on the property. Because of the heavy undergrowth and the known presence of rattlesnakes and other biological hazards, most unauthorized hunting likely occurs from the internal access roads.

An environmental covenant will be placed on the property prohibiting residential use. Signs will be posted warning of the possible presence of MEC.

Based on the investigations conducted and the removal actions completed, SWMU 8 was determined to fall within the category for: MEC presence is based on isolated historical discoveries (explosive ordnance disposal [EOD] report) prior to investigation; or a Defense Environmental Response Program (DERP) response action has been conducted to physically remove MEC or known suspected hazard remains to support this selection (surface removal where subsurface not addressed); or the MEC concentration is below a project-specific threshold to support this selection (0.5 per acre at 50 percent confidence).

2.2 Matrix 2 Scoring: Severity of an Incident

The scoring for severity of an incident following interim measures for SWMU 8 is classified in the Matrix (Table B-2) as **Catastrophic/Critical and "D" Unlikely** based on the type and chance to encounter MEC within SWMU 8.

M406 40-mm high explosive (HE)-filled grenades, 40-mm orthochlorobenzalmalononitrile (CS or tear gas) grenades, and M301 Illumination Projectile for 81-mm mortar were recovered during investigative and removal activities. Many munitions items were recovered historically during investigative activities as detailed in Table 3 of the Corrective Action Plan. In 2018 through 2020, corrective actions were completed within 58.41 acres of SWMU 8 in accordance with the GA EPD approved Interim Measures Work Plan (Jacobs 2018) and resulted in the recovery of 4 MEC and 574 MPPEH items within SWMU 8.

2.3 Matrix 3 Scoring: Likelihood of Detonation

The scoring for Likelihood for Detonation of SWMU 8 is classified in the Matrix (Table B-3) as **High and "3" Inconsequential** based on the type of MEC within SWMU 8 and its future land use.

M406 40-mm HE-filled grenades, 40-mm CS grenades, and M301 Illumination Projectile for 81-mm mortar were recovered during investigative and removal activities. Based on likelihood of detonation of munitions, SWMU 8 was determined to fall in the High category.

The current and future use limit the possibility for encountering residual potential MEC items because of the restricted access and allowable land use. Based on these conditions, SWMU 8 was determined to fall in the Inconsequential category.

2.4 Matrix 4 Scoring: Acceptable and Unacceptable Site Conditions

This matrix combines the results of Matrix 1 through 3 to differentiate Acceptable and Unacceptable Site Conditions (Table B-4). Based on these matrices SWMU 8 is scored as **Acceptable** with appropriate land use controls.

3. Scenario 2: SWMU 9 Following Implementation of Additional Land Use Controls

3.1 Matrix 1 Scoring: Likelihood of Encounter

The scoring for likelihood of encounter for SWMU 9 following the interim measures is classified in the Matrix (Table B-1) as **Intermittent and Unlikely** based on the current and future land use and lack of MEC present.

For SWMU 9, the current land use is undeveloped with restricted access through locked gates. Potential encounters with MEC are limited to site workers and possible trespassers. Hunters have been known to occasionally trespass on the site in the past because of the presence of deer and wild hogs on the property. Because of the heavy undergrowth and the known presence of rattlesnakes and other biological hazards, most unauthorized hunting likely occurs from the internal access roads.

An environmental covenant will be placed on the property prohibiting residential use. Signs will be posted warning of the possible presence of MEC.

Historically, SWMU 9 was used as a disposal area for munitions. Historical documents indicate that drum burial and detonation of munitions occurred in this area (CH2M 2007). Previous investigations included excavation and disposal of 408 subsurface drums within two trenches containing M406 40-mm grenade ball assemblies, flare/ordnance and explosives waste mixtures, bio waste, 81-mm mortar components,

riot control agents (such as CS), and assorted waste. The entire area was also swept by technicians on "hands and knees" who identified components from fuzes, trip flares, primers, grenades, and CS canisters. Geophysical sweep of 5 percent of SWMU 9 identified 218 total anomalies, eight of which were classified as munitions debris (MD) and resulted in the recovery of 15 munitions items during the MEC Phase I and II RFIs (CH2M 2009, 2010).

Based on the investigations conducted, SWMU 9 was determined to fall within the category for: Investigation of the SWMU did not identify evidence of MEC presence; or a DERP response action has been conducted that will achieve unlimited use/unlimited exposure (UU/UE).

3.2 Matrix 2 Scoring: Severity of Incident

The scoring for severity of an incident following interim measures for SWMU 9 is classified in the Matrix (Table B-2) as **Catastrophic/Critical and "D" Unlikely** based on the type and chance to encounter MEC within SWMU 9.

M301 Illumination Projectile for 81-mm mortars were recovered during investigative and removal activities and many other munitions items were recovered historically during investigative activities as detailed in Table 4 of the Corrective Action Plan.

3.3 Matrix 3 Scoring: Likelihood of Detonation

The scoring for Likelihood for Detonation of SWMU 9 as classified in the Matrix (Table B-3) as **Low and "3" Inconsequential** based on the type of MEC within SWMU 8 and its future land use.

This matrix relates the sensitivity of the MEC items to the likelihood for energy to be imparted on the item during an encounter. The items encountered are unlikely to impart energy during an encounter. Reports indicate that if remaining debris exist, it will likely consist of inert metal fragments and drum lids.

The current and future use limit the possibility for encountering residual potential MEC items because of the restricted access and allowable land use. Based on these conditions, SWMU 9 was determined to fall in the Inconsequential category

3.4 Matrix 4 Scoring: Acceptable and Unacceptable Site Conditions

This matrix combines the results of Matrices 1 through 3 to differentiate Acceptable and Unacceptable Site Conditions (Table B-4). Based on these matrices, SWMU 8 is scored as **Acceptable** with appropriate land use controls.

4. References

Apex Environmental, Inc. 1996. *Report of the Phase II RCRA Facility Investigation (RFI) Conducted on the Union Carbide Corporation Woodbine, Georgia Facility*. Prepared for Thiokol Corporation. Apex Job No. 097.001. September 20.

Apex Environmental, Inc. 1997. *Addendum to the Report of the Phase II RCRA Facility Investigation (RFI) Conducted on the Union Carbide Corporation Woodbine, Georgia Facility*. Prepared for Thiokol Corporation. Apex Job No. 097.005. June 12.

CH2M HILL Engineers, Inc. (CH2M). 2009. *Results of Phase I Munitions and Explosives of Concern RCRA Facility Investigation, Union Carbide Corporation-Woodbine, Draft*. Prepared for Union Carbide Corporation. Contract No. NA-1022. Purchase Order No. 93179724. June.

CH2M HILL Engineers, Inc. (CH2M). 2010. *Results of Phase II Munitions and Explosives of Concern RCRA Facility Investigation.* Union Carbide Corporation-Woodbine. Contract No. NA-1022. Purchase Order No. 93228228. March.

Jacobs Engineering Group Inc. (Jacobs). 2018. *Interim Measures Work Plan for Solid Waste Management Units (SWMUs) 8 and 9*. Draft. Prepared for Union Carbide Corporation, a wholly owned subsidiary of The Dow Chemical Company. August.

Law Environmental, Inc. 1993. *Report of Surface Debris Removal and Disposal*. Prepared for Union Carbide Corporation, Woodbine, Georgia. Law Environmental Project Number 41-2590. October.

U.S. Army Corps of Engineers (USACE). 2016. *Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites (MRS)*. Final. December 7.

U.S. Army Corps of Engineers (USACE). 2017. *Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects*. Technical Memorandum. January 3.

Matrices 1 through 4

Table B-1. Matrix 1 - Likelihood of Encounter

Likelihood of Encounter, Matrix 1: Relates the site characterization data for amount of MEC potentially present to site use, including accessibility, in order to determine the likelihood of encountering MEC. Amount of MEC vs. Access Conditions	**Regular** (e.g., daily use, open access)	**Often** (e.g., less regular or periodic use, some access)	**Intermittent** (e.g., some irregular use, or access limited)	**Rare** (e.g., very limited use, access prevented)
▪ MEC is visible on the surface and detected in the subsurface.	Frequent	Frequent	Likely	Occasional
▪ The area is identified as a Concentrated Munitions Use Area (CMUA) where MEC is known or suspected (e.g., MD indicative of MEC is identified) to be present in surface and subsurface.	Frequent	Likely	Occasional	Seldom
▪ MEC presence based on physical evidence (e.g., MD indicative of MEC), although the area is not CMUA; or ▪ The MEC concentration is below a project-specific threshold to support this selection (e.g., less than 1.0 per acre at 95% confidence).	Likely	Occasional	Seldom	Unlikely
▪ MEC presence is based on isolated historical discoveries (e.g., EOD report) prior to investigation, or ▪ A DERP response action has been conducted to physically remove MEC or known suspected hazard remains to support this selection (e.g., surface removal where subsurface not addressed); or ▪ The MEC concentration is below a project-specific threshold to support this selection (e.g., 0.5 per acre at 50% confidence).	Occasional	Seldom	Unlikely	Unlikely
▪ MEC presence is suspected based on historical evidence of munitions use only; or ▪ A DERP response action has been conducted to physically remove surface and subsurface MEC (evidence that some residual hazard remains to support this selection); or ▪ The MEC concentration is below a project-specific threshold to support this selection (e.g., less than 0.25 per acre at 95% confidence).	Seldom	Seldom	Unlikely	Unlikely
▪ Investigation of the Solid Waste Management Unit (formerly referred to as Munitions Response Site) did not identify evidence of MEC presence; or ▪ A DERP response action has been conducted that will achieve UU/UE.	Unlikely	Unlikely	Unlikely	Unlikely

Table B-2. Matrix 2 - Severity of Incident

Severity of Explosive Incident: Assesses the likelihood of encounter from Matrix 1 as related to the severity of an unintentional detonation.	**Frequent** (Regular or inevitable occurrences)	**Likely** (Several or numerous occurrences)	**Occasional** (Sporadic or intermittent occurrences)	**Seldom** (Infrequent, rare occurrences)	**Unlikely** (Not probable)
Catastrophic/Critical: May result in one or more deaths, permanent total or partial disability, or hospitalization.	A	A	B	B	D
Modest: May result in one or more injuries resulting in emergency medical treatment, without hospitalization.	B	B	B	C	D
Minor: May result in one or more injuries requiring first aid or medical treatment.	B	C	C	C	D
Improbable: No injury is anticipated.	D	D	D	D	D

"A" indicates conditions most likely to result in determination of an unacceptable risk.

"D" indicates conditions most likely to result in determination of an acceptable risk.

Table B-3. Matrix 3 - Likelihood of Detonation

Likelihood of Explosive Detonation: Relates the sensitivity of the MEC items to the likelihood for energy to be imparted on the item during an encounter.	**High** (e.g., areas planned for development or seasonally tilled.)	**Modest** (e.g., undeveloped, wildlife refuge, parks)	**Inconsequential** (e.g., not anticipated, prevented, mitigated)
High (e.g., classified as sensitive)	1	1	3
Moderate: (e.g., HE or pyrotechnics)	1	2	3
Low: (e.g., propellant or bulk secondary explosives)	1	3	3
Not Sensitive: (e.g., grenade and mortar components and fragments)	2	3	3

Table B-4. Matrix 4 - Acceptable and Unacceptable Site Conditions

Acceptable and Unacceptable Site Conditions: Combines the results of Matrix 1 thru 3 to differentiate Acceptable and Unacceptable Site Conditions.	A	B	C	D
1	Unacceptable	Unacceptable	Acceptable	Acceptable
2	Unacceptable	Unacceptable	Acceptable	Acceptable
3	Unacceptable	Acceptable	Acceptable	Acceptable

Appendix E
Tide and Current Evaluation