FINAL

Focused Feasibility Study Report
Fort Custer Veterans Affairs Area
Post Cemetery Dump
FUDS E05MI0006
Augusta, Michigan

Prepared for

U.S. Army Corps of Engineers

Louisville District

600 Dr. Martin Luther King Jr. Place

Louisville, Kentucky 40202-2232

Contract No. W912BV-15-D-0015 – Delivery Order CY01

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Prepared by

ch2m

Statement of Technical Review

Remedial Investigation/Feasibility Study and Proposed Plan/Decision Document for the Veterans Affairs Area Post Cemetery Dump in Augusta, Kalamazoo County, Michigan

Final Focused Feasibility Study Report

The CH2M HILL, Inc. team has completed the technical review of the submittal of the Final Focused Feasibility Study Report. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan. During the independent technical review, compliance with established policy principles and procedures, using justified and valid assumptions, was verified, including review of assumptions; methods, procedures, and material used in analyses; the appropriateness of data used, and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with the law and existing U.S. Army Corps of Engineers policy.

Independent Technical Reviewer	**Signature**	**Date of Review**
Tom Simpkin		02/20/2020
Project Manager	**Signature**	**Date of Review**
Kimberly Amley		02/20/2020

Executive Summary

This Focused Feasibility Study (FFS) report develops and evaluates remedial alternatives for the former Fort Custer Post Cemetery Dump (the Site) in Augusta, Kalamazoo County, Michigan, as part of the Defense Environmental Restoration Program under U.S. Army Corps of Engineers, Louisville District Contract Number W912BV-15-D-0015, Delivery Order CY01. The Site is part of a Formerly Used Defense Site (FUDS) and is designated as property number E05MI0006.

The Site is located within the Fort Custer National Cemetery in Kalamazoo County, Michigan, approximately 6 miles west of Battle Creek and 20 miles east of Kalamazoo, Michigan. The area where disposal occurred is bordered by newly developed crypt fields to the west, a building known as the Meditation Place to the north across Fort Custer Drive, committal shelters to the east, and an unpaved maintenance road and shed within a forested area are located south of the Site (Professional Environmental Engineers, Inc. (PE), 2016).

The U.S. Environmental Protection Agency (EPA) established source containment as the presumptive remedy for municipal landfill sites regulated under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) in September of 1993. In accordance with EPA's 1996 directive *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* (1996), EPA expects that the containment presumptive remedy will be applied to military landfills in situations where landfill contents meet the municipal-type waste definition and excavation of contents is not practicable. *Code of Federal Regulations* (CFR) Title 40 §300.430(a)(1)(iii)(B) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) contains the expectation that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat where treatment is impracticable. The NCP identifies municipal landfills as a type of site where treatment of the waste is impracticable because of the size and heterogeneity of the contents. Use of the containment presumptive remedy obviates the need to characterize the nature and extent of contamination or the content of the landfill. However, characterization and evaluation of risks that could result if chemicals migrate from the landfill is still required for all potential exposure pathways outside the waste limits. The containment presumptive remedy is expected to ensure the consistent selection of remedial actions and reduce the cost and time required to clean up sites. Because previous investigations identified chemicals of potential concern at concentrations greater than applicable screening criteria, the remedial investigation (RI) was conducted. Results of the previous investigations, in conjunction with application of the presumptive remedy approach, were used to develop a streamlined approach to characterizing surface water conditions in the wetlands area and potential groundwater impacts downgradient of the waste limits, evaluate potential ecological and human health risks, and provide sufficient data to evaluate remedial alternatives rather than characterizing the nature and extent of all contamination in the landfill.

The waste was also found to contain asbestos-containing material (ACM) at the surface, with the potential for additional ACM in the subsurface. The majority of suspect ACM were noted in the central portion of the dump; however, the location and extent of ACM is heterogenous and not completely characterized. All visible friable ACM encountered during investigations was removed for sampling. Inorganic compounds and dioxins/furans (as 2,3,7,8-tetrachlorodibenzo-p-dioxin) exceeded federally established EPA regional screening levels and/or potential applicable or relevant and appropriate requirements, including EPA maximum contaminant levels and Michigan Department of Environment, Great Lakes, and Energy Part 201 screening criteria in surface soils/waste, sediment/waste, and surface water at the Site. The human health risk assessment (HHRA) identified no chemicals of concern in surface soil/waste, sediment/waste, surface water, and downgradient groundwater. The ecological risk assessment (ERA) identified no unacceptable ecological risk (that is, no chemicals of ecological concern) with respect to biota in the upland forested area and the wetland area within the Site. The weight-of-evidence evaluation and risk description presented in the baseline ecological risk assessment resulted in no chemicals of ecological concern posing unacceptable ecological risk to biota communities and populations in the upland terrestrial area and the wetland area from concentrations in soil/waste, sediment/waste, and surface water. Data indicate that groundwater contamination is contained to groundwater/leachate and has not migrated beyond the limits of the waste; however, results indicate that site-related potential COCs in groundwater are present at downgradient wells at concentrations less than risk-based screening criteria. The site-related potential COCs present in the groundwater/leachate, although not completely characterized, present low level threat for potential exposure scenarios and migration pathways within the landfill. The RI, including the HHRA and ERA, indicated that there are no unacceptable risks associated with groundwater downgradient of the Site and groundwater impacts downgradient of the Site are not expected to increase in the future. Buried waste in surface soil/waste, subsurface soil/waste, and sediment/waste remains present at the Site. Waste materials observed at the Site include municipal-type waste consistent with site-related activities including slag, glass, scrap metal, sand/gravel/rock, cinders, demolition debris, ash, porcelain dishware, wood/sticks and plant debris, un-combusted coal, radio tubes, cloth/clothing, plastic, paper, and other unidentified substances/items. Site-related potential chemicals of concern were detected in groundwater/leachate and subsurface soil/waste within the limits of the waste at concentrations greater than risk-based screening criteria. Risks associated with subsurface soil/waste, groundwater/leachate underneath the waste, and ACM were not quantitatively evaluated per the presumptive remedy guidance.

The dump is approximately 10 acres and extends under Fort Custer Road. The size of the dump is approximately 95,000 cubic yards (depths up to 24 feet) and would not be considered practical for excavation in accordance with the EPA presumptive remedy guidance (EPA, 1996). Based on the size of the landfill, the presence of municipal and non-military wastes, distribution, and nature of the wastes, site conditions are similar to those expected to be found at CERCLA municipal landfills. EPA's 1996 directive *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* stipulates that the containment presumptive remedy application to municipal landfills as described in the *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA, 1993) is expected to be applied to military landfills in situations similar to those at the Site. The HHRA and ERA indicate there are no chemicals of concern or chemicals of environmental concern identified that require further evaluation. Additionally, because the continued land use of the property as a National Cemetery is anticipated and the U.S. Department of Veterans Affairs' preference is to keep the wetland and forested portion of the Site as a natural green space for the facility, the containment presumptive remedy application to municipal landfills is considered appropriate for the Site, and an FFS was recommended.

The objective of this FFS was to develop and evaluate remedial alternatives in accordance with the EPA presumptive remedy guidance and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) that meet the applicable or relevant and appropriate requirements and meet the remedial action objectives. The remedial action objective developed for the Site includes the following:

- Protect human receptors from direct contact, ingestion, inhalation exposure to subsurface soil/waste by eliminating exposure pathways and contaminant migration to groundwater and surface water.

This FFS report evaluates alternatives consisting of appropriate components of the containment presumptive remedy for municipal landfills and the no action alternative required by the NCP. Use of the containment presumptive remedy for municipal landfills is authorized by Enclosure 3, Section 4.b(5)(a)3.d of the Department of Defense Manual 4715.20, *Defense Environmental Restoration Program (DERP) Management*. Therefore, the alternatives required to be considered by the DERP Manual and Paragraph 4-4.3.7 of Engineering Regulation 200-3-1, "Environmental Quality: Formerly Used Defense Sites (FUDS) Program Policy," have been screened out from further consideration.

The following remedial alternatives were developed and assessed, using the seven NCP evaluation criteria, and compared in terms of ability to satisfy the criteria:

- Alternative 1—No Action
- Alternative 2—Land Use Controls with Long-term Management
- Alternative 3—Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management

The No Action Alternative (Alternative 1) was included in accordance with the NCP and to assess whether chemicals of concern and chemicals of ecological concern leaving the waste area meet unrestricted use/unrestricted exposure or unrestricted (residential) land use scenario under FUDS. Alternative 2 (Land Use Controls with Long-term Management) is the least-cost remedy that is effective in preventing exposure to waste material. Alternative 2 (Land Use Controls with Long-term Management) meets the Remedial Action Objectives (RAO) by relying upon the existing soil cover with well-established vegetation and the establishment of a land-use control and long-term management, which complies with the presumptive remedy guidance. Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) meets the RAO by consolidating waste, constructing a soil cover over upland areas, implementing land use controls, and long-term management. Although Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) may offer greater reduction in potential exposure to buried waste within upland areas of the Site, construction of a soil cover has a higher sustainability footprint, would adversely affect wetland habitat and natural resources, may mobilize chemicals that were originally immobile, and may not reduce migration of contaminants to surface water or groundwater/leachate under the pond. Additionally, the cost of Alternative 3 (Consolidation, Construction of a Soil Cover, Long-term Management, and Land Use Controls) is nearly four times the cost of Alternative 2 (Land Use Controls with Long-term Management). Recommendations on the preferred remedial alternative will be made in the Proposed Plan.

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Acronyms and Abbreviations

µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
ACM	asbestos-containing material
amsl	above mean sea level
AOC	Area of Contamination
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
cm/sec	centimeter(s) per second
COC	chemical of concern
COPC	chemical of potential concern
DCE	dichloroethene
DERP	Defense Environmental Response
DoD	Department of Defense
DU	decision unit
EGLE	Michigan Department of Environment, Great Lakes, and Energy
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FFS	Focused Feasibility Study
FML	flexible membrane liner
ft/ft	foot (feet) per foot
FUDS	Formerly Used Defense Sites
HHRA	human health risk assessment
HTRW	Hazardous, Toxic, and Radioactive Waste
ISM	incremental sampling method
LUC	land use control
LUCIP	land use control implementation plan
MAC	Michigan Administrative Code
MCL	maximum contaminant level
MDEQ	Michigan Department of Environmental Quality
mph	miles per hour
MWH	Montgomery Watson Harza

NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbon
Parsons	Parsons Engineering Science, Inc.
PCB	polychlorinated biphenyl
PE	Professional Environmental Engineers, Inc.
pg/g	picogram(s) per gram
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act of 1966
RI	remedial investigation
RSL	regional screening level
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	Site Investigation
Site	former Fort Custer Old Post Cemetery Dump
SVOC	semivolatile organic compound
SWPPP	Storm Water Pollution Prevention Plan
T&E	Threatened and Endangered
TBC	to be considered
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TMV	toxicity, mobility, or volume
USFWS	U.S. Fish and Wildlife Service
USACE	U.S. Army Corps of Engineers
U.S.C.	*United States Code*
USGS	U.S. Geological Survey
VA	U.S. Department of Veterans Affairs
VISL	vapor intrusion screening level
VOC	volatile organic compound
WWI	World War I
WWII	World War II

Introduction

This Focused Feasibility Study (FFS) report develops and evaluates remedial alternatives for the former Fort Custer Post Cemetery Dump (Site) in Augusta, Kalamazoo County, Michigan. The FFS was prepared as part of the Defense Environment Restoration Program (DERP) under U.S. Army Corps of Engineers (USACE), Louisville District under Contract Number W912BV-D-0015, Delivery Order CY01.

The Site, previously referred to as the “former post dump,” the “former post cemetery dump,” the “former cemetery landfill”, the “former cemetery landfill”, and “Area G” is located within the Fort Custer National Cemetery in Kalamazoo County, Michigan, approximately 6 miles west of Battle Creek and 20 miles east of Kalamazoo. It is located in the eastern quarter of the southeastern quarter of Section 35 and the western quarter of the southwestern quarter of Section 36, Township 1 South, Range 9 West. The Site is approximately 1.5 miles east of Augusta, 1 mile west of the Kalamazoo/ Calhoun County line, less than 1 mile southeast of the Kalamazoo River, and approximately 0.5 mile north of Eagle Lake (Figure 1-1). The Fort Custer National Cemetery is bordered by West Dickman Road to the south, River Road to the west and north, and a U.S. Department of Veterans Affairs (VA) hospital to the east. The main entrance into the cemetery is from West Dickman Road via a gently curving access road (referred to as Battle Creek Boulevard and/or the Avenue of Flags) that connects to the main, somewhat circular, thoroughfare known as Fort Custer Drive (Figure 1-2).The Site is bordered by newly developed crypt fields to the west, a building known as the Meditation Place to the north across Fort Custer Drive, committal shelters to the east, and an unpaved maintenance road and shed within a forested area are located south of the Site.

1.1 Purpose and Objectives

An FFS is used to ensure that appropriate remedial alternatives are developed and evaluated with relevant information concerning the remedial action options to select an appropriate remedy at the Site. Alternatives are developed that protect human health and the environment by recycling waste or by eliminating, reducing, and/or controlling risks posed through each pathway by the Site. The FFS will establish remedial action objectives (RAOs) for chemicals of concern (COCs) and media of concern, potential exposure pathways, and site-specific remedial goals in consideration of potential applicable or relevant and appropriate requirements (ARARs). In accordance with the RAOs, remedial alternatives are developed to provide options to reduce risks to the environment and human health. The recommended alternative listed in the FFS will be presented in a Proposed Plan for public review and comment. State acceptance and public comments will be considered in the final selection of a remedy, which will be documented in a Decision Document. Responses to public comments will be addressed in the responsiveness summary of the Decision Document.

In September 1993, the U.S. Environmental Protection Agency (EPA) established source containment as the presumptive remedy for municipal landfill sites regulated under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) in accordance with *Code of Federal Regulations* (CFR) Title 40 §300.430(a)(1)(iii)(B) for waste that poses low long-term threat or where treatment is impracticable. EPA's 1996 directive *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* states that the containment presumptive remedy will be applied to military landfills in situations where landfill contents meet the municipal-type waste definition and excavation of contents is not practicable. Use of the containment presumptive remedy for municipal landfills obviates the need to characterize the nature and extent of contamination or the content of the landfill. However, characterization and evaluation of risks that could result if chemicals migrate from the landfill is still required for all potential exposure pathways outside the waste limits. The containment presumptive remedy is expected to ensure the consistent selection of remedial actions and reduce the cost and time required to clean up sites. Because previous investigations identified chemicals of potential concern (COPCs) greater than applicable screening criteria, a remedial investigation (RI) was conducted. Results of the previous investigations, in conjunction with application of the containment presumptive remedy approach, were used to develop a streamlined approach for characterizing surface water conditions in the wetlands area and potential groundwater impacts downgradient of the waste limits, evaluating potential ecological and human health risks, and providing sufficient data to evaluate remedial alternatives rather than characterizing the nature and extent of all contamination in the landfill.

This FFS was used to evaluate alternatives for waste identified during environmental investigations that remains in place at the Site. This FFS was developed in accordance with CERCLA, as amended by the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), the presumptive remedy guidance (EPA, 1996), the procedures established by the EPA (EPA, 1998), and applicable Department of Defense (DoD) and Army regulations, policies, and guidance for the Formerly Used Defense Sites (FUDS) program (Engineering Regulation 200-3-1).

1.2 Site Background

The U.S. Army established Fort Custer as a military reservation/training base in 1917, near Battle Creek, Michigan. The training base initially was identified as Camp Custer and consisted of 8,299.19 acres comprising 130 parcels of land, mainly small farms leased to the government by the local chamber of commerce as part of the military mobilization for World War I (WWI). Full-time operation of the camp was discontinued at the end of WWI. Between WWI and World War II (WWII), the facility was used as a part-time training base during the summer months and weekends by the Reserve Officer Training Corps, Citizen’s Military Training Camp, and by the Civilian Conservation Corps. On May 10, 1923, the U.S. Army transferred 675 acres of the camp to the Battle Creek VA; construction of the Battle Creek Veterans Hospital on this transferred property was completed in 1924.

On August 7, 1940, Camp Custer was officially renamed Fort Custer. The fort grew to 14,412.43 acres during WWII and was used to train approximately 300,000 troops and containment of approximately 5,000 prisoners of war. Following WWI, the facility was used as a separation center to process soldiers leaving the Army; the VA hospital served as a convalescent center, which used nearby Eagle Lake for therapeutic recreation. Battalions of the 22nd and 79th Anti-Aircraft were stationed at Fort Custer in the late 1940s and early 1950s.

In 1951, Fort Custer was activated for the Korean War and used to train an additional 17,000 soldiers. In 1953, Fort Custer was declared inactive. During the inactive status, portions of the fort were used by the Michigan Department of Mental Health, used for Army and Marine reserve training, leased locally for livestock grazing, and used as a Semi-Automatic Ground Environment Air Force Station. The Army’s use of Fort Custer officially ended on June 14, 1968, when the state of Michigan (Department of Military) and VA took over operation of the property.

The General Services Administration disposed of approximately 6,450 acres of Fort Custer to the City of Battle Creek, State of Michigan, City of Springfield, Bedford Township, and several private companies and individuals. In October 1979, the VA announced that Fort Custer had been chosen as the site for a National Cemetery. The cemetery was to consist of a portion of the original 675-acre VA hospital property and an additional 554.73 acres of newly transferred land from Fort Custer, which included the Site and old Post Cemetery. The property was transferred to the VA in two separate quitclaim deeds dated July 11, 1947 and June 2, 1980 for use as Fort Custer National Cemetery and hospital (MWH, 2009). In April 1983, construction began at the National Cemetery, including the plotting of more than 10,000 gravesites and construction of roads and sewers, an administration building, a maintenance building, public restrooms, and committal shelters.

The Fort Custer VA property (which includes the Site) was designated as DERP FUDS Property No. E05MI0006 on September 27, 1991; the former dump area is referred to as Area G (or Area of Interest G) within this FUDS property. A revised DERP FUDS Inventory Project Report was approved by the Department of the Army, U.S. Army Engineer Division, Great Lakes and Ohio River, USACE on September 6, 2011, authorizing the Hazardous, Toxic, and Radioactive Waste (HTRW) project Post Cemetery Dump E05MI000603.

1.2.1 History of Disposal

There are no available historical records providing information on the disposal history and contents at the dump area. According to the 1997 Site Investigation (SI) report by Parsons Engineering Science, Inc. (Parsons), the dump was in use from approximately 1920 through the closure of the fort in 1968, primarily for the disposal of ash and iron boiler/tank parts (Parsons, 1997). A 2009 Preliminary Assessment (PA) report by Montgomery Watson Harza (MWH) states that the dump resulted from past DoD use, as evidenced by aerial photographs taken between 1938 and 1974, which show disturbance in this area and the wetland footprint decreasing in size due to presumed dumping activities. According to retired fire/security department personnel (Mr. William Weidlech; MWH, 2009) who worked at the fort from 1951 to 1965, the post used the wetland basin/ravine as a dump to dispose of refuse at the fort, including barrels and garbage from the mess halls.

As described in the 2012 SI report by Professional Environmental Engineers, Inc. (PE), two incinerators existed at the fort, as identified on 1950 Sanitary Sewer and Water Utility Maps (PE, 2016). Much of the material observed in the dump (slag, cinders, and melted glass/bottles) during clearing, trenching, drilling, and miscellaneous reconnaissance activities for the 1997 SI indicate that a large portion of the wastes were incinerated prior to disposal (Parsons, 1997). Specific waste materials observed during the 2012 SI (in order of relative abundance) include slag, glass (primarily bottles, both melted and un-melted), scrap metal (empty and rusted boilers/tanks/drums, mechanical pieces, rusted/empty cans, conduit and pipes/rods, strapping, chain-link fencing, trash-can lids, wire mesh, washing machine), sand/gravel/rock, cinders, demolition debris (concrete, bricks, tile, drywall, roofing materials, broken ceramic/clay pipe, corrugated panels, railroad ties), ash, porcelain dishware, wood/sticks and plant debris, un-combusted coal, radio tubes, cloth/clothing, plastic, paper, and other unidentified substances/items (PE, 2016).

Based on the age discrepancies for the dump identified above (and the lack of available information on dumping activities at the fort), historical aerial photographs and topographic maps from 1930 to the present were reviewed in the SI in order to gain information on the historical use of the dump area.

In general, the photographic and topographic historical data indicate a retreating (shrinking) wetland boundary to the south with clear constructed, extensive disturbances in the basin from the early to mid-1940s through 1967. Disturbances are along the entire south/southeastern portion of the basin, but also extend along the eastern portion of the wetlands. These disturbed areas have roads leading up to them and increase in size over time (as the wetland retreats) from the south to the north.

Based on the information reviewed, the Site appears to have first been used as a dump in the early to mid-1940s, likely shortly after the camp was re-instated on a full-time basis to train troops for WWII. The use of this area as a dump continued throughout the rest of the 1940s, 1950s, and most of the 1960s (through 1967). However, the fort was permanently shut down in June 1968, and by 1974 the Site was overgrown and abandoned without any signs of dumping activities. Observations from field activities at the Site indicate that smaller/isolated, more-recent dumping activities on top of the post cemetery dump (paper trash, tire, and plastic bottles) have occurred by unknown parties after 1968, but appear to be minor.

1.2.2 Environmental Investigations

Between 1994 and 2018, various environmental investigations were performed at the Site, as presented in Table 1-1. These investigations evaluated the potential presence of munitions and explosives of concern and provided visual characterization of the waste. Vertical and horizontal extent of the waste was defined as approximately 1,200 feet long (north to south) and 300 feet (north) to 640 feet (south) wide (Figure 1-3). Asbestos-containing material (ACM) was identified at the Site in surface soil/waste, indicating the potential for additional ACM in the subsurface soil/waste.

Based on the size of the landfill, the presence of municipal and non-military wastes, distribution, and nature of the wastes, the containment presumptive remedy for municipal landfills is considered appropriate for the Site. Additional characterization of the landfill contents was not required; however, contamination beyond the limits of the landfill source must be characterized. Therefore, the RI employed a site-specific approach to site characterization downgradient of the waste rather than characterizing the nature and extent of all contamination in the landfill. The RI focused on characterizing surface water conditions in the wetlands area and potential groundwater impacts downgradient of the waste limits. Field work for the RI was conducted from July 2016 through April 2018. Results of previous investigations were presented with the results of the RI fieldwork in the RI report (CH2M, 2019), which also includes human health and ecological risk assessment findings. Information regarding site investigations is available in the following documents and summarized in Table 1-1:

- Archives Search Report Findings, Fort Custer and Fort Custer Recreation Area, August, Michigan, Project Nos. E05MI00060 and E05MI001300 (USACE, 1994)
- *Site Investigation Report, Former Fort Custer Military Reservation, Augusta, Michigan* (Parsons, 1997)
- *Final Preliminary Assessment, Fort Custer, Augusta and Battle Creek Michigan, Property Nos. E05MI0006 and E05MI0013,* (MWH, 2009)
- *Final Site Inspection Report, Former Fort Custer Military Reservation, Former Cemetery Landfill, Battle Creek, Michigan* (CH2M, 2009)
- *Draft Site Inspection Report, Fort Custer National Cemetery – Former Post Dump, Kalamazoo County, Michigan* (PE, 2016)
- *Draft Remedial Investigation Report, Fort Custer National Cemetery – Former Post Dump, Kalamazoo County, Michigan* (CH2M, 2019)

1.3 Environmental Setting

This section summarizes site characteristics regarding site geology, hydrogeology, nature, extent, fate, and transport of contamination that may pose risk to human health or the environment at the Site, as identified during the RI (CH2M, 2019).

1.3.1 Topography

The Site is located within the City of Augusta, which lies in the Central Plains province of the Interior Plains physiographic region. Augusta is located within the dissected till plains region of the Central Lowlands Physiographic Province. The region is further categorized into sections. The Site is located within the Eastern Till section. The Site is located within an area characterized as containing ground moraines, morainic ridges, swamps, and small lakes. Local topographical changes are the result of unequal accumulation of glacial deposits or resulted from erosion of weaker portions of the characteristically non-homogenous glacier deposition (USGS, 1974).

The Site is located within a closed topographical basin within the Fort Custer National Cemetery that is several hundred feet wide (east to west) and approximately 1,300 feet long (north to south) (Figure 1-3). Elevations across the Site generally range from approximately 795 feet above mean sea level (amsl) (interior of the basin) to 830 feet amsl (ridges surrounding the basin).

1.3.2 Surface Water Characteristics

The only surface water at the site is present in the topographic low spot in the northern portion of the dump. Since the Site is essentially a topographic “bowl,” all drainage is toward the interior of the basin and the lower elevation wetland. There is no outlet for water flowing into the wetland. The shallow wetland is approximately 600 feet long by 100 to 300 feet wide but fluctuates seasonally. The surface water elevation and lateral extent of the wetland fluctuates in response to snowmelt and precipitation events.

There was no surface water present at the Site during the September 2017 monitoring event and there were no seeps observed during this event. The soft bottom elevation was surveyed at 796.70 feet and the hard bottom elevation was surveyed at 793.64 feet on September 26, 2017, by a licensed surveyor.

Most of the gravesites at the cemetery are located on the outside of the circular Fort Custer Drive in isolated sections surrounded by wooded acreage. Two crypt fields are located on the inside of Fort Custer Drive (near the southwest portion of the dump). A drainage system associated with the crypt fields exists southwest of the Site and drains via pipes into the closed topographic basin. The effect of drainage through the pipes on surface water and groundwater quality and quantity is unknown as flow was not exhibited during the RI to collect a crypt drainage sample.

1.3.3 Soil Characteristics

The subsurface at the Site is composed primarily of glacial sands with varying amounts of silt and gravel. Within the closed basin, peat and clay deposits consistent with a wetland are present overlying the glacial sands. Waste and fill material are present within much of the closed basin overlying the peat deposits; the extent and nature of these waste materials are discussed in more detail in the RI report (CH2M, 2019). Within the slopes of the basin, tan sands were generally the native material encountered in the higher elevation test pits while gray sand and gravels were the native materials encountered in the lower elevation test pits. Within the floor of the basin, a dark brown to black peat (4 to 11.5 feet thick) underlain by brown to gray, poorly-sorted, fine- to medium-grained sand was encountered below most of the waste and fill material. The peat is prevalent in the current wetland area and its presence below the waste material to the south is most likely indicative of the approximate existing topographic elevations prior to disposal of waste in this area. No peat was observed below the waste/fill material in the southwest portion of the dump where the waste materials were the thickest or where the borings were drilled high on the southwestern slope. A light gray clayey silt to brown clayey sand (1 to 2 feet thick) was encountered in two borings between the peat or waste/fill material and the underlying sand.

The thinning of material from the southwest portion of the dump to the north is readily apparent. As previously mentioned, the presence of a peat layer below the waste material is indicative of the former basin floor. Isolated pockets of clay underlie the peat at various locations. The waste/fill material is typically less than 5 feet in this area and is present under a portion of the wetland. The peat layer is present and is underlain by a clay layer. The waste/fill material is typically less than 8 feet in this area, but thickest on the eastern portion of the basin. The peat layer is also thicker in the eastern portion of the basin (up to 10 feet) than in the western portion. There are no apparent clay layers below the peat within this section of the dump. The thinning of waste and fill material from the thickest part of dump to the east is readily apparent. The peat layer is present and there are no apparent clay layers below the peat within this section of the dump.

1.3.4 Groundwater Characteristics

Groundwater is present within the glacial outwash deposits and fill material at the Site. During the installation of soil borings, test pits, and groundwater monitoring wells for the 2012 SI, saturated conditions were encountered from approximately 0.5 to 9 feet below ground surface (bgs) in the test pits, 4 to 31 feet bgs (approximately 787 to 803 feet amsl) in the soil borings, and from 11 to 31 feet bgs (approximately 794.47 to 808.93 feet amsl) in the nine monitoring wells. Within the limits of the waste materials, saturated conditions were observed between 1 and 13 feet bgs, typically at an elevation of 787 to 788 feet amsl (PE, 2016). Shallow groundwater elevations at the site ranged between 793.98 and 809.87 feet amsl. Typically, the water table was lower during the winter months (November through March) when average precipitation was less than 2 inches per month and higher during the spring/summer months (May, June, and July) when average precipitation was greater than 3 inches per month. The water table increased in elevation during the May 2017 and April 2018 sampling events, most likely in response to recharge of the water table by infiltration of snowmelt and heavy spring rains. This observation is consistent with water level fluctuations observed during previous investigations and precipitation measurements recorded for the Site.

Hydraulic conductivity of the aquifer materials ranges between 9.84×10^{-4} to 1.15×10^{-1} centimeters per second (cm/sec) (PE, 2016). These values are typical for sands and gravels. Groundwater flow is to the west-northwest toward the Kalamazoo River.

Two years of quarterly water levels collected from nine existing groundwater monitoring wells indicate that the vertical gradient ranged from -0.001 to 0.001 foot per foot (ft/ft) between the downgradient well pairs FCMW-4S and FCMW-4I in 14 of 16 measurement events, from -0.002 to 0 ft/ft between wells FCMW-4S and FCMW-5I in 14 of 16 measurement events, and from ranged from 0 to 0.002 ft/ft between FCMW-6S and FCMW-6I in 15 of 16 measurement events. This indicates that contaminant transport will primarily occur in the horizontal (lateral) direction.

Two years of quarterly water levels collected from nine existing groundwater monitoring wells indicate that the horizontal groundwater gradient has consistently been to the west-northwest toward the Kalamazoo River.

1.3.4.1 Groundwater-Surface Water Interactions

One of the objectives of the RI was to evaluate groundwater interactions with the wetland at the Site. For groundwater to discharge to surface water, the groundwater potentiometric surface needs to intersect the pond bottom and groundwater potentiometric heads need to be higher than the surface water potentiometric head. Groundwater potentiometric elevation at FCMW-1 is higher than the surface water potentiometric head; indicating that upgradient groundwater/leachate is discharging to the surface water. Therefore, there is hydraulic connection between the groundwater/leachate and surface water that would create a groundwater/surface water interface.

Groundwater potentiometric elevations at downgradient monitoring wells FCMW-4S, FCMW-4I, FCMW-5S, FCMW-5I, FCMW-6S, and FCMW-6I and sidegradient monitoring wells FCMW-2 and FCMW-3, are consistently lower than the surface water potentiometric surface, indicating that surface water is discharging to groundwater downgradient of the wetland pond. This relationship is consistent with the observation that there is no surface water outlet for the wetland. Surface water in the wetland appears to discharge to groundwater. Hence, migration of surface water to downgradient groundwater is the only identified pathway for surface water. The wetland has no outlet and is underlain by sediments that are less permeable than the glacial outwash that constitutes the uppermost aquifer.

Geochemical and waste-release indicator parameters including bicarbonate and carbonate alkalinity, ammonia, calcium, sodium, magnesium, chloride, sulfate, nitrate, phosphorus, sulfide, total organic carbon, total dissolved solids, total suspended solids, chemical oxygen demand, and biochemical oxygen demand were used to assess groundwater-surface water interaction and are not considered site-related chemicals. Overall, when combined with precipitation data, these results indicate there can be variable influences on downgradient groundwater, with the wells nearest the wetland (FCMW-6I/6S) often showing influence from surface water (wetland) recharge and the more southern downgradient wells (FCMW-4S/4I) often showing similarities to upgradient groundwater. The May 2017 results indicate that snowmelt and precipitation recharge through the waste materials may be an important factor because this can result in downgradient groundwater characteristics that are different than upgradient groundwater and surface water characteristics. However, there are no COCs detected in groundwater at the monitoring well network downgradient of the wetland and the waste, indicating that COCs are contained within the waste limits and have not migrated downgradient.

1.3.5 Waste Characteristics

1.3.5.1 Description of Waste Materials

Waste materials observed in test pit excavations for the 2012 SI generally consisted of sand, cinders, ashes, slag, glass and china/porcelain pieces, metal debris, coal pieces, brick fragments, and wood debris (PE, 2016). Waste materials observed in the soil borings advanced during the 2012 SI generally consisted of sand, slag, ashes, wood and metal debris, coal pieces, glass/dishware pieces, and other unidentifiable materials. Specific waste materials observed during the 2012 SI (in order of relative abundance) include slag, glass (primarily bottles, both melted and un-melted), scrap metal (empty and rusted boilers/tanks/ drums, mechanical pieces, rusted/empty cans, conduit and pipes/rods, strapping, chain-link fencing, trash-can lids, wire mesh, washing machine), sand/gravel/rock, cinders, demolition debris (concrete, bricks, tile, drywall, roofing materials, broken ceramic/clay pipe, corrugated panels, railroad ties), ash, porcelain dishware, wood/sticks and plant debris, un-combusted coal, radio tubes, cloth/clothing, plastic, paper, and other unidentified substances/items.

Material within the wetland consisted primarily of waste with two noticeable layers of sediment over it (PE, 2016). The first and uppermost layer is a fine-grained sediment, highly-saturated and unconsolidated material that is fluid in nature and approximately 6 inches thick. The second layer is fill material with heavy root material that ranges in thickness from 6 inches to several feet.

1.3.5.2 Waste Thickness and Extent

The waste thickness and extent were evaluated as part of the 1997 SI (Parsons, 1997) and the 2012 SI (PE, 2016). The extent of waste within the wetland was supported by observations during VA expansion of the crypt field during the summer of 2012 and field observations during the low water level in September 2017 as part of the RI.

Soil borings advanced for the 1997 SI indicated an average depth of waste of 8 feet bgs, with the waste thickest in the center of the landfill (up to 15 feet bgs) and thinnest at the edges (5 feet bgs). Parsons estimated that approximately 78,000 cubic yards of waste materials were present. (Parsons, 1997)

During the 2012 SI, the dump boundary could not be precisely identified on the northern end and was assumed to exist within the wetland based on visual evidence of wastes, geophysical data, and the presence of waste materials confirmed at other nearby locations. Lateral limits of waste/fill to the southwest was defined by the adjacent crypt field 4A (Figure 1-4). Construction of the crypt field (conducted during the summer of 2012) included excavation of all soils to approximately 8 feet bgs, installation of crypts, and associated drainage system, backfill of the area with native sand/gravel materials and topsoil, seeding/sodding. Based on discussion with the crypt field contractor, a small portion of the dump did extend into the crypt field (specifically in the northeast corner where the drainage outfall for the crypt field is located) but was removed during construction activities and is no longer present. (PE, 2016)

Several dashed, or inferred, dump boundaries are present on Figure 1-3, including areas to the north, west, and south. Factors that prevented the locating of actual dump boundaries in the area to the north included the presence of the wetland that prevented exploration beyond the reach of the backhoe. As previously stated, the inferred northern boundary corresponds to preliminary geophysical information in this area. Visual observations during low water levels in the wetlands during June 2012 indicate the inferred boundary is reasonably accurate (waste was observed in areas within the inferred boundary, but not outside of it) (PE, 2016).

Factors that prevented the locating of an actual dump boundary to the south/southwest included the presence of Fort Custer Drive in this area. Data indicate the dump boundary is somewhere below the and does not exist southwest of the inferred contact.

A heterogeneous mixture of waste at the Site overlies native soils. Based on the above information, the actual boundaries of the waste/fill materials, as confirmed from trenching and boring activities, indicate that the dump is approximately 1,200 feet in length (from north to south) and varies from about 300 feet wide in the northern portion to about 640 feet wide in the southern portion of the Site (refer to Figure 1-3). The approximate area of the dump is 10.5 acres (455,390 square feet) with an estimated 95,315 cubic yards of waste material present. The thickness of the waste ranges up to 25 feet thick in the southern portion of the Site, thinning to the north. The lateral extent of waste is inferred in several locations, including in the southern portion of the Site where the waste underlies Fort Custer Road. Waste found beyond the inferred boundaries would be expected to have limited thickness. Therefore, the boundary of the waste is considered well defined.

The dump is thickest in the southwestern portion, where wastes up to 24 feet were recorded, and fans out (decreasing in thickness) to the north, east, and south from this thicker area. Waste/fill material was observed from 8 to 12 feet thick in the central portion of the dump area where the basin floor is relatively flat. Wastes within, and adjacent to, the wetland area were typically less than 5 feet thick. Historical aerial photographs of the Site from 1938 to 1967 show the presence of one or more roads leading to the south-southwestern portion of the dump with the majority of the disturbance in the southern portion of the basin. This information, combined with the field data, suggest that the dump was most likely filled from this southwestern area, with waste and fill material being spread throughout the basin toward the north, east, and south.

1.3.6 Land and Water Use

The Site is currently owned and operated by the VA as part of the Fort Custer National Cemetery (constructed in the early to mid-1980s). The Site consists of approximately 10 to 15 acres of vacant forest and wetland that lie mostly within the circular Fort Custer Drive. The master plan for the Fort Custer National Cemetery is to have enough capacity to provide gravesites well into the 21st century (Figure 1-4). It is likely to remain a cemetery indefinitely. The portion of the Site immediately north and south of Fort Custer Drive is currently grass covered and mowed (maintained) by the VA (Figure 1-3). The Site's topography (steep-sided basin) and the presence of a wetland make the wetland forest portion of the Site undesirable for development and the VA has stated a desire to keep the wooded dump area and wetland a natural green space for the facility. As such, the Site is considered nonresidential for both current and future uses, although currently no land use controls are in place that restrict access to the Site.

Municipalities near the Site use the Augusta-Galesburg regional aquifer for potable water. The Town of Augusta uses two municipal wells to supply potable water to the community. The wells reportedly are installed at depths of approximately 100 feet bgs and produced 30.4 million gallons of water for domestic use in 1987 (Rheaume, 1990). Both wells are located within the city limits of Augusta, approximately 2 miles west and sidegradient of the Site and are completed in the glacial outwash aquifer on the west side of the river. Given the groundwater flow direction and hydraulic conductivity, groundwater from the Site is not anticipated to reach the municipal wells.

There is no current use of the onsite groundwater at the Site other than for irrigation purposes. The VA installed four onsite wells, including three irrigation wells and an observation well (used to measure drawdown for Irrigation Well 1 during initial pumping tests). Each of these wells is installed in the glacial drift, consisting primarily of sand and gravel. Irrigation Well 1 and the observation well were constructed in October 1996 and are located approximately 1,000 feet north of the Site in a sidegradient direction; Irrigation Well 1 is an 8-inch-diameter structure screened from 91 to 109 feet bgs (approximately 719 to 737 feet amsl). Irrigation Well 2, constructed in July 2000 and located approximately 1,000 feet east/southeast of the Site in an up-gradient direction, is an 8-inch-diameter well screened from 47 to 62 feet bgs (approximately 780 to 795 feet amsl). Irrigation Well 3 is located in the northeast portion of the VA property, approximately 2,450 feet from the Site in a sidegradient direction and was installed in 1988. It is a 5-inch-diameter well screened from 54 to 59 feet bgs. According to the VA, the wells are plumbed to the onsite sprinkler systems and to spigots located near onsite trash receptacles. Signage on the trash receptacles adjacent to the spigots read "Do Not Drink the Water." Potable water at the cemetery is obtained from the Augusta public water supply.

In addition to the irrigation wells described above, several private water wells are located 1,800 to 2,900 feet in a downgradient direction of the Site (PE, 2016). The well (39000000798) directly downgradient from the main portion of the Site (approximately 2,900 feet west/northwest) is a 4-inch-diameter well, screened from 77 to 81 feet bgs (approximately 719 to 723 feet amsl), and was constructed in September of 1987 (PE, 2016). This well was sampled as part of the 1997 Parsons Investigation; no metals (total and dissolved), volatile organic compounds (VOCs), or semivolatile organic compounds (SVOCs) were detected above laboratory method detection limits and Parsons concluded that no environmental impact to this well has occurred from Fort Custer Military Reservation activities (Parsons, 1997).

1.4 Nature and Extent of Contamination

The source of contamination is the waste and fill material placed at the Site from the 1920s to 1968. Incineration of solid waste took place in other areas during operation of Fort Custer. Records do not exist that would confirm ash or other residues were disposed of in the dump area from these incinerators. However, it is probable that incineration residues were disposed of in the former dump based on the descriptions of waste from previous investigations (that is, the large presence of ash, cinders, slag, and melted bottles imply that incinerator wastes likely were dumped here). Incineration temperatures are capable of generating polychlorinated dibenzo-dioxins and polychlorinated dibenzo-furans in the presence of chlorine and chlorinated chemicals.

The analytical data collected during the 2016 RI and previous investigations were first assessed of whether detected concentrations exceeded background conditions and thus may represent a site-related chemical. Potential site-related chemicals were then hierarchically evaluated against potential ARARs. The analytical data were compared to the EPA regional screening levels (RSLs) for tap water, EPA maximum contaminant levels (MCLs), and the most current State of Michigan's applicable Part 201 Residential and Nonresidential Cleanup Criteria Requirements for Response Activity (Cleanup Criteria). The Michigan Department of Environment, Great Lakes, and Energy (EGLE) (formerly the Michigan Department of Environmental Quality [MDEQ]), Natural Resources and Environmental Protection Act, Act 451 of 1994, Part 201 Cleanup Criteria Rules, now numbered from 299.1 to 299.50, (referred to herein as Part 201 criteria), including groundwater-surface water interface (GSI) criteria, were updated as recently as June 2018. COPCs by media that were detected during previous investigations at concentrations greater than screening criteria are presented in Table 1-2 and summarized below.

1.4.1 Within the Limits of the Waste

1.4.1.1 Extent of Waste

A heterogeneous mixture of waste at the Site overlies native soils. The actual boundaries of the waste/fill materials, as confirmed from trenching and boring activities, indicate that the dump is approximately 1,200 feet in length (from north to south) and varies from about 300 feet wide in the northern portion to about 640 feet wide in the southern portion of the Site (refer to Figure 1-3). The approximate area of the dump is 10.5 acres (455,390 square feet) with an estimated 95,315 cubic yards of waste material present. The thickness of the waste ranges up to 25 feet thick in the southern portion of the Site, thinning to the north. The lateral extent of waste is inferred in several locations, including in the southern portion of the Site where the waste underlies Fort Custer Road.

Waste materials observed in test pit excavations for the 2012 SI generally consisted of sand, cinders, ashes, slag, glass and china/porcelain pieces, metal debris, coal pieces, brick fragments, and wood debris (PE, 2016). Waste materials observed in the soil borings advanced during the 2012 SI generally consisted of sand, slag, ashes, wood and metal debris, coal pieces, glass/dishware pieces, and other unidentifiable materials. Specific waste materials observed during the 2012 SI (in order of relative abundance) include slag, glass (primarily bottles, both melted and un-melted), scrap metal (empty and rusted boilers/tanks/ drums, mechanical pieces, rusted/empty cans, conduit and pipes/rods, strapping, chain-link fencing, trash-can lids, wire mesh, washing machine), sand/gravel/rock, cinders, demolition debris (concrete, bricks, tile, drywall, roofing materials, broken ceramic/clay pipe, corrugated panels, railroad ties), ash, porcelain dishware, wood/sticks and plant debris, un-combusted coal, radio tubes, cloth/clothing, plastic, paper, and other unidentified substances/items.

Material within the wetland consisted primarily of waste with two noticeable layers of sediment over it (PE, 2016). The first and uppermost layer is a fine-grained sediment, highly-saturated and unconsolidated material that is fluid in nature and approximately 6 inches thick. The second layer is fill material with heavy root material that ranges in thickness from 6 inches to several feet.

1.4.1.2 Surface Soil/Waste

Surface soil/waste samples (within 5 feet of the surface) were collected at nine locations during the 1997 SI (Parsons, 1997) (Figure 1-3). Surface soil/waste was sampled as the decision unit (DU) 1 incremental sampling method (ISM) sample, consisting of 55 incremental sampling grids (each approximately 0.17 acre in area) that were generally biased toward areas of waste and analyzed for 13 metals (Figure 1-5). Three replicate samples (1A, 1B, and 1C) were collected from DU1.

- Cadmium, chromium, copper, lead, mercury, nickel, and zinc results exceeded the applicable background values in at least one of the nine samples during the 1997 SI. Concentrations of cadmium, chromium, mercury, and zinc exceeded screening criteria.
- Barium, boron, cadmium, chromium, copper, lead, mercury, nickel, and zinc were detected at concentrations above applicable background levels in DU1 ISM. The DU1 concentrations for arsenic, beryllium, cadmium,

chromium, manganese, selenium, and silver were all below applicable background levels. Concentrations of boron, lead, mercury, and zinc exceeded screening criteria.

- One surface soil/waste sample was analyzed for VOCs as part of the 1997 SI. Benzene, methylene chloride, toluene, and total xylenes were all detected in the sample, although samples all had an "X" data qualifier, indicating that due to instrument failure, results were based on a four-point (instead of five-point) calibration curve and all data must be considered estimated. The reported concentrations were below screening, except for the methylene chloride detection (100 XB micrograms per kilogram [µg/kg]), which was estimated at a concentration equal to the EPA RSL (100 µg/kg) and Part 201 residential and nonresidential drinking water protection criteria (100 µg/kg). Methylene chloride is a common laboratory contaminant and was detected in laboratory method blanks; therefore, methylene chloride is attributed to laboratory contamination and does not represent a site-related chemical. Concentrations of VOCs in surface soil/waste are attributed to laboratory contamination and are not considered site-related chemicals.
- There were no VOC samples collected during the DU1 ISM sampling. ISM sampling requires composite of the grid locations. Discrete samples were not considered to be representative of Site conditions given the heterogenous mixture of the waste and therefore were not collected.
- One surface soil sample was analyzed for SVOCs as part of the 1997 SI (Parsons, 1997). Seven SVOCs (benzo[a]anthracene, benzo[b]fluoranthene, bis[2-ethylhexyl] phthalate, chrysene, fluoranthene, phenanthrene, and pyrene) were detected in the sample. All detected concentrations were below screening criteria.
- Twenty-one SVOCs were detected in the DU1 ISM sample. All reported concentrations for these SVOCs were less than EPA RSLs and Part 201 criteria. Concentrations of SVOCs in surface soil/waste are conservatively considered site-related chemicals since no site-specific background SVOC concentrations were established for the Site; however, all reported SVOC concentrations were less than screening criteria.
- The DU1 ISM sample was analyzed for polychlorinated biphenyls (PCBs). Aroclor 1254 and Aroclor 1260 were detected in the DU1 samples, but detected concentrations were less than EPA RSLs (970 µg/kg and 990 µg/kg, respectively) and Part 201 criteria (4,000 µg/kg and 4,000 µg/kg, respectively). Concentrations of PCBs in surface soil/waste may be site-related; however, all reported PCB concentrations were less than screening criteria.
- Twenty-two dioxins and furans were detected in the DU1 ISM sample. Representative concentrations of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) exceeded the residential direct contact criteria for the DU1 sample; the representative concentration for 2,3,7,8-TCDD also exceeded the EPA RSL (0.022 picograms per gram [pg/g]) and Part 201 non-residential direct contact (0.00009 pg/g) and residential soil particulate inhalation criteria (0.071 pg/g). Concentrations of dioxins and furans in surface soil/waste are conservatively considered site-related chemicals because no site-specific background dioxin concentrations were established for the Site.
- Asbestos content ranged from 20 to 70% chrysotile; two of the materials were classified as friable (the brown/beige layered fabric consisting of 65 to 70% chrysotile and the gray/white layered fabric at 65% chrysotile). Soil testing indicated that soil/waste in contact with friable ACM may also contain asbestos. Chrysotile was detected in the soil sample below the friable brown/beige layered fabric only, indicating that the non-friable materials are likely not releasing fibers. The soil sample associated with FTC-01 resulted in a detection of asbestos. This indicates that FTC-01 had released asbestos fibers to the soils immediately surrounding material; therefore, soil that is in contact with the friable materials may contain some asbestos due to its contact with a friable ACM.

1.4.1.3 Subsurface Soil/Waste

Five subsurface soil/waste samples (between 5 and 20 feet bgs) were collected during the 1997 SI (Parsons, 1997) and analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, VOCs, and SVOCs (Figure 1-3).

- Arsenic, copper, lead, and zinc concentrations exceeded background concentrations during the 1997 SI. Concentrations of arsenic, copper, lead, nickel and zinc in subsurface soil/waste are considered site-related; however, only arsenic concentrations exceeded screening criteria.
- Acetone, carbon disulfide, chloroform, ethylbenzene, methylene chloride, toluene, and total xylenes were all detected in at least one sample, but at concentrations below EPA RSLs and Part 201 criteria except for methylene chloride detections in two samples. Acetone, methylene chloride, and toluene are common laboratory contaminants and methylene chloride was detected in laboratory method blanks; therefore, these chemicals do not represent site-related chemicals. Chloroform is a disinfection byproduct commonly found in tap water. Carbon disulfide can be produced naturally by soil micro-organisms and in marsh environments and is also a common laboratory contaminant. Concentrations of acetone, methylene chloride, carbon disulfide, chloroform, and toluene are attributed to laboratory contamination and are not considered site-related chemicals. Because the containment presumptive remedy was considered appropriate for the Site, complete characterization of the subsurface soil/waste was not required. Concentrations of the other VOCs detected in subsurface soil/waste (ethylbenzene and total xylenes) may be site-related; however, the detections of these compounds were all less than screening criteria.
- Seventeen SVOCs were detected in at least one of the five subsurface soil/waste samples analyzed for SVOCs as part of the 1997 SI. SVOCs detected included polynuclear aromatic hydrocarbons (PAHs) (2 methylnaphthalene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, fluoranthene, fluorene, indeno[1,2,3-c,d]pyrene, naphthalene, phenanthrene, and pyrene) and bis(2-ethylhexyl) phthalate, carbazole, and dibenzofuran. All detected concentrations were less than EPA RSLs and Part 201 criteria. Although bis(2-ethylhexyl)phthalate is a common laboratory contaminant, this compound was detected in multiple media at the Site (groundwater, subsurface soil/waste, and surface soil/waste) and therefore may be site-related. Because the containment presumptive remedy was considered appropriate for the Site, complete characterization of the subsurface soil/waste was not required. Concentrations of SVOCs in subsurface soil/waste may be site-related chemicals.

1.4.1.4 Sediment/Waste

DU2 refers to the saturated sediment/waste material within the wetland (Figure 1-6) (PE, 2016). The predominant surface material here consists of sediment, including clay, silt, and organic vegetation. A total of 57 increment sample grids (each approximately 0.02 acre in area) were sampled within the DU2 footprint and analyzed for SVOCs, PCBs, dioxin and furans, and metals.

- Arsenic, barium, cadmium, chromium, copper, manganese, mercury, and silver were detected in the DU2 samples, but all concentrations were less than applicable background concentrations and are not considered site-related. Boron, lead, selenium, and zinc were detected at concentrations exceeding background concentrations. Concentrations of boron, selenium, and zinc exceeded screening criteria. Concentrations of lead did not exceed EPA RSL or EGLE Part 201 screening criteria. Concentrations of boron, selenium, lead, and zinc in sediment/waste are considered site-related chemicals.
- Six SVOCs (benzo[b]fluoranthene, benzylaldehyde, bis[2-ethylhexyl]phthalate, chrysene, and pyrene) were detected in at least one of the triplicate samples from DU2. All concentrations were less than screening criteria. Although bis(2-ethylhexyl)phthalate is a common laboratory contaminant, this compound was detected in multiple media at the Site (groundwater, subsurface soil/waste, and surface soil/waste) and therefore may be site-related. Concentrations of SVOCs in sediment/waste may be site-related chemicals.
- Aroclor-1254 was detected in the DU2 samples; however, the concentration was less than EPA RSL screening criteria (970 µg/kg). Aroclor-1254 in sediment/waste is considered a site-related chemical.
- Twenty-two dioxins and furans were detected in the DU2 ISM sample. Representative concentrations of 2,3,7,8-TCDD exceeded the residential direct contact criteria for the DU2 sample; the representative concentration for 2,3,7,8-TCDD also exceeded the EPA RSL and Part 201 non-residential direct contact and residential soil particulate inhalation criteria. Concentrations of dioxins and furans in sediment/waste are conservatively considered site-related chemicals.

1.4.1.5 Groundwater/Leachate

During the 1997 SI (Parsons, 1997), six temporary well point locations were advanced within the waste up to 4 feet bgs and one location was advanced to 11.5 feet bgs (CLF-4, CLF-7, CLF-10, CLF-13, CLF-15, CLF-18, CLF- 20, and CLF-22; CLF-22 is a duplicate sample) (Figure 1-3). In May 2009, five temporary monitoring wells were installed to 4 feet bgs using a hand auger within the limits of the waste and in the suspected upgradient direction of the wetland (TMW-1 to TMW-5; Figure 1-3). The 1997 and 2009 groundwater/leachate results provide an indication of groundwater/leachate conditions within the waste limits.

- Acetone, carbon disulfide, chloromethane, and cis-1,2-dichloroethene (DCE) were detected in one or more of the five samples collected during the 2009 SI at concentrations less than screening criteria. None of the detections were greater than the EPA RSL for acetone (1,400 µg/L) or the EPA RSL for toluene (110 µg/L). Acetone and toluene are common laboratory contaminants. Concentrations of chloromethane and cis-1,2-DCE in groundwater/leachate within the limits of the waste, although less than screening levels, may be site-related.
- Bis(2-ethylhexyl)phthalate was detected in five samples, while benzo(b)fluoranthene, benzo(g,h,i)perylene, and indeno(1,2,3-c,d)pyrene were detected in one groundwater/leachate sample from the 1997 SI. Concentrations of benzo(g,h,i)perylene and bis(2-ethylhexyl)phthalate did not exceed screening criteria. Concentrations of benzo(b)fluoranthene and indeno(1,2,3-c,d)pyrene exceeded the screening criteria but were flagged "J" as estimated. Fluoranthene, phenanthrene, and pyrene were detected in four of the five groundwater/leachate samples from the 2009 SI at concentrations less than screening criteria. The SVOC analytes detected in groundwater/leachate samples all have very low solubilities and were likely detected due to their adsorption to colloidal suspended solids as opposed to actually being present in the dissolved phase and mobile in groundwater. Concentrations of bis(2-ethylhexyl)phthalate, benzo(b)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-c,d)pyrene, fluoranthene, phenanthrene, and pyrene in groundwater/leachate within the limits of the waste are conservatively considered site-related chemicals because no site-specific background SVOC concentrations were established for the Site.
- Concentrations of arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc exceeded screening criteria during the 1997 SI (Parsons, 1997). Concentrations of arsenic, boron, cadmium, lead, manganese, mercury, and zinc exceeded screening criteria during the 2009 SI (CH2M, 2009).
- The nature of the samples (temporary well grab samples that tend to be turbid) and heterogeneity of the waste materials make full characterization of the groundwater/leachate conditions within the waste materials impractical. Additionally, because the containment presumptive remedy was considered appropriate for the Site, complete characterization of the groundwater/leachate was not required.

1.4.1.6 Surface Water

Because the wetland is a closed body without an inlet or outlet, the surface water samples collected are assumed to represent the water quality of the entire shallow wetland. One surface water sample was collected for the 1997 SI (Parsons, 1997). Five surface water samples were collected during the 2009 SI (CH2M, 2009). For the 2016 RI (CH2M, 2019), surface water samples were collected during the first quarterly events for four quarters in July 2016, October 2016, May 2017, and July 2017.

- The surface water sample collected from the 1997 SI (Parsons, 1997) had a detectable concentration of acetone less than screening criteria.
- Carbon disulfide was detected in two of the 2009 SI (CH2M, 2009) samples and chloromethane was detected in four of the 2009 SI samples at concentrations less than screening criteria.
- Carbon disulfide was detected in the October 2016 and July 2017 surface water samples during the 2016 RI (CH2M, 2019) at concentrations less than screening criteria. Acetone and carbon disulfide are common laboratory contaminants. Concentrations of VOCs in surface water are attributed to laboratory contamination and are not considered site-related chemicals.

- The surface water sample collected from the 1997 SI (Parsons, 1997) contained detectable concentrations of benzo(b)fluoranthene and benzo(g,h,i)perylene greater than screening criteria; but results were flagged "J" as estimated. (Benzo[b]fluoranthene was one of six SVOCs detected in at least one of the triplicate samples from sediment/waste within DU2 during the 2012 SI [PE, 2016]).
- Surface water samples collected during the 2009 SI (CH2M, 2009) (five samples from within the wetland area) did not have detectable levels of PAHs.
- SVOCs were not detected in surface water samples collected during the 2016 RI (CH2M, 2019) except for a detection of fluoranthene in the July 2016 sample; the concentration was less than screening criteria. Concentrations of SVOCs in surface water may be site-related.
- 1,2,3,4,6,7,8-Heptachlorodibenzofuran, 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin, heptachlorinated dibenzofurans (total), heptachlorinated dibenzo-p-dioxins (total), and octachlorodibenzo-p-dioxin were detected in at least one of the four 2016 RI (CH2M, 2019) surface water samples at concentrations greater than screening criteria. Dioxin and furans in surface water are conservatively considered site-related chemicals because no site-specific background dioxin/furan concentrations were established for the Site.
- Total chromium, total lead, and total and dissolved zinc were detected in the surface water sample during the 1997 SI (Parsons, 1997). All the concentrations were below screening criteria.
- Arsenic, boron, lead, manganese, silver and zinc were detected during the 2009 SI at concentrations greater than screening criteria.
- Arsenic, barium, boron, cadmium, copper, lead, mercury, silver, and zinc were detected during the 2016 RI (CH2M, 2019) at concentrations greater than screening criteria.
- The July 2016 surface water exceedances for metals and dioxins are likely are related to suspension of sediment particles in the surface water body caused by the sampling method used in July 2016.
- Concentrations of metals (including arsenic, boron, barium, cadmium, chromium, copper, lead, manganese, selenium, silver, and zinc detected in surface water may be site-related.

1.4.2 Groundwater Outside the Limits of the Waste

Because the containment presumptive remedy is considered applicable for the Site, the 2012 SI (PE, 2016) and the 2016 RI (CH2M, 2019) employed site-specific approaches focused on characterizing potential groundwater impacts downgradient of the waste limits. The 2012 through 2018 groundwater monitoring results provide information on groundwater conditions downgradient, sidegradient, and upgradient of the waste limits. The 2012 SI (PE, 2016) included the installation of one upgradient well (FCMW-1), two sidegradient wells (FCMW-2 and FCMW-3), and six downgradient monitoring wells (FCMW-4S, FCMW-4I, FCMW-5S, FCMW-5I, FCMW-6S, and FCMW-6I). These wells were sampled during eight bimonthly events from May 2013 through June 2014. The 2016 RI (CH2M, 2019) included sampling one upgradient (FCMW-1), two sidegradient (FCMW-2 and FCMW-3) and six downgradient monitoring wells (FCMW-4S, FCMW-4I, FCMW-5S, FCMW-5I, FCMW-6S, and FCMW-6I) quarterly between July 2016 and April 2018 to characterize groundwater downgradient of the waste rather than characterizing the nature and extent of all contamination in the landfill.

- Acetone, benzene, bromochloromethane, carbon disulfide, chloroform, dibromochloromethane, methylene chloride, and toluene were detected in at least one sample collected during the 2012 SI. The detections were sporadic both spatially and temporally and all detected concentrations were less than 2 µg/L. None of the detected concentrations of acetone, benzene, carbon disulfide, bromochloromethane, dibromochloromethane, and toluene exceeded the respective EPA RSL, EPA MCL (where established), or Part 201 criteria during the 2012 SI (PE, 2016).
- During the 2016 RI (CH2M, 2019), chloroform exceeded the EPA RSL (0.22 microgram per liter [µg/]L) in groundwater samples at FCMW-4S, FCMW-5I, FCMW-5S, and FCMW-6-I during the May 2013 monitoring event. Chloroform is a common byproduct when chlorine or other disinfectants are added to drinking water and is likely attributed to potable water use during monitoring well installation and development activities

during the 2012 SI (PE, 2016). Chloroform was not detected during the following seven bi-monthly monitoring events during the 2012 SI or the eight quarterly events during the 2016 RI.

- Methylene chloride, acetone, and carbon disulfide were detected during the 2016 RI (CH2M, 2019) sampling. All detected concentrations were less than 2 µg/L and below all screening criteria. These VOCs are common laboratory contaminants, and methylene chloride also was detected in samples from upgradient/sidegradient monitoring wells.

Therefore, concentrations of VOC in groundwater downgradient of the limits of the waste are laboratory or non-site related contaminants and are not considered site-related chemicals.

- Acetophenone, bis(2-ethylhexyl)phthalate, benzyl butyl phthalate, diethyl phthalate, di-n-butyl phthalate, fluoranthene, naphthalene, 3-methylphenol (m-cresol), and phenol were detected sporadically and at low concentrations (generally estimated concentrations below 1 µg/L) in the samples collected during the 2012 SI (PE, 2016). Phthalates are common laboratory contaminants and bis(2-ethylhexyl)phthalate is a common component of polyvinyl chloride.
  - Acetophenone was detected in downgradient well FCMW-6I in May 2013. The concentration was flagged “J” as estimated. Sample results for well FCMW-6I for this chemical were non-detect for the following seven bimonthly sampling events during the 2012 SI (PE, 2016).
  - Bis(2-ethylhexyl)phthalate was detected at a concentration greater than the EPA RSL (5.6 µg/L) and Part 201 residential and non-residential drinking water criteria (6 µg/L) at upgradient well FCMW-1 in June 2014 and downgradient well FCMW-4I in September 2017, with the highest concentration detected at the upgradient well FCMW-1.
  - Benzyl butyl phthalate was detected in background well FCMW-2 in January 2014 and March 2014 and downgradient wells FCMW-4I in September 2013 and June 2014, FCMW-4S in September 2013 and June 2014, and FCMW-6I in June 2014 at concentrations less than screening criteria. With the exception of wells FCMW-4I in June 2014 and FCMW-4S in September 2013, the concentrations were flagged “J” as estimated.
  - Diethyl phthalate was detected in background well FCMW-3 in January 2014 and downgradient wells FCMW-5I in January 2014, FCMW-5S in July 2013 and January 2014, and FCMW-6S in January 2014 at concentrations less than screening criteria. The concentrations were flagged “J” as estimated.
  - Di-n-butyl phthalate was detected in downgradient wells FCMW-4S in June 2014 and FCMW-6S in January 2014 at concentrations less than screening criteria. All concentrations were flagged “J” as estimated.
  - Fluoranthene was detected in background well FCMW-1 in November 2013 at a concentration less than screening criteria. The concentration was flagged “J” as estimated. Sample results for well FCMW-1 for this chemical were non-detect for the other seven SI sampling events.
  - Naphthalene was detected at downgradient well FCMW-5S in samples from January 2014 and March 2014 at concentrations greater than the EPA RSL (0.17 µg/L). The concentrations were flagged “J” as estimated. Sample results for well FCMW-5S for this chemical were non-detect for the other six SI sampling events.
  - 3-Methylphenol (m-cresol) was detected at downgradient well FCMW-6I in July 2013 at a concentration less than screening criteria. The concentrations were flagged “J” as estimated. Sample results for well FCMW-6I for this chemical were non-detect for the other seven 2012 SI (PE, 2016) sampling events.
  - Phenol was detected in downgradient well FCMW-6I in May 2013 and July 2013 at a concentration less than screening criteria. Sample results for well FCMW-6I for this chemical were non-detect for the other six 2012 SI (PE, 2016) sampling events.
- The only SVOC detection during the eight 2016 RI (CH2M, 2019) groundwater sampling events was a detection of bis(2-ethylhexyl) phthalate at well FCMW-6S during the May 2017 event at a concentration of 0.39 J µg/L. The concentration was flagged “J” as estimated. Sample results for well FCMW-6S for this

chemical were non-detect for the other seven RI sampling events, indicating the May 2017 result is anomalous and likely related to laboratory contamination. No SVOCs were detected at concentrations greater than the EPA RSLs or Part 201 cleanup criteria during the 2016 RI.

Therefore, concentrations of SVOCs in groundwater beyond the limits of the waste detected in the 2012 SI (PE, 2016) are considered anomalous and attributed to laboratory contamination or upgradient sources and not migration of contaminants from the groundwater/leachate within the limits of the waste. Therefore, no site-related SVOCs are identified for groundwater beyond the limits of the waste.

- During the 2012 SI (PE, 2016), concentrations of arsenic, cadmium, chromium, mercury, selenium, and silver exceeded screening criteria.
- Because of the sporadic metals detections exceeding screening criteria during the 2012 SI (PE, 2016) sampling, special care was taken during the 2016 RI (CH2M, 2019) sampling events to ensure that collected samples were low turbidity. During the 2016 RI, concentrations of arsenic and cadmium exceeded the respective EPA RSL. There were no detections exceeding the numerical Part 201 screening criteria during the 2016 RI. Reported concentrations for arsenic and cadmium in groundwater during the 2016 RI were less than the maximum concentration reported for those chemicals in Kalamazoo County groundwater. Additionally, 2016 RI groundwater data were compared to statewide background groundwater concentrations presented in a Michigan Department of Natural Resources and U.S. Geological Survey (USGS) report (Dumouchelle et al., 1987). The 90th percentile metals statewide background concentrations for arsenic and cadmium were higher than the maximum 2016 RI groundwater detection. Therefore, concentrations of arsenic and cadmium in groundwater outside the limits of the waste are not attributed to migration of groundwater/leachate from within the limits of the waste.

Therefore, concentrations of arsenic and cadmium in groundwater outside the limits of the waste are not attributed to migration of groundwater/leachate from within the limits of the waste. Results of the 2012 SI (PE, 2016) and 2016 RI (CH2M, 2019) demonstrate that groundwater/leachate is contained to the limits of the waste.

1.5 Primary Migration Pathways

The primary fate and transport mechanisms occurring at the Site were identified based on review of the distribution (nature and extent) of the site-related chemicals relative to the environmental setting, their physical and chemical properties, and comparison to screening levels. Potential routes of migration relative to the Site include:

- Air emissions from surface soils/waste via volatilization or dust
- Potential leaching from surface soils/waste, subsurface soils/waste, and sediment/waste to groundwater and surface water
- Potential erosion of surface soils/waste into adjacent surface water
- Discharge of groundwater/leachate to the wetland at the Site and/or surface water downgradient of the waste

A migration pathway is considered complete if a chemical present in a source is detected in other media some distance from the source at concentrations that illustrate a trend over background. An important component of migration pathway evaluation is the consideration of contaminant fate and transport mechanisms. A primary objective of the contaminant fate and transport assessment is to determine if COPCs have the potential to reach downgradient receptors.

The RI identified the following COPCs at the Site:

- Surface Soil/Waste (0 to 5 feet bgs): boron, cadmium, chromium, lead, mercury, zinc, SVOCs, PCBs, and dioxins/furans
- Subsurface Soil/Waste (5 to 20 feet bgs): arsenic and SVOCs

- Sediment/Waste: boron, lead, selenium, zinc, SVOCs, PCBs, and dioxins/furans
- Surface Water: Arsenic, barium, boron, cadmium, copper, lead, manganese, mercury, silver zinc, SVOCs, and dioxins/furans
- Groundwater/Leachate: Arsenic, boron, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, zinc, and SVOCs

Significant factors affecting the fate and transport of COPCs include the chemical and physical properties of the COPCs and of the surrounding geology/environment. The noted COPCs, particularly the high molecular weight PAHs, PCBs, and dioxins/furans, generally are insoluble in water and have a strong affinity to remain bound to soil. They therefore are not mobile in the dissolved phase and migrate primarily by colloidal transport or while sorbed to particulates. The surrounding geology/environment at the Site also limits the potential for COPCs to migrate in groundwater. The permeabilities of the Site soils and parent geologic materials in the shallow subsurface beneath the landfill are low, as identified in the RI presentation of site hydrogeology. Therefore, groundwater transport is likely a less significant mechanism for contaminant transport than surface runoff.

The qualitative fate and transport evaluation indicate the migration pathways most important to consider in developing remedial alternatives for the Site are surface soil/waste to sediment/waste via surface water runoff, and surface soil/waste to subsurface soil/waste via infiltration/leaching. There is some evidence of migration of contaminants from surface soil/waste to surface water via runoff, and from subsurface soil/waste to groundwater/leachate via leaching. However, these migration routes are considered of less significance because the contaminants are not readily mobile in the dissolved phase and typically rely on transport via colloids or sorption to larger particulates, in groundwater or surface water.

1.6 Baseline Risk Assessment

This section summarizes the risk assessment. The baseline risk assessment is an analysis of adverse health effects that could result from exposure to substances at a site. The results of the baseline risk assessment contribute to the selection of appropriate remedial alternatives.

As outlined in the presumptive remedy guidance (EPA, 1996), a quantitative risk assessment is not necessary to evaluate whether the containment remedy addresses all pathways and COCs associated with the source. Rather all potential exposure pathways can be identified using the conceptual site model and compared to the pathways addressed by the containment presumptive remedy. The human health risk assessment (HHRA) for the Site was conducted to determine if any COCs are present in surface soil/waste or sediment/waste, and groundwater downgradient of the waste. If an HHRA does not identify site-related COCs, there are no COCs for the media and pathways evaluated that would support a conclusion that containment is occurring under the CERCLA landfill containment presumptive remedy approach (EPA, 1996).

The baseline HHRA evaluated potential current and future risks that could result from exposure to surface soil/waste, sediment/waste, surface water, and groundwater downgradient of the waste at the Site on the basis of potential receptor populations. Exposure scenarios evaluated in the risk assessment are based on conservative assumptions. The following receptors and exposure scenarios were evaluated:

- Under current land-use conditions, current/future visitor exposures to soil/waste (via direct contact and dust emission from surface soil/waste) and sediment/waste and surface water (via direct contact)
- Current/future maintenance worker exposures to surface soil/waste (via direct contact and dust emissions) and sediment/waste and surface water (via direct contact)
- Future maintenance worker exposures to groundwater from irrigation spigots (via direct contract) if irrigation wells are installed in areas of the Site where groundwater is impacted (within the groundwater/leachate) and who may inhale COPCs in groundwater that migrate to indoor air (if future buildings are constructed atop impacted groundwater/leachate) were evaluated

The maintenance worker and visitor exposures were assumed the same under future land-use conditions as those under current land-use conditions.

The baseline HHRA determined that both cancer and non-cancer risks for the media and pathways evaluated were in the NCP acceptable risk range, as defined in 40 CFR 300.430 (E)(2)(i)(A) (2-5). Therefore, no COCs were identified in the surface soil/waste, sediment/waste, or groundwater downgradient of the waste. Because no COCs were identified in evaluated Site media, there are no COCs that would be leaving the Site and the waste can be considered contained under the presumptive remedy approach (EPA, 1996).

The ecological risk assessment (ERA) was completed through Step 3 of the 8-step ERA process (EPA, 1997). The screening component of this iterative approach eliminated groundwater from further ecological consideration. Detected concentrations in groundwater were below the ecological screening values; therefore, all detected groundwater analytes were eliminated during the screening-level risk evaluation. No unacceptable risk to downgradient aquatic receptors is likely due to exposure from groundwater. No further ecological evaluation of groundwater is warranted.

The weight-of-evidence evaluation and risk description presented in the baseline ecological risk assessment resulted in no chemicals of ecological concern posing unacceptable ecological risk to biota communities and populations in the upland terrestrial area and the wetland area from concentrations in soil/waste, sediment/waste, and surface water. No further ecological-based consideration is required for soil/waste, sediment/waste, and surface water at the Site.

Although the risk assessment concluded there were no COCs identified in surface soil/waste, sediment/waste or groundwater downgradient of the waste, subsurface soil/waste and groundwater/leachate risks were not quantified in accordance with the presumptive remedy guidance. The site-related chemicals present in subsurface soil/waste and groundwater/leachate, although not completely characterized, may present a low-level long-term threat for potential exposure scenarios and migration routes identified in Section 1.5 and as outlined in the presumptive remedy guidance. The Site is anticipated to remain a cemetery in perpetuity and the current Fort Custer Master Plan does not include development of the wetland and forested portions of the Site. While redevelopment of the wetland and forested portions of the landfill is unlikely, disturbance of the area near Fort Custer Drive is possible. As outlined in Section 1.3.5, the crypt fields were excavated to a depth of 8 feet prior to construction of the crypts and associated drainage system. Waste materials encountered in the crypt field were removed during construction. The potential for exposure to subsurface soil/waste also exists in the grass-covered area immediately north and south of Fort Custer Drive that is currently mowed (maintained) by the VA. An incremental sample approach was employed for surface soil/waste and sediment/waste decision units. Given the incremental sampling approach, no hot spots were identified; however, variability may exist as documented in observations in test pits outlined in the RI report (CH2M, 2019). Therefore, exposure to subsurface soil/waste is possible based on current and reasonably foreseeable future site conditions. Risks associated with subsurface soil/waste, groundwater/leachate within the waste limits, and ACM were not quantitatively evaluated per the presumptive remedy guidance. Therefore, a FFS was recommended in the 2016 RI (CH2M, 2019) to address the waste that remains in place at the Site. The 2016 RI also recommended that the FFS consider the presence of asbestos and owner preferences for natural green space within the facility and the anticipated continued land use as a National Cemetery in perpetuity.

1.7 Regulatory Framework

The Site is part of a FUDS and is designated as property number E05MI0006. Environmental response actions at FUDS conform to the requirements of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 *United States Code* (U.S.C.) 9601 et seq., the NCP, commonly called the National Contingency Plan, as applicable.

In accordance with Defense Environmental Restoration Program (DERP) legislation (10 U.S.C. 2701 et. seq.), the Secretary of the DoD is authorized to carry out response actions with respect to releases of hazardous substances from active installations and FUDS. The DERP/FUDS program follows the remedial process outlined by the CERCLA of 1980, as amended by SARA, and the NCP. The USACE is the lead agency for purposes of implementing the FUDS program in Michigan for the DoD and works in coordination with EGLE.

EPA established source containment as the containment presumptive remedy for municipal landfill sites regulated under CERCLA in September 1993. EPA's 1996 directive *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* states that the presumptive remedy will be applied to military landfills in situations where landfill contents meet the municipal-type waste definition and excavation of contents is not practicable. Use of the containment presumptive remedy for municipal landfill sites is authorized by Enclosure 3, Section 4.b(5)(a)3.d of the DoD Manual 4715.20 DERP Management. Therefore, the alternatives required to be considered by the DERP Manual and Paragraph 4-4.3.7 of Engineering Regulation 200-3-1, "Environmental Quality: Formerly Used Defense Sites (FUDS) Program Policy," have been screened out from further consideration.

The 1996 EPA directive lists the following characteristics as Appropriate Municipal Landfill Characteristics for Applicability of the Presumptive Remedy (under Highlight 2 of the directive):

- Risks are low-level, except for "hot spots"
- Treatment of wastes is impractical due to the volume and heterogeneity of waste
- Waste types include household, commercial, nonhazardous sludge, and industrial solid wastes
- Lesser quantities of hazardous wastes are present as compared to municipal wastes
- Land application units, surface impoundments, injection wells, and waste piles are not included

Based on information provided in the 2016 RI (CH2M, 2019), the type of wastes observed buried at the Site are consistent with the above-listed characteristics and are largely municipal-type waste.

Additionally, Highlight 3 (Examples of Municipal-Type and Military-Specific Wastes) included in the above-referenced 1996 EPA directive describes the types of municipal and military-specific wastes. The types of military-specific wastes described in Highlight 3 include (i)] low-hazard military-specific wastes such as low-level radioactive waste, decontamination kits, munitions hardware; (ii)] high-hazard military-specific waste namely military munitions such as chemical warfare agents and training kits, artillery, small arms, bombs; and (iii)] military munitions such as demolition charges, pyrotechnics, propellants and smoke grenades. The nature of wastes observed at the Site show no evidence of the presence of military-specific wastes as described in Highlight 3.

A Decision Framework (Highlight 4) in the 1996 EPA directive provides several factors to be considered for applying a remedy for CERCLA municipal landfills. These factors are listed below along with information regarding their relevance to the Site:

1. *Collection of data on site history such as source, operating history, types and volumes of landfill wastes placed in the landfill:*

   The approximate area of the dump is 10.5 acres, with approximately 95,315 cubic yards of waste material present. Thickness of the waste ranges up to 25 feet thick in the southern portion of the Site thinning to the north. Although there are no available historical records providing information on the disposal history and contents of the dump area, based on record review, the Site appears to have been used as a dump in from the early to mid-1940s to dispose of incinerated waste and construction debris until the fort was permanently shut down in June of 1968. Smaller/isolated, more-recent dumping activities (paper trash, tires, and plastic bottles) have occurred by others after 1968.

2. *Consideration of future land reuse plans affecting the presumptive remedy selection:*

   The Site is currently owned and operated by the VA as part of the Fort Custer National Cemetery (constructed in the early to mid-1980s). The master plan for the Fort Custer National Cemetery is to have enough capacity to provide gravesites well into the 21st century (see Figure 1-4). It is likely to remain a cemetery indefinitely. The Site's topography (steep-sided basin) and the presence of a wetland make the wetland and forested portion of the Site undesirable for development, and the VA has stated a desire to keep the wooded dump area and wetland a natural green space for the facility. Consolidation of materials to reduce the overall footprint, specifically from the grass-covered areas north and south of Fort Custer Drive that are maintained by the VA, is possible.

3. *Information on landfill contents to evaluate if contents meet municipal landfill-type waste definition:*

   Historical site information from multiple investigations that included test pits and soil borings indicate the predominance of municipal-type waste as being present at the Site.

4. *Information on landfill contents to evaluate if military-type waste is present within the landfill:*

   Test pitting and investigations to determine the thickness of the existing soil cover at the Site did not identify military wastes. Additionally, the nature of contaminants detected at the Site in surface soil/waste, subsurface soil/waste, sediment/waste and groundwater/leachate do not indicate the presence of military-specific wastes described above.

5. *Practicality of excavations:*

   Because of the potential ubiquitous presence of wastes at the Site, the volume of landfill material (approximately 95,315 cubic yards), the presence of and required disturbance of wetlands and the VA’s preference to keep the wetland and forested portion of the Site as a natural green space, excavation of the landfill contents for transportation and offsite disposal is impractical, cost- prohibitive, and potentially detrimental to natural and cultural resources. Additionally, the required duration of excavation and backfilling activities and required land disturbance to develop adequate staging areas for segregation and testing of various landfill contents prior to waste characterization for offsite disposal of landfill waste would adversely impact the ongoing activities at Fort Custer National Cemetery. Removal also presents a potential hazard to remedial action workers during excavation and waste handling activities.

6. *Application of the presumptive remedy:*

   The end point of the decision framework in Highlight 4 of the 1996 EPA directive prescribes the use of the containment remedy when excavation of the landfill contents is impractical, which is the case at the Site as indicated in the previous step. Therefore, site conditions satisfy the guidance for applying the containment presumptive remedy.

Therefore, use of the containment presumptive remedy approach (source containment) is appropriate for the Site. Use of the containment presumptive remedy for municipal landfill sites obviates the need to characterize the nature and extent of contamination or the content of the landfill. However, characterization and evaluation of risks that could result if chemicals migrate from the landfill is still required for all potential exposure pathways outside the landfill extents. The containment presumptive remedy is expected to ensure the consistent selection of remedial actions and reduce the cost and time required to clean up sites.

The following steps were used to develop and evaluate remedial alternatives for the containment presumptive remedy at the Site:

1. Develop RAOs
2. Identify potential ARARs
3. Develop remedial alternatives based on components of the containment presumptive remedy, and variations thereof
4. Perform detailed analysis of remedial alternatives
5. Perform comparative analysis of each alternative’s ability to satisfy the evaluation criteria

Remedial Action Objectives and Applicable or Relevant and Appropriate Requirements

This section describes the RAOs for the Site and identifies standards under federal environmental laws that are potential ARARs. This section also discusses the development and screening of remedial alternatives to address waste that remains in place at the Site and the appropriate presumptive remedial technologies to achieve the RAOs. Remedial alternatives should assure adequate protection of human health and the environment and achieve or waive ARARs.

Site historical data and nature of wastes observed at the Site indicate that site conditions are similar to those expected to be found at CERCLA municipal landfills. EPA's 1996 directive *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* indicates that the containment presumptive remedy application to municipal landfills as described in the 1993 EPA directive *Presumptive Remedy for CERCLA Municipal Landfill Sites* should also be applied to military landfills in situations similar to those at the Site. Because continued land use as a National Cemetery is anticipated and the VA preference is to keep the wetland and forested portion of the Site as a natural green space for the facility, the containment presumptive remedy application to municipal landfills is considered appropriate for the Site.

2.1 Remedial Action Objectives

RAOs are goals specific to media or operable units for protecting human health and the environment. The risks used to develop RAOs can be associated with current or potential future exposures. RAOs should be as specific as possible, but not so specific that the range of alternatives that can be developed is unduly limited. The *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA, 1993) directive indicates that the primary RAOs at municipal landfill sites include:

Presumptive Remedy

1. Preventing direct contact with landfill contents
2. Minimizing infiltration and resulting contaminant leaching to ground water
3. Controlling surface water runoff and erosion
4. Collecting and treating contaminated ground water and leachate to contain the contaminant plume and prevent further migration from source area
5. Controlling and treating landfill gas

Non-Presumptive Remedy

1. Remediating ground water
2. Remediating contaminated surface water and sediments
3. Remediating contaminated wetland areas

Based on the 2016 RI (CH2M, 2019) results, surface water runoff and erosion has not adversely affected the wetland sediments or surface water, therefore Bullet 3 of the Presumptive Remedy is not required. The heavy vegetation at the Site and lack of observed rills/channels limit exposure to buried waste. Groundwater analytical results from permanent monitoring wells of the 2012 SI (PE, 2016) and 2016 RI (CH2M, 2019) demonstrate that groundwater/leachate is contained to the limits of the waste. Groundwater analytical results in combination with the lack of seeps support that groundwater/leachate collection and treatment is not necessary for the Site (Bullet 4 of the Presumptive Remedy). Based on the age of the landfill and lack of chemicals of potential concern in groundwater for the vapor intrusion pathway, landfill gas control and treatment (Bullet 5 of the Presumptive

Remedy) is also not needed. Additionally, RAOs for the three Non-Presumptive Remedy bullets are not required because the 2016 RI (CH2M, 2019) demonstrated that these media do not pose unacceptable risk to human and ecological receptors. Therefore, the following RAO was developed for the Site:

- Protect human receptors from direct contact, ingestion, inhalation exposure to subsurface soil/waste by eliminating exposure pathways and contaminant migration to groundwater and surface water.

2.2 Applicable or Relevant and Appropriate Requirements

CERCLA remedial actions must meet ARARs for the onsite remedial action unless a waiver is requested. ARARs include the substantive or technical components of federal and state environmental requirements that define the extent of site cleanup, identify sensitive land areas or land uses, develop remedial alternatives, and direct site remediation. CERCLA, as amended by SARA, requires that remedial actions comply with ARARs. Potential ARARs are discussed in this section because they can affect the development of RAOs. Remedial alternatives are then developed and evaluated to determine whether they meet ARARs. Once a remedy is selected, final ARARs are identified in the Decision Document. ARARs do not include administrative or procedural requirements. Also, no federal, state, or local permit is required for onsite CERCLA actions under CERCLA §121(e). EPA's interpretation of CERCLA §121(e) waives the requirement to obtain a permit and the associated administrative and procedural requirements of permits, but not the substantive provisions of permitting regulations that are ARARs.

ARARs are defined in the NCP (40 CFR §300.5) as either applicable requirements or relevant and appropriate requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address circumstances at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are well suited to the conditions of the site (EPA, 1988). A requirement must be determined to be both relevant and appropriate to be considered an ARAR.

The criteria for determining relevance and appropriateness are listed in 40 CFR § 300.400(g)(2) and include the following:

- Purpose of both the requirement and the CERCLA action
- Medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site
- Substances regulated by the requirement and the substances found at the CERCLA site
- Actions or activities regulated by the requirement and the response action contemplated at the CERCLA site
- Variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site
- Type of place regulated and the type of place affected by the release or CERCLA action
- Type and size of structure or facility regulated and the type and size of structure or facility affected by the release or proposed in the CERCLA action
- Consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site

According to CERCLA ARARs guidance (EPA, 1988), a requirement may be "applicable" or "relevant and appropriate," but not both. ARARs must be identified on a site-specific basis and involve a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is both relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (EPA, 1988).

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be all of the following:

- A state law or regulation
- An environmental or facility siting law or regulation
- Promulgated (of general applicability and legally enforceable)
- Substantive (not procedural or administrative)
- More stringent than federal requirements
- Identified in a timely manner
- Consistently applied

There are three types of ARARs:

- *Chemical-specific* ARARs are health-based or risk-based numbers or discharge limitations that restrict chemical concentrations in or discharged to the environment.
- *Location-specific* ARARs are restrictions on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations and may impose additional constraints on the remedial action because of the location.
- *Action-specific* ARARs are activity or technology based. These ARARs control remedial activities involving the design or use of certain equipment or impose specific requirements on discrete actions (that is, hazardous waste handling, landfill closure, air emission controls).

Non-promulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may, however, be useful and are "to be considered" (TBC). TBC requirements (40 CFR § 300.400[g][3]) complement ARARs, but do not override them and may be considered along with ARARs in determining the level and implementation of cleanup for the protection of the environment. A list of federal potential ARARs and TBCs for the Site are summarized in Table 2-1 and discussed below.

2.2.1 Chemical-specific ARARs

Chemical-specific requirements include limitations set on the amount or concentration of a chemical that can be either present in or discharged to the environment under promulgated federal and/or state regulations (EPA, 1998). These limits are typically health- or risk-based requirements. Under current and future land-use conditions site-related COCs were not identified in Site media or detected in groundwater downgradient from the Site. Therefore, evidence indicates there are no COCs within or leaving the Site and waste within the Site is considered contained under the presumptive remedy approach (EPA, 1996). Accordingly, because there are no Site COCs in the media evaluated, there are no chemical-specific ARARs. However, EPA Federal Maximum Contaminant Levels or EGLE Part 201 cleanup criteria may be ARARs if a release of COCs from the Site triggers a response action.

2.2.2 Location-specific ARARs

The impact of a contaminated site on human health and the environment is often determined by its location (EPA, 1998). Compliance with location-specific regulatory requirements prevents damage to unique or sensitive areas such as floodplains, historic places, wetlands, and fragile ecosystems and can limit remedial activities that are potentially harmful because of where they take place. Federal actions that involve potential impacts to, or take place within, sensitive areas should avoid long- and short-term adverse effects associated with occupancy and modification of an area.

2.2.2.1 Clean Water Act

Wetlands include “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” (33 CFR 328.3(c)(4)). A wetland that is determined to be a “water of the United States” is subject to federal jurisdiction under the Clean Water Act which restricts or prohibits the use of an area for discharge of dredged or fill material if the discharge will have unacceptable adverse impacts. This type of wetland is referred to as a “jurisdictional wetland”. Accordingly, any portion of the Site determined to be a jurisdictional wetland is subject to Section 404(b)(1) of the Clean Water Act and the substantive requirements of 40 CFR 230, if the selected remedial alternative will result in a discharge of dredged or fill material into that wetland.

Specifically, the following requirements of 40 CFR 230.10 are potential ARARs to the Site’s wetlands determined to be jurisdictional:

- 40 CFR 230.10(a) – requires that the discharge represent the least damaging, practicable alternative;
- 40 CFR 230.10(c) – requires that discharge of dredged material not result in significant degradation of the aquatic ecosystem; and
- 40 CFR 230.10(d) – requires that all practicable means be used to minimize adverse environmental impacts

2.2.2.2 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 U.S.C. 703(a)) necessitates action be taken to protect migratory birds and their habitat. The taking of any native species of wild bird is prohibited. The Act is a potential ARAR if migratory birds are present during the remedial actions.

2.2.2.3 Archaeological Resources Protection Act

A hillside dump (RAI-7) along the edge of a marsh is identified as an historic period site in the *Archaeological Literature Search and Cultural Resource Survey, Fort Custer National Cemetery, Michigan* (Veterans Affairs, November 29, 1982). Therefore, remedies that involve proposed covers or capping over the limits of the waste will comply with Archeological and Historic Preservation Act (16 U.S.C. 470ee(a)) to provide procedures for the preservation of scientific, historical, and archaeological data that might be destroyed.

2.2.3 Action-specific ARARs

Action-specific ARARs are activity- and technology-based requirements that are applicable or relevant and appropriate to one or more remedial alternative (EPA, 1998).

2.2.3.1 Hazardous Waste Management

The remedy will comply with substantive requirements of 40 CFR 265, Subpart I Use and Management of Containers for alternatives that include waste generated during the remedial action and substantive requirements of 40 CFR 262.11 regarding requirements to determine if a solid waste is hazardous which is applicable to environmental media generated during the remedial action. Resource Conservation and Recovery Act of 1966 (RCRA) also may impose location- or action-specific potential ARARs. EPA investigation- or remediation-derived waste policy discusses options for managing materials, such as purge water, generated during field activities.

2.2.3.2 Asbestos Emissions

ACM was encountered during intrusive test pit activities and at limited surface locations during the visual inspections. The majority of suspect ACM were noted in the central portion of the dump; however, the location and extent of ACM is heterogenous and not completely characterized. All visible pieces of ACM on the surface was removed at the time of sampling to ensure sufficient sample volume. With the discovery of ACM, the remedy will comply with substantive requirements related to asbestos handling in the National Emission Standards for Hazardous Air Pollutants for Asbestos in 40 CFR 61.145(c)(6)(i) and 40 CFR 150(a)(1) including the control of asbestos emissions through adequate wetting and proper packaging and handling of ACM. An Asbestos Management Plan is recommended to advise personnel and contractors handling asbestos during remedial actions.

2.2.3.3 Erosion and Sediment Control

The substantive requirements for implementing erosion and sediment control and other best management practices during land disturbing activities in 40 CFR 450.21 are relevant and appropriate to remedies that involve disturbing one or more acres of land.

Identification and Screening of Technologies

3.1 Components of the Presumptive Remedy

Site historical data and nature of wastes observed at the Site indicate that conditions are similar to those found at CERCLA municipal landfills. EPA's 1996 directive *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* (1996) indicates that the containment presumptive remedy application to municipal landfills (as described in the 1993 EPA directive *Presumptive Remedy for CERCLA Municipal Landfill Sites*) should also be applied to military landfills in situations similar to those at the Site.

Based on the site conditions presented in Section 1.7, the Site lends itself to the use of the EPA guidance document *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991), which provides detailed descriptions of technologies applicable to municipal CERCLA landfills. Section 4 of this EPA guidance is being used to propose alternatives consistent with the presumptive containment remedy. Consideration of the containment presumptive remedy is authorized by Enclosure 3, Section 4.b(5)(a)3.d of the DoD Manual 4715.20 DERP Management. Therefore, the alternatives required to be considered by the DERP Manual and Paragraph 4-4.3.7 of Engineering Regulation 200-3-1, "Environmental Quality: Formerly Used Defense Sites (FUDS) Program Policy," have been screened out from further consideration.

The 1991 EPA guidance document states that for municipal CERCLA landfill sites, it is expected that:

- *Engineering controls such as containment will be used for waste that poses a relatively low long-term threat or where treatment is impractical.*
- *Institutional controls such as deed restrictions will be used to supplement engineering controls, as appropriate, to prevent exposure to hazardous wastes.*
- *Groundwater will be returned to beneficial uses whenever practical, within a reasonable time, given the particular circumstances of the site.*

As presented in the EPA's *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA, 1993*)*, the potential components of the presumptive remedy for municipal landfill sites include:

- Landfill cap
- Source area ground-water control to contain plume
- Leachate collection and treatment
- Landfill gas collection and treatment
- Institutional controls to supplement engineering controls

These five components and their pertinence to the Site are described Section 3.1.

3.1.1 Landfill Cap/Cover/Consolidation

A landfill cover is being preliminarily considered to reduce the potential for direct contact with soil/waste and to reduce potential leaching if consolidation is conducted. A landfill cap/covering is commonly applied to landfills because it is generally less expensive than other technologies and effectively mitigates potential risks to human health and the environment. The landfill cap/cover would mitigate potential risks by eliminating direct contact exposures with contaminated surface soil/waste by eliminating the migration of contaminated surface soil/waste to surrounding areas via surface water runoff. The landfill cap/cover would also reduce leaching to groundwater by minimizing surface water infiltration and erosion. The soil remedy for the Site is, therefore, appropriately addressed using the 1991 EPA guidance cited above, which identifies capping technologies used at landfills to include the following three alternatives:

- Native soil cover

- Single barrier (for example, clay)
- Composite barrier (for example, clay plus flexible membrane liner (FML)

The 1991 EPA guidance document also includes a simplified decision tree (shown on Figure 3-1) for determining an appropriate soil cap based on site conditions and landfill waste characteristics. An examination of this decision tree indicates that site conditions requiring a Composite-Barrier (clay cap with an FML) are not present at the Site for the following reasons:

- Approximately 1.2 acres is saturated (surface materials are below water in the wetland pond). The primary purpose of an FML layer is to prevent or limit infiltration into the landfill wastes and thereby minimize leaching of contaminants from the landfill waste into groundwater and surface water. At the wetlands pond, the landfill contents have been in place within the water table for several decades (in and adjacent to wetlands) and have been subjected to several decades of infiltration, "flushing," and passive venting through the native soil cover comprised of soil and vegetation. The greatest impact to groundwater and surface water from leaching of landfill contaminants would therefore have already occurred. Results of the 2012 SI (PE, 2016) and 2016 RI (CH2M, 2019) demonstrate that groundwater/leachate is not migrating beyond the limits of the waste and not expected to increase in the future. Further limiting the leaching to groundwater is not practical or necessary at the Site.
- Extensive land disturbance to prepare a subbase to place an FML cap again raises concerns about the required disturbance of wetlands and wetland habitat, potential detriment to natural and cultural resources, the VA's preference to keep the wetland and forested portion of the Site as a natural green space, and the potential for remedial action workers to be exposed to waste. This FFS, therefore, will not evaluate the Composite Barrier (clay plus FML) as a soil capping alternative.
- No exceedances of screening criteria for groundwater were observed during the RI for the groundwater samples collected downgradient of the waste limits. The waste limits have a native soil and vegetative cover that has historically allowed infiltration of stormwater into the landfill wastes.

Installing a soil cover would reduce exposure to areas consolidated within the limits of the waste. The cover would be graded so that water would be directed to the wetland pond. This, along with the cover itself, would reduce seep generation. In addition, the cover would prevent site personnel, wildlife, and visitors from coming into direct contact with the surface soil/waste. Removal of trees and placement of soil cover would also isolate ACM and prevent potential migration of ACM to the surface due to uprooted trees. This component is included as Alternative 3.

Figure 1-3 shows the approximate extent of waste identified during the 2012 SI (PE, 2016). The area of waste disposal is approximately 15 acres. Consolidation and treatment of hot spot materials under a landfill cap is not practical at the Site because the extent of waste is divided among two decision units and hot spots are not defined. Incremental soil/waste and incremental sediment/waste samples were collected in May 2014 as part of the 2014 SI (PE, 2016). Incremental samples are more representative of exposure area than grab samples for a receptor. Given the incremental sampling approach, no hot spots were identified and treatment is not possible at the Site. Additionally, treatment of contaminated surface soil/waste, sediment/waste, and landfill waste is not practicable or necessary based on results of the HHRA and ERA. However, consolidation of materials to reduce the overall footprint, specifically from areas maintained by the VA, is possible, and would allow for the potential reuse of the consolidated areas.

Consolidation of waste material would be undertaken to reduce landfill footprint and allow for the potential reuse of the consolidated areas, specifically, the area north and south of Fort Custer Drive (the southern portion of the waste footprint) that is actively maintained by the VA. In accordance with EPA's Area of Concern (AOC) Policy, 53 FR 51444, wastes present at a landfill may be moved and reconsolidated within previously existing horizontal and vertical limits of waste placement (that is, the AOC). The AOC policy applies to remediation waste that is in or on the land, and in this case, applies to soil and waste within the Site (that is, the AOC). Consistent with this policy, soil from within the Site cannot be used to backfill excavated areas outside the limits of the Site without triggering a new point of waste generation, and the RCRA land disposal restrictions or minimum technology requirements (for hazardous soil). Figure 3-2 shows the different areas where wastes have been found. This figure also depicts the approximate area of waste north of Fort Custer Drive to be consolidated and spread to low areas within the footprint of the waste and covered. In addition, the area would be cleared and grubbed before construction, as it is currently covered with dense vegetation.

Consolidating waste material and covering is easily implemented, and the resources required are anticipated to be available. Equipment and technical support is not anticipated to be difficult to locate as covers are commonly applied to landfills. Heavy equipment (such as bulldozers) and trained operators would be required for implementing this alternative. Because of the VA's preference to keep the Site as a natural green space for the facility, consolidation would be limited to areas maintained by the VA, with relocation in areas to minimize potential impact to wetland habitat within the limits of the waste. Consolidation would mitigate impacts to areas where wastes are present within the areas maintained by the VA. Therefore, consolidating the wastes would effectively reduce potential risks posed by the landfill to maintenance workers. Consolidation would require excavation using standard construction equipment. This component is included in Alternative 3.

3.1.2 Source Area Groundwater Control to Contain the Plume

Groundwater control to contain the plume include technologies that prevent migration beyond the limits of the waste such as a slurry wall or extraction and treatment technologies. Extraction and treatment of groundwater/leachate is not warranted to control offsite migration of wastes at the Site. Results of the 2012 SI (PE, 2016) and 2016 RI (CH2M, 2019) demonstrate that groundwater/leachate is not migrating beyond the limits of the waste. This component is not retained.

3.1.3 Leachate Collection and Treatment

Leachate is liquid generated from rainfall and the natural decomposition of waste that is filtered through the landfill to a leachate collection system. The primary purpose of a leachate collection system is to minimize or eliminate the migration of leachate away from the landfill and prevent discharges to surface water or groundwater. Typical leachate collection systems are composed of subsurface drains and/or vertical extraction wells to intercept leachate before it can infiltrate to groundwater. Collected leachate would require treatment prior to disposal or discharge. Extraction and treatment of contaminated groundwater/leachate is not warranted to control offsite migration of wastes at the Site. Results of the 2012 SI (PE, 2016) and 2016 RI (CH2M, 2019) demonstrate that groundwater/leachate, although not completely characterized, is not migrating beyond the limits of the waste. This component is not retained.

3.1.4 Landfill Gas Collection and Treatment

Landfill gas is produced by the biological decomposition of general solid waste and other organic materials in the landfill. Landfill gas collection and treatment can consist of passive vents or active systems that gather, process, and treat landfill gas to remove contaminants, reduce emissions and odors, and/or reduce accumulation of explosive gases. There has been no evidence of landfill gas being a concern at the Site. Based on the age of the landfill, landfill gas generation is unlikely. The screening levels used for groundwater exposure via vapor intrusion (that is, indirect exposure to chemicals in groundwater through inhalation of indoor air) were EPA's vapor intrusion screening levels (VISLs), from the VISL online calculator (EPA, 2018). No chemicals were identified as COPCs in groundwater for the vapor intrusion pathway; therefore, landfill gas treatment, is not warranted as requirements for a remedy at the Site. Additionally, there are no proposed buildings in the VA master plan in the area of the Site (Figure 1-4). This component is not retained.

3.1.5 Land Use Controls

LUCs can include institutional and/or engineering controls that help to minimize the potential for exposure to contamination and/or protect the integrity of a response action. Institutional controls can include administrative and legal controls, while engineering controls restrict access to contaminants, such as fencing or pavement.

Because risks associated with soil/waste and groundwater/leachate within the waste limits have not been quantified, a LUC to restrict access to soil/waste and groundwater/leachate that remains in place are appropriate.

Implementation of a LUC would reduce exposure to groundwater/leachate, surface soil/waste, subsurface soil/waste, and sediment/waste. Residential use is not a reasonably foreseeable future use as the Site is anticipated to remain a cemetery in perpetuity. Additionally, given the topography of the Site, construction of a commercial structure is unlikely. Therefore, a LUC restricting site development would likely be implementable. Groundwater/leachate within the waste limits is not presently used, therefore a LUC restricting groundwater use within the limits of the waste would be effective. The LUC will be an interagency agreement between USACE and the VA. For purposes of this FS report, the LUC consists of an education control (signage), an administrative soil/waste relocation restriction from areas outside the limits of the waste, and an administrative groundwater use restriction. Preliminary input has been solicited from the VA. The administrative/government controls will be implemented through an interagency agreement for the Site and in the land use control implementation plan (LUCIP).

Restricting excavation of soil/waste and sediment/waste and restricting relocation of soil/waste and sediment/waste outside the waste limits would also be effective at preventing direct contact with landfill contents. Education controls, such as warning signs, would also be implementable and restrict access to waste that remains in place. A LUCIP and periodic inspections would be required to manage the LUC. Implementation of a LUC with long term management would be easily implemented and, in concept, has been discussed with the VA and EGLE. The VA would be responsible for enforcing the LUC in place at the time of the Decision Document. USACE will install, operate, and maintain education controls (signage) and ensure the VA implements the administrative LUCs within the facility Master Plan prior to execution of the Decision Document. This component is included in Alternatives 2 and 3.

3.2 Identification of Alternatives

The following alternatives have been identified for the Site based on the initial screening of the containment presumptive remedy components:

- Alternative 1—No Action
- Alternative 2—Land Use Controls with Long-term Management
- Alternative 3—Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management

There are no site-specific risks identified for surface soil/waste and sediment/waste within the limits of the waste. Subsurface soil/waste and groundwater/leachate risks were not quantified. Construction of a soil cover was carried through only as an option for increased protectiveness at the Site for consolidation activities.

3.2.1 Alternative 1: No Action Alternative

This alternative consists of taking no action. The NCP requires that a No Action alternative be retained throughout the FFS process as a baseline for comparison to the other approaches and to assess whether chemicals of concern and chemicals of ecological concern leaving the waste area meet unrestricted use/unrestricted exposure or unrestricted (residential) land use scenario under FUDS. Under no action, the waste present at the Site would not be removed or treated, and no actions would be taken to prevent exposure to the waste. The no action alternative is required to be considered in the FFS process. No action means that nothing would be done at the Site to change the current conditions. Additionally, no action would be taken to restrict potential exposures to wastes. Natural attenuation processes are expected to occur with the potential to reduce contaminant concentrations over time; however, the concentrations would not be monitored and the degree to which natural attenuation is occurring would not be documented. This alternative provides no institutional controls restricting future site use. No Action is retained as a baseline alternative, as required by the NCP.

3.2.2 Alternative 2: Land Use Controls with Long-term Management

Alternative 2 involves implementation of a LUC to restrict access to waste that remains in place and would include a LUC prohibiting the installation of irrigation and municipal wells within the limits of the waste. The LUC will require an administrative interagency agreement between USACE and the VA. The LUC for Alternative 2 consists of an education control (signage), an administrative soil/waste relocation restriction from areas outside the limits of the waste, and an administrative groundwater use restriction. The administrative/government controls will be implemented through amendment of the VA's facility Master Plan for the property and in the LUCIP. Restricting excavation of soil/waste and sediment/waste and restricting relocation of soil/waste and sediment/waste outside the waste limits would also be effective at preventing direct contact with landfill contents. Education controls, such as warning signs, would also be implementable and restrict access to waste that remains in place. A LUCIP and periodic inspections would be required to manage the LUC. Implementation of a LUC with long term management would be easily implemented and, in concept, has been discussed with the VA and EGLE. The VA would be responsible for enforcing the LUC in place at the time of the Decision Document. USACE will install, operate, and maintain education controls (signage) and ensure the VA implements the administrative LUCs within the facility Master Plan prior to execution of the Decision Document. USACE will review the effectiveness of the LUC during CERCLA 5 year reviews.

Long-term management also is part of this alternative. The groundwater monitoring frequency and network are referenced for the basis of the cost estimate for the proposed alternatives. The final monitoring program would be documented in the landfill long-term management plan and would be expected to include groundwater monitoring and site inspection and provisions for decreased or suspended monitoring, as applicable. Tentatively, the groundwater monitoring network would comprise nine existing monitoring wells located upgradient, sidegradient, and downgradient of the Site. It is assumed that groundwater monitoring would be conducted for 30 years. During the first 5 years, groundwater monitoring would occur quarterly for years 1, 2, and 3, and semiannually for years 4 and 5. For years 6 through 30, quinquennial (every 5 years) monitoring is assumed. The monitoring plan would be re-evaluated during the CERCLA 5-year review process.

3.2.3 Alternative 3: Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management

Alternative 3 involves consolidating waste and then constructing a soil cover over 10.5 acres of the landfill. A LUC with long-term management also is part of this alternative. The final monitoring program would be documented in a landfill long-term management plan and would be expected to include groundwater monitoring and provisions for decreased or suspended monitoring, as applicable. The groundwater monitoring frequency and network are referenced for the basis of the cost estimate for the proposed alternatives. Tentatively, the groundwater monitoring network would comprise nine existing monitoring wells located upgradient, sidegradient, and downgradient of the Site. Some existing wells may be abandoned during construction of the soil cover, but they would be replaced with new wells. It is assumed that groundwater monitoring will be conducted for 30 years. During the first 5 years, groundwater monitoring would occur quarterly for years 1, 2 and 3, and semiannually for years 4 and 5. For years 6 through 30, quinquennial monitoring is assumed. The monitoring plan would be re-evaluated during the CERCLA 5-year review process.

A LUC also would restrict the future use of the Site, restrict the use of the groundwater/leachate beneath the waste, and prevent intrusive activities within the waste limits.

Alternative 3 includes the following components:

- Clearing and grubbing of existing vegetation
- Consolidating waste within the area to be covered
- Constructing a soil cover consisting of at least 12-inch-thick native soil cover, overlain with 6 inches of topsoil to support vegetative cover
- Restoring consolidated areas

- Implementing long-term management measures to ensure the protectiveness of the cover
- Groundwater monitoring from the monitoring well network
- Implementing the LUC

This alternative consists of periodic sampling of the nine existing monitoring wells located upgradient, sidegradient, and downgradient of the waste to assess potential migration of groundwater/leachate and migration from surface water to groundwater beyond the limits of the waste. Quarterly sampling would be conducted years 1, 2, and 3, followed by semiannual sampling in years 4 and 5, then quinquennial sampling for years 6 through 30. Groundwater samples would be analyzed for VOCs, SVOCs and total and dissolved Michigan 10 metals plus boron. Prior to sample collection, field parameters would be measured for dissolved oxygen, temperature, oxidation-reduction potential, specific conductance, turbidity, and pH.

Periodic inspections of the landfill would also be required under this remedy. Inspections would be performed concurrent with groundwater sampling; quarterly in years 1, 2, and 3 followed by semiannual sampling in years 4 and 5, then quinquennial sampling for years 6 through 30.

All the alternatives are carried through for a detailed analysis.

SECTION 4

Detailed Analysis of Alternatives

4.1 Evaluation Criteria

Provisions of the NCP require that each alternative be evaluated against nine criteria listed in 40 CFR 300.430(e)(9). These criteria were published in the March 8, 1990 *Federal Register* (55 *FR* 8666) to provide grounds for comparison of the relative performance of the alternatives and to identify their advantages and disadvantages. This approach is intended to provide sufficient information to adequately compare the alternatives and support selection of a preferred alternative for implementation. The evaluation criteria are:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume (TMV) through treatment
5. Short-term effectiveness
6. Implementability
7. Cost
8. Community acceptance
9. State acceptance

The criteria are divided into three groups: *threshold, balancing,* and *modifying* criteria. *Threshold* criteria must be met by a particular alternative for it to be eligible for selection as a remedial action. There is little flexibility in meeting the *threshold* criteria—either they are met by a particular alternative or the alternative is not considered acceptable. The two threshold criteria are:

- Overall protection of human health and the environment
- Compliance with ARARs

Unlike the threshold criteria, the five *balancing criteria* weigh the tradeoffs between alternatives. A low rating on one *balancing* criterion can be compensated for by a high rating for another. The five balancing criteria include the following:

- Long-term effectiveness and permanence
- Reduction of TMV through treatment
- Short-term effectiveness
- Implementability
- Cost

The *modifying* criteria are community and state acceptance. These are evaluated following public comment and are used to modify the selection of the preferred alternative. Community and state acceptance are not addressed in this FFS report but will be included in the Decision Document. The criteria are discussed in further detail below.

4.1.1 Threshold Criteria

To be eligible for selection, an alternative must meet the two threshold criteria described below, or in the case of ARARs, must justify why a waiver is appropriate.

4.1.1.1 Overall Protection of Human Health and the Environment (Criterion 1)

Protectiveness is the primary requirement that remedial actions must meet under CERCLA. A remedy is protective if it adequately eliminates, reduces, or controls current and potential risk for each site-specific receptor and exposure pathway. The assessment against this criterion describes how the alternative achieves and maintains protection of human health and the environment.

4.1.1.2 Compliance with ARARs (Criterion 2)

Compliance with ARARs is a statutory requirement of remedy selection. ARARs are federal and state cleanup standards, standards of control, and other substantive environmental statutes or regulations that are either "applicable" or "relevant and appropriate" to the cleanup action. The assessment against this criterion describes how the alternative complies with ARARs or presents the rationale for waiving an ARAR.

ARARs are discussed in terms of chemical-specific, location-specific, and action-specific. An alternative that does not comply with an ARAR may have grounds for invoking a waiver as described in the NCP under paragraph 40 CFR 300.430(f)(1)(ii)(C).

4.1.2 Balancing Criteria

The five balancing criteria for detailed evaluation of alternatives are indicated below.

4.1.2.1 Long-Term Effectiveness and Permanence (Criterion 3)

Long-term effectiveness and permanence are measured by how much risk remains after the remedy is completed. Alternatives providing the highest degree of long-term effectiveness and permanence are those that leave little or no waste, have little or no long-term maintenance and monitoring requirements, and minimize or eliminate the need for land use controls. The evaluation for long-term effectiveness includes consideration of the following factors:

- Magnitude of the potential risk from untreated waste or treatment residues after active remedial activities to human and environmental receptors
- Type, degree, and adequacy of long-term management required for untreated waste or treatment residues after active remedial activities
- Long-term reliability of engineering to provide continued protection from untreated waste or treatment residues
- Potential need for replacement of the action and the continuing need for repairs to maintain the performance of the remedy

4.1.2.2 Reduction of TMV through Treatment (Criterion 4)

The statutory preference is a remedial action that employs treatment to reduce the TMV of hazardous substances. Criterion 4 addresses the anticipated performance of technologies to reduce TMV of hazardous substances. Alternatives that do not include treatment technologies are not considered to reduce TMV. This criterion considers the following:

- Treatment process(es)
- Amount of hazardous substances that will be treated or destroyed
- Degree of expected reduction in TMV through treatment, including how the treatment addresses the principal threats (if any)
- Degree to which the treatment will be irreversible
- Type and quantity of residual wastes that will remain following treatment

4.1.2.3 Short-Term Effectiveness (Criterion 5)

This criterion evaluates the period of time needed to implement the remedy and adverse impacts to workers, the community, and the environment during construction and operation of the remedy until RAOs are achieved. Short-term effectiveness is measured by the following factors:

- Short-term risks to the community during implementation of an alternative

- Potential adverse impacts on workers during implementation, and the effectiveness and reliability of protective measures
- Potential for adverse environmental impacts during implementation, and effectiveness and reliability of mitigation measures
- Estimated duration of implementation needed to achieve the remedial objectives

4.1.2.4 Implementability (Criterion 6)

Implementability deals with the difficulties of constructing and operating an alternative and the availability of materials and services required. The following facets are considered:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy
- Administrative feasibility, including activities needed to coordinate with other offices and agencies, and the ability and time required to obtain necessary approvals and permits from other agencies (for offsite actions)
- Availability of services and materials necessary for implementing the alternative, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; availability of necessary equipment and specialists, and provisions to provide necessary additional resources; and availability of prospective technologies

4.1.2.5 Cost (Criterion 7)

Under this criterion, an alternative is assessed in terms of its present worth capital and O&M costs. Preliminary cost estimates were developed for Alternatives 2 and 3 for the Site, as no costs are associated with the no action alternative (Alternative 1) (Appendix A). These estimates are based on available information and are based on information provided by vendors, regulators, and personnel with experience on similar projects. The expected accuracy of these cost estimates is +50% to -30% (EPA 1991). These cost estimates should not be considered the actual cost of designing and implementing a remedial action, but rather relative costs among the alternatives using consistent assumptions and estimating methods.

Capital costs presented in this report include allowances for construction management (15%) and contingency (20%). O&M costs include a contingency of 20%. The present net worth is based on a 30-year project duration, and assumes a 2.6% discount rate (EPA, 2000).

4.1.3 Modifying Criteria

State and community acceptance of a proposed remedial action are important elements in remedy selection. Concerns of state regulators and the local community must be addressed during the selection process and are generally termed “modifying criteria.”

4.1.3.1 State Acceptance (Criterion 8)

This evaluation criterion assesses the technical and administrative issues and concerns that the EGLE may have about each alternative. Preliminary input has been solicited from EGLE and will be incorporated into the evaluation of the alternatives in this document. Additional consideration will be provided for the state acceptance criterion after receiving comments on the Proposed Plan. This criterion will be fully addressed in the Decision Document.

4.1.3.2 Community Acceptance (Criterion 9)

This evaluation criterion evaluates the issues and concerns that the public may have regarding each of the alternatives. Community input regarding the alternatives will be solicited during the public comment period, during which time the Proposed Plan will be available for public review. A responsiveness summary will be prepared to address comments received during the public comment period. This criterion will be fully addressed in the Decision Document after public comments on the Proposed Plan are received.

4.2 Individual Analysis of Alternatives

Detailed analysis of the alternatives consists of assessment of each alternative against the nine criteria specified in Section 300.430(e)(9) of the NCP. A sustainability analysis of Alternatives 2 and 3 was conducted to provide a quantitative assessment of the potential environmental and social impact of each alternative. The sustainability analysis was performed using SiteWise Version 3.1 (Battelle, 2015) for Alternatives 2 and 3. Alternative 1 (No Action) does not include any action. Results of the sustainability analysis are provided in detail in Appendix B and presented in applicable subsections.

4.2.1 Alternative 1: No Action

Alternative 1 (No Action) consists of taking no action. The NCP requires that a No Action alternative be retained throughout the FS process as a baseline for comparison to the other approaches. No action would leave waste, with no mechanisms in place to prevent or control exposure to receptors. There are no capital or operation and maintenance costs for the Alternative 1 (No Action). Therefore, a cost estimate was not necessary.

Overall protectiveness of human health and the environment – The HHRA identified no COCs in surface soil/waste, sediment/waste, surface water, and downgradient groundwater. No unacceptable ecological risk (that is, no chemicals of ecological concern) was identified with respect to biota in the upland forested area and the wetland area within the Site. The site-related chemicals present in subsurface soil/waste and groundwater/leachate and ACM, although not completely characterized, present a low-level long-term threat for potential exposure scenarios and migration routes. Potential risks associated with the subsurface soil/waste and groundwater/leachate were not quantitatively evaluated in the HHRA per the presumptive remedy guidance. However, characterization and evaluation of potential risks associated with groundwater beyond the limits of the waste was completed for risks that result if chemicals migrate from the landfill. Potential exposure to waste and groundwater/leachate that remains in place would not be managed through inspections or remedial action. Therefore, this alternative is not protective of human health and the environment.

Compliance with ARARs – This alternative does not disturb the land, discharge stormwater, alter surface water flow, generate hazardous waste, or impact the wetlands, floodplain, or habitat. This alternative complies with the Site potential ARARs.

Long-term effectiveness and permanence – This alternative is not effective in the long-term since waste would not be treated or contained. Exposure to the subsurface soil/waste and groundwater/leachate may pose risks to human receptors, and, if natural processes expose waste, may also pose risks to environmental receptors.

Reduction of toxicity, mobility, or volume of contaminants through treatment – The volume of waste would not be reduced over time.

Short-term effectiveness – This alternative would have no impact in the short-term.

Implementability – High.

Cost – The capital cost is $0 and the present value for 30 years is $0.

4.2.2 Alternative 2: Land Use Controls with Long-term Management

This remedial alternative consists of periodic sampling of the nine existing monitoring wells located upgradient, sidegradient, and downgradient of the Site to assess potential migration of groundwater/leachate contamination beyond the limits of the waste. Because the limits of the waste are well defined, groundwater monitoring would be conducted for 30 years. During the first 5 years, groundwater monitoring would occur quarterly for years 1, 2 and 3, and semiannually for years 4 and 5. For years 6 through 30, quinquennial monitoring and inspection are assumed. The final monitoring program would be documented in the long-term management plan and include evaluations to optimize sample parameters and frequency. This alternative would also include a LUC that consists of an education control (signage), an administrative soil/waste relocation restriction from areas outside the limits of the waste, and an administrative groundwater use restriction. The administrative/government controls will be implemented through amendment of the VA's facility Master Plan for the property and in the LUCIP. Vegetation clearing outside the limits of the waste would be required to facilitate installation of the sign posts in some areas and access to the monitoring well network.

Overall protectiveness of human health and the environment – The site-related chemicals present in subsurface soil/waste and groundwater/leachate, although not completely characterized, present a low-level long-term threat for potential exposure scenarios and migration routes. The HHRA identified no COCs in surface soil/waste, sediment/waste, surface water, and downgradient groundwater. No unacceptable ecological risk (that is, no chemicals of ecological concern) was identified with respect to biota in the upland forested area and the wetland area within the Site. The existing soil cover, which did not pose an unacceptable risk to human and ecological receptors, has well-established vegetation across the landfill, including the wetlands, which minimizes direct exposure to underlying subsurface soil/waste. Potential future subsurface soil/waste exposure would be managed through inspections concurrent with groundwater monitoring. Based on investigation observations, the location and extent of ACM is heterogenous and not completely characterized. Visible friable ACM encountered during previous investigations was removed for sampling. Because the most likely mechanism for migration of subsurface soil/waste, including waste and ACM to the surface is uprooting of trees, inspections for waste and ACM would also be conducted following storm events that have wind speeds greater than 60 mph. Waste and ACM found during inspections would be removed and disposed of in accordance with state and federal requirements. Therefore, this alternative is expected to maintain reliable protection of human health and the environment over time.

Compliance with ARARs – This alternative would not disturb the land, discharge stormwater, alter surface water flow, generate hazardous waste, or impact the wetlands, floodplain, or habitat. Results of the 2012 SI (PE, 2016) and 2016 RI (CH2M, 2019) demonstrate that groundwater/leachate is not migrating beyond the limits of the waste. This alternative complies with the Site potential ARARs.

Long-term effectiveness and permanence – No COCs were identified in surface soil/waste, sediment/waste, and downgradient groundwater based on results of the baseline HHRA and ERA. The heavy vegetation at the Site and lack of observed rills/channels limit exposure to buried waste. However, natural processes, such as uprooting of trees may expose the buried waste. This potential would be mitigated by the LUC and periodic and post-storm inspections. Therefore, this alternative is expected to maintain reliable protection of human health and the environment over time, once remedial goals have been met.

Reduction of toxicity, mobility, and volume of contaminants through treatment – The volume of waste would not be reduced under this alternative.

Short-term effectiveness – Vegetation clearing would be required to facilitate installation of the sign posts in some areas; however, the vegetative clearing would be minor and would comply with the owner preference for natural green space within the facility. Management of the waste generated during post installation and groundwater monitoring would limit potential adverse environmental impacts during implementation. Material manufacturing and transportation are primary sustainability contributors to the greenhouse gas and energy footprints for this alternative (Appendix B).

Implementability – This alternative would be easily implemented and technically and administratively feasible. The groundwater and surface sampling locations have already been established and waste materials (purge water) would be containerized and disposed of offsite in compliance with hazardous waste requirements. However, vegetation control for access to these locations would be required annually to facilitate sampling and inspection events. USACE will be responsible for inspection and maintenance of the signs. Because USACE does not own the land, sampling and inspection are dependent upon site access. Site access requests are at the discretion of the land owner through an executed access agreement. If the alternative is selected, USACE would attempt to negotiate a perpetual access agreement with VA prior to the Decision Document. A LUC would be managed through a LUCIP and periodic inspections. The VA would be responsible for enforcing the LUC in place at the time of the Decision Document. USACE would review the effectiveness of the LUC during CERCLA 5 year reviews. Therefore, this alternative is technically and feasibly implementable pending an executed access agreement.

Cost – The capital cost is approximately $50,266 and the present value for 30 years is $784,603. (This cost estimate is budgetary in nature and as such is suitable for feasibility and budget planning only.)

4.2.3 Alternative 3: Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management

Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) combines consolidation of surface soil/waste from areas maintained by the VA and spread within low areas of the landfill, and construction of a soil cover over the surface soil/waste materials. The soil cover would not be constructed over sediment/waste or the wetland pond. Onsite materials would be used to the maximum extent possible to establish closure grades for the Site. Long-term management would be included in this alternative. Finally, a LUC would be implemented to restrict the future use of the Site, restrict the use of the groundwater/leachate beneath the limits of the waste, and prevent intrusive activities on the soil cover. Portions of the Site would be regraded to help prevent the ponding of water in outside areas of the wetland pond. This alternative is expected to reduce the footprint of the waste and reduce the potential for site personnel and site visitors from coming into direct contact with waste material.

For cost estimating purposes, the Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management)components include the following:

- The section of the Site where wastes are present beneath areas maintained by the VA would be excavated and consolidated within the limits of the waste. At this stage, it has been estimated that approximately 2 acres will be consolidated. Keeping a conservative margin of 50% to account for workspace required during construction, and staging piles, the total area identified for clearing and grubbing is approximately 10.6 acres.
- Sustainable use options would be developed for the cleared vegetation.
- Excavated waste would be consolidated within the limits of the waste and covered. The area of the proposed cover is approximately 10.6 acres; however, the extent of soil cover could be limited to the area of consolidation. The area of the cover is an estimate, and actual area would be determined during the soil cover design. Based on current information, the area of the cover will not be extended into the approximately 5 acres of the wetland. Removing portions of the waste in areas maintained by the VA will require ditch restoration on each side of the Fort Custer Drive to improve surface water drainage while maintaining structural integrity of the road, landfill slope and future soil cover.
- The assumed average depth of excavation during consolidation of wastes would be approximately 4 feet. The assumed average depth is based on the observations made during the test pitting activities conducted for the 2012 SI (PE, 2016). The depth of waste in the consolidation areas were between the ground surface and 6 feet. The excavated material would be brought within the landfill cover area.
- In preparation for soil cover, the surface of the landfill will be roughly graded, as appropriate for surface drainage.
- A soil cover would be constructed, consisting of at least a 12-inch-thick native soil cover, overlain by 6 inches of topsoil. Seeding, mulching (1 inch thick), and watering of cover area also would be completed.
- Due to the limited extent of soil cover, lack of proposed construction in the area of the Site in the VA's management plan, and unlikely generation of landfill gas based on the age of the landfill, design and installation of vents to prevent accumulation of landfill gases is not anticipated.
- Long-term O&M measures also would be implemented to ensure the protectiveness of the soil cover.

- Surface water drainage would be addressed through the construction of drainage swales along the Fort Custer Drive in the areas of excavation. There is no surface water outlet for the wetland; therefore, potential downstream impacts are not applicable.
- Monitoring would be conducted quarterly for 3 years and then semiannually for additional 2 years. It is assumed that the groundwater would be monitored quinquennially after that for the next 25 years. Samples would be tested for VOCs, SVOCs, and Michigan 10 Metals plus boron.
- Maintenance of the soil cover (mowing) to prevent tree growth on the cover would be required.
- A LUC would be implemented.

This remedial technology consists of periodic sampling of the nine boundary wells to assess potential migration of contamination downgradient of the waste. The final monitoring program would be documented in the long-term management plan. This alternative would also include a LUC described in Section 3.1 in addition to warning signs. Vegetation clearing will be required to facilitate installation of the soil cover.

Overall protectiveness of human health and the environment – No COCs were identified in surface soil/waste, sediment/waste, and groundwater downgradient of the waste based on results of the baseline HHRA and ERA. Potential risks from exposure to subsurface soil/waste, groundwater/leachate, and ACM were not quantified per the presumptive remedy guidance. A soil cover will minimize direct exposure to underlying subsurface soil/waste. Consolidation of waste from the southern extent of the waste limits at Fort Custer Drive will eliminate potential exposure to subsurface soil/waste during subsurface activities by maintenance workers. Potential future subsurface soil/waste exposure would be managed through inspections concurrent with monitoring of groundwater downgradient of the waste. Therefore, this alternative is protective of human health and the environment.

Compliance with ARARs – Remedial actions would not occur within the surface water body and actions would be taken to avoid adverse impact to the water body in accordance with 40 CFR 230.10(a), (c), and (d). Because the Site can serve as migratory bird habitat seasonally, construction during non-nesting season or migratory bird inspections would be required during implementation of the remedial action to ensure compliance with the Migratory Bird Treaty Act. A hillside dump (RAI-7) along the edge of a marsh is identified as an historic period site in the Archaeological Literature Search and Cultural Resource Survey, Fort Custer National Cemetery, Michigan (Veterans Affairs, November 29, 1982). There is the potential for undisturbed land to be excavated; however, inspections would be performed and recovered artifacts preserved as required pursuant to the act and its implementing regulations. Therefore, this alternative does comply with the potential ARARs.

Long-term effectiveness and permanence – No COCs were identified at concentrations greater than those established for acceptable risk in surface soil/waste, sediment/waste, and groundwater downgradient of the waste based on results of the baseline HHRA and ERA. Installation of a soil cover would reduce contact with waste material but would require ongoing maintenance to establish and maintain vegetation. However, natural processes may expose the buried waste. Buried wastes that become exposed would be identified by the periodic and post-storm inspections and subsequently mitigated. Landfill soil covers are a reliable and proven technology. The effectiveness of the soil cover would depend on inspection and maintenance. Because USACE does not own the land, inspection and maintenance are dependent on site access. Site access requests are at the discretion of the land owner through an executed access agreement. If the alternative is selected, USACE would attempt to negotiate a perpetual access agreement with VA prior to the Decision Document. This alternative is expected to maintain reliable protection of human health and the environment over time, once remedial goals have been met.

Reduction of toxicity, mobility, and volume of contaminants through treatment – The volume of waste would not be reduced; however, the overall footprint of the waste limits would be reduced. Consolidation may result in greater reduction in potential exposure to buried waste because waste would be removed from areas more likely to have potential exposures, such as near the road and maintenance area. Although the soil cover may reduce the migration of contaminants to surface soil/waste, subsurface soil/waste, and groundwater/leachate, the sediment/waste in the wetland pond would not be covered and the disturbance of waste during consolidation activities may mobilize chemicals that were originally immobile. Therefore, this alternative does not reduce migration of contaminants to surface water or groundwater/leachate under the pond.

Short-term effectiveness – Dust generation, increased noise levels, and increased truck traffic may have a small impact on the surrounding community (site workers and site visitors). Construction would introduce some environmental impacts. These impacts would be from the production and use of fuel for the heavy equipment, the disturbance of soil, destruction of wetland habitat and natural resources, and dust generation. Monitoring would represent an environmentally sustainable remedial alternative; however, the environmental impacts from Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) would not comply with the owner preference for natural green space within the facility. The consolidation and soil cover (remedial action construction) sustainability footprint for Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) is significantly larger than the long-term management footprint for Alternative 2 (Land Use Controls with Long-term Management), primarily from equipment use and material production: fill and topsoil from a borrow pit. Transportation is the largest sustainability contributor to the greenhouse gas and energy footprints for the long-term management component. The required land disturbance for consolidation and cover activities and required disturbance to develop adequate staging would adversely impact the ongoing activities at Fort Custer National Cemetery.

Implementability – Soil cover is an easily implemented technology that has been done at many other locations and proven to work; however, Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management). The groundwater and surface sampling locations have already been established and waste materials (purge water) would be containerized and disposed of offsite in compliance with hazardous waste requirements. Vegetation maintenance of these locations would be required annually to facilitate sampling events. However, placement of a landfill cover over the waste materials in the wetland is technically impracticable. This alternative would involve land disturbance during vegetation clearing to facilitate consolidation and construction of the soil cover, access to monitoring wells, land disturbance during consolidation activities, generation non-hazardous waste, and potential impact to wetland habitat and cultural and natural resources. A LUC would be managed through a LUCIP and periodic inspections. The VA would be responsible for enforcing the LUC in place at the time of the Decision Document. USACE will be responsible for inspecting and maintaining the soil cover. Because USACE does not own the land, inspection and maintenance are dependent on site access. Site access requests are at the discretion of the land owner through an executed access agreement. If the alternative is selected, USACE would attempt to negotiate a perpetual access agreement with VA prior to the Decision Document. USACE would review the effectiveness of the LUC during CERCLA 5 year reviews. Therefore, this alternative is technically and feasibly implementable pending an executed access agreement.

Cost – The capital cost is $2,497,550 and the present value for 30 years is $3,136,218. (This cost estimate is budgetary in nature and as such is suitable for feasibility and budget planning only.)

4.3 Comparative Analysis of Remedial Alternatives

A comparative analysis of the remedial alternatives allows evaluation of how well each alternative satisfies the seven evaluation criteria described above (excluding the modifying criteria, which would be evaluated as part of the public comment period). Table 4-1 presents the analysis of how well each alternative achieves (or does not) the RAOs and the seven criteria, based on professional judgment. This approach is intended to compare the alternatives and to select the most appropriate alternative for implementation as a remedial action.

4.3.1.1 Protection of Human Health and the Environment

The nature of human receptors and exposure pathway to subsurface soil/waste and groundwater/leachate is presented in Section 1.6.

Based on current and reasonably foreseeable future site conditions, potential exposure to subsurface soil/waste is likely for current and future site workers for maintenance activities that involve disturbances within the waste limits, construction for subsurface utilities and/or roadway or burial ground expansion, and via natural mechanisms such as the uprooting of trees, for example. The potential for exposure to subsurface soil/waste is higher in the area immediately north and south of Fort Custer Drive that is currently grass-covered and mowed (maintained) by the VA. Therefore, exposure to subsurface soil/waste is possible based on current and reasonably foreseeable future site conditions. Workers could also be exposed to groundwater from within the waste limits if an irrigation or drinking water well were installed. Currently, there are no restrictions in place to prevent the installation of an irrigation or water well within the limits of the waste within groundwater/leachate.

Alternatives 2 and 3 are protective of human health and the environment. Alternative 2 (Land Use Controls with Monitoring) prevents direct exposure to underlying subsurface soil/waste through the existing soil cover with well-established vegetation across the landfill, including the wetlands and inspections and complies functionality of the landfill cap within the presumptive remedy. Alternative 2 prevents direct exposure because of the signage and modification of the VA's master plan restricting groundwater use and surface disturbance (ICs) to preserve the existing soil cover and make the alternative protective. Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) includes consolidation to reduce the landfill footprint and construction of a soil cover and, therefore, minimizes direct exposure to underlying subsurface soil/waste during subsurface activities by maintenance workers. Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) would result in potential impact to wetland habitat and natural resources. Under Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management), ecological receptors may be impacted from construction activities near the wetland; however, these activities would be temporary and the ecological habitats, although of low quality, are expected to recover. Alternative 1 (No Action) would not protect human health and the environment because no action would be taken to mitigate potential risks.

4.3.1.2 Compliance with ARARs

Alternative 1 (No Action) and Alternative 2 (Land Use Controls with Long-term Management) would comply with potential ARARs. Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) also would comply with potential ARARs. Compliance with potential ARARs for Alternatives 2 and 3 would depend on continued implementation and enforcement of a LUC and long-term landfill management.

4.3.1.3 Long-Term Effectiveness and Permanence

Alternatives 2 and 3 are expected to maintain reliable protection of human health and environment over time as long as the land use controls remain in effect and are enforced and maintained. Alternative 1 (No Action) would not meet this criterion because no action would be taken.

4.3.1.4 Reduction in Toxicity, Mobility, and Volume through Treatment

None of the alternatives would reduce the toxicity, mobility, or volume of contaminants through treatment. Treatment is not associated with any of the alternatives. Under Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management), consolidation would reduce the footprint of the waste and soil cover would reduce the migration of contaminants to groundwater/leachate. The benefits would be offset in that the sediment/waste in the wetland pond would not be covered in Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) and the alternative may mobilize chemicals that were originally immobile, and therefore, there is no reduction in migration of contaminants to groundwater/leachate under the pond. Alternative 2 (Land Use Controls with Long-term Management) has a lower overall sustainability footprint in all categories because Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) contains all components of Alternative 2 (Land Use Controls with Long-term Management) with the addition of the waste consolidation and soil cover.

4.3.1.5 Short-Term Effectiveness

Alternative 1 (No Action) has no short-term risks to the remediation workers or to Site visitors because no activities would be planned under this alternative. The short-term risks associated with the vegetation clearing and sign posts installation activities under Alternatives 2 would be minimized by implementing appropriate health and safety procedures and other pollution prevention procedures. Short-term disruptions would be greater in

Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) from the heavy equipment operations, such as increased traffic of construction trucks in and out of the Site, increased noise levels, destruction of natural resources, and dust generation from the heavy equipment during consolidation, regrading, and soil cover construction. These disruptions would be minimized through a proper planning for traffic routing and scheduling, soil erosion and sediment controls implementation, and periodic dust suppression. Additionally, the soil cover would require more maintenance and may be less stable than the existing vegetation cover until the cover is established.

4.3.1.6 Implementability

Implementability is high for Alternative 1 (No Action) because no action would be implemented. The technologies in both Alternatives 2 and 3 are readily implementable because they are well accepted and conventional, and they have been used successfully at numerous other landfill sites in Michigan and across the country. However, Alternative 2 (Land Use Controls with Long-term Management) would be easier to implement than Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) because of the relative ease of installing sign posts and signs compared with construction and compaction of the soil cover materials. Additionally, Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) would require permits. Overall, Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) would not be as easily implemented as Alternative 2 (Land Use Controls with Long-term Management), but a soil cover could be engineered at the Site.

4.3.1.7 Cost

As shown in Table 4-1, with the exception of Alternative 1 (No Action), Alternative 2 (Land Use Controls with Long-term Management) is the most cost-efficient alternative.

4.3.1.8 State Acceptance

Alternative 1 (No Action) is not acceptable because it does not meet the threshold criteria. Assessment of EGLE acceptance of Alternatives 2 (Long-term Management and Land Use Controls) and 3 (Consolidation, Construction of a Soil Cover, Long-Term Management, and Land Use Controls will be fully addressed after receiving comments from the regulatory agency.

4.3.1.9 Community Acceptance

Assessment of community and stakeholder (VA) acceptance will be fully addressed in the Decision Document after receiving comments on the Proposed Plan.

Summary

The objective of the FFS was to develop and evaluate remedial alternatives to address potential risk to human health and to meet potential ARARs. As part of the evaluation, location-, action-, and chemical-specific potential ARARs were evaluated to develop remedial alternatives. The following RAO was established, based on regulatory requirements, standards, and guidance:

- Protect human receptors from direct contact, ingestion, inhalation exposure to subsurface soil/waste by eliminating exposure pathways and contaminant migration to groundwater and surface water.

Buried waste in surface soil/waste, subsurface soil/waste, and sediment/waste remains present at the Site, and risks associated with subsurface soil/waste, groundwater/leachate underneath the waste, and ACM were not quantitatively evaluated. A containment presumptive remedy application to municipal landfills is considered appropriate for the Site, and this FFS was completed.

Remedial alternatives were developed from the array of containment presumptive remedy components and then evaluated using the seven NCP evaluation criteria, and compared in terms of ability to satisfy the criteria:

- Alternative 1—No Action
- Alternative 2—Land Use Controls with Long-term Management
- Alternative 3—Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management

The No Action Alternative (Alternative 1) was included in accordance with the NCP. Alternative 2 (Land Use Controls with Long-term Management) is the least-cost remedy that is effective in preventing exposure to waste material. Alternative 2 (Land Use Controls with Long-term Management) meets the RAO by relying upon the existing soil cover with well-established vegetation and the establishment of a LUC with long-term management for the Site, which complies with the presumptive remedy guidance. Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) meets the RAO by consolidating waste, constructing a soil cover over upland areas, implementing land use controls, and long-term management. Although Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) may offer greater reduction in potential exposure to buried waste within upland areas of the Site, the benefits are offset in that construction of a soil cover would have a higher sustainability footprint, would adversely affect wetland habitat and natural resources, and may mobilize chemicals that were originally immobile. Additionally, the cost of Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) is nearly four times the cost of Alternative 2 (Land Use Controls with Long-term Management). Recommendations on the preferred remedial alternative will be made in the Proposed Plan. A Decision Document will be drafted after receiving and addressing public comments on the Proposed Plan. The Decision Document will summarize the RI results, present the remedial alternatives evaluated in the FFS, and describe the selected remedy.

State acceptance was achieved through comment resolution from the State regulators on this FFS. Community acceptance will be evaluated in the Proposed Plan process through a public review and comment period. The preferred alternative will be presented in the Proposed Plan, with the remedy selected and formally documented in a Record of Decision.

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Tables

Table 1-1. Chronology of Investigations at the Site

Former Fort Custer VA Area, Post Cemetery Dump, Augusta, Kalamazoo County, Michigan

Archives Search Report (USACE, 1994)
U.S. Army Corps of Engineers (USACE) identified the Site as an area of interest in the 1994 Archive Search Report. An addendum was prepared in 2003 to address the possibility of munitions and explosives of concern.
1997 Site Investigation (Parsons, 1997)
Parsons Engineering Science, Inc. (Parsons) performed a SI at the Site. The investigation consisted of sampling 25 borings for soil and groundwater/leachate; one surface water and one sediment sample from the wetland were collected. Soil samples collected from the borings were field-screened for lead. Waste/soil, groundwater/leachate, surface water, and sediment samples were collected for laboratory analysis of metals, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). The investigation identified metals concentrations in waste/soil and groundwater/ leachate exceeding Michigan Department of Environmental Quality's residential and non-residential cleanup criteria, formerly referred to as Part 201 cleanup criteria. (The Part 201 Cleanup Criteria Rules were rescinded on December 31, 2013. Taking their place are new cleanup criteria rules, numbered from 299.1 to 299.50, which became effective on December 30, 2013.) No other analytes exceeded screening criteria for any of the samples analyzed. This investigation also included some limited visual characterization of the waste present at the Site including slag, cinder, and glass.
2009 Preliminary Assessment (MWH, 2009)
Montgomery Watson Harza (MWH) performed a PA at the Site. Investigation activities included reviewing historical information and documents, conducting interviews and reconnaissance activities, and evaluating exposure pathways. MWH concluded the potential for contamination from buried waste and past releases to have impacted the Site, which may warrant further investigation.
2010 Site Investigation (CH2M, 2009)
CH2M conducted a limited-scope SI to re-establish baseline conditions at the Site (CH2M, 2009). Five temporary wells within the limits of the waste were sampled and five surface water samples were collected from the wetland. The samples were analyzed for Michigan 10 metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc), boron, VOCs, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs). Metals in surface water and groundwater/leachate were detected in exceedance of legacy Part 299 residential and non-residential screening criteria. No other analytes exceeded screening criteria for any sample analyzed.
2012 Site Investigation (PE, 2016)
Professional Environmental Engineers, Inc. (PE) conducted an expanded SI to document the vertical and horizontal extents of waste, characterize surface materials within the limits of waste, document contamination against target levels, and monitor groundwater at the Site. The media investigated included surface soil/waste, sediment/waste, and groundwater outside the limits of the waste. Soil/waste and sediment/waste samples were collected using an incremental sampling method (ISM) over two separate decision units. ISM samples were analyzed for SVOCs, metals, boron, dioxin/furans, and PCBs. Three ISM soil samples also were submitted for asbestos analysis. Nine permanent groundwater monitoring wells were installed during the investigation. Groundwater samples were collected over eight events and analyzed for VOCs, SVOCs, and metals plus boron (both total and dissolved). Suspected ACM was submitted for analysis of asbestos. The investigation indicated that the vertical and horizontal extents of the waste were greater than previously defined (about 1,200 feet long [north to south] and 300 feet [north] to 640 feet wide [south]). The waste also was found to contain ACM at the surface, with the potential for additional ACM in the subsurface. In addition, surface soil/waste and sediment/waste samples from the Site contained metals exceeding legacy Part 299 residential and non-residential drinking water protection, groundwater surface water interface protection, residential direct contact (2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD] exceeded non-residential direct contact criteria also), and/or residential soil particulate inhalation criteria. Chemicals exceeding one or more of the above listed criteria include arsenic, boron, chromium, lead, manganese, mercury, selenium, silver, zinc, 2,3,7,8-TCDD, and 2-methylnaphthalene. Groundwater/leachate samples collected at several downgradient wells (FCMW-4I and FCMW-6I) contained concentrations of cadmium and/or chromium that exceeded legacy Part 201 drinking water and generic groundwater-surface water interface criteria. Total chromium values were compared to hexavalent chromium criteria, which are more conservative (lower criteria) than criteria for total chromium or trivalent chromium. Exceedances of these Michigan 10 metals were not observed in any of the three background wells located up- or cross-gradient from the Site. Results of the investigation were presented in the 2012 SI report (PE, 2016).

Table 1-1. Chronology of Investigations at the Site

Former Fort Custer VA Area, Post Cemetery Dump, Augusta, Kalamazoo County, Michigan

2016 Remedial Investigation (CH2M, 2019)
Based on the size of the landfill, the presence of municipal and non-military wastes, distribution, and nature of the wastes, it was concluded that the presumptive remedy is appropriate for the Site, and that additional characterization of the landfill contents was not required. However, contamination beyond the limits of the landfill source needed to be characterized and potential risks evaluated. Therefore, the 2016 RI employed a site-specific approach to site characterization downgradient of the waste rather than characterizing the nature and extent of all contamination in the landfill. The RI focused on characterizing surface water conditions in the wetlands area and potential groundwater impacts downgradient of the waste limits. The human health risk assessment (HHRA) identified no Site-related chemicals of concern in in surface soil/waste, sediment/waste, surface water, and downgradient groundwater, and no ecological risk (that is, no chemicals of ecological concern) was identified with respect to biota in the upland forested area and the wetland area within the Site. Risks associated with subsurface soil/waste and groundwater/leachate within the waste were not quantitatively evaluated in accordance with the presumptive remedy approach.

Table 1-2. Summary of Potential Chemicals of Concern Greater than Screening Criteria

Former Fort Custer VA Area, Post Cemetery Dump, Augusta, Kalamazoo County, Michigan

Media	Potential Chemical of Concern Greater than Screening Criteria
Surface Soil/Waste (Decision Unit 1)	Asbestos-containing material (ACM), boron, cadmium, chromium, lead mercury, and zinc
Subsurface Soil/Waste	Arsenic
Sediment/Waste (Decision Unit 2)	ACM, boron, selenium, zinc, and 2,3,7,8-tetrachlorodibenzo-p-dioxin
Groundwater/Leachate (Within the Limits of the Waste)	Benzo(b)fluoranthene and indeno(1,2,3-c,d)pyrene, arsenic, boron, cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc[1]
Surface Water	Benzo(b)fluoranthene, benzo(g,h,i)perylene, 1,2,3,4,6,7,8-Heptachlorodibenzofuran, 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin, heptachlorinated dibenzofurans (total), heptachlorinated dibenzo-p-dioxins (total), octachlorodibenzo-p-dioxin, arsenic, barium, boron, cadmium, copper, lead, manganese, mercury, silver, and zinc[2]
Groundwater (Outside the Limits of the Waste)	Arsenic and cadmium[3]

Notes:

1. The semivolatile organic compound analytes detected in groundwater/leachate samples all have very low solubilities and may be attributed to their adsorption to colloidal suspended solids.
2. Detections of dioxins/furans in July 2016 are expected to be a result suspension of sediment particles in the surface water body.
3. Reported concentrations for arsenic and cadmium in groundwater during the 2016 Remedial Investigation (RI) were less than the maximum concentration reported for those chemicals in Kalamazoo County groundwater. Additionally, 2016 RI groundwater data were compared to statewide background groundwater concentrations presented in a Michigan Department of Natural Resources and U.S. Geological Survey report (Dumouchelle et al., 1987). The 90th percentile metals statewide background concentrations for arsenic and cadmium were higher than the maximum 2016 RI groundwater detection. Therefore, concentrations of arsenic and cadmium in groundwater outside the limits of the waste are not attributed to migration of groundwater/leachate from within the limits of the waste.

Table 2-1. Federal Potential Applicable or Relevant and Appropriate Requirements for Remedial Action Alternatives

Former Fort Custer VA Area, Post Cemetery Dump, Augusta, Kalamazoo County, Michigan

Requirement	Requirement Synopsis
Location-Specific ARARs	
Federal	
Clean Water Act Section 404(b)(1) **40 CFR 230.10(a), (c), and (d) - Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, Restrictions on Discharge**	Except as provided under Section 404(b)(2) of the Clean Water Act, no discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternative that would have less adverse impact. Actions must be taken to avoid adverse impacts during dredge or fill activities in surface waters of the U.S., including wetlands under the U.S. Army Corps of Engineers (USACE) jurisdiction. Specifically, these regulations require that the discharge represent the least damaging, practicable alternative; that discharge of dredged material not result in significant degradation of the aquatic ecosystem; and that all practicable means be utilized to minimize adverse environmental impacts. This Act may be an ARAR if the remedies will result in dredge or fill activities in waters of the U.S.
Migratory Bird Treaty Act (16 U.S.C. 703(a))	The taking of any native species of wild bird is prohibited. The Act is an ARAR if migratory birds are present during the remedial actions.
Archeological Resources Protection Act (16 U.S.C. 470ee(a)	Establishes procedures to provide for preservation of scientific, historical, and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. If scientific, historical, or archaeological artifacts are discovered at the site, work in the area of the site affected by such discovery will be halted pending the completion of any data recovery and preservation activities required pursuant to the act and its implementing regulations. This Act is an ARAR during the remedial activities if scientific, historic, or archaeological artifacts are identified during implementation of a remedy.
Action-Specific ARARs	
Federal	
Standards Applicable to Generators of Hazardous Waste **40 CFR 262.11(a), (b), and (d)**	Requirement to determine if a solid waste is hazardous is applicable to solid waste, including environmental media, generated during the remedial action.
Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities **40 CFR 265, Subpart I Use and Management of Containers**	Management requirements for the temporary storage of hazardous waste in containers. These rules are ARARs for remedies that generate hazardous waste that will be stored onsite in container.
National Emissions Standards for Asbestos **40 CFR 61.145(c)(6)(i) and 40 CFR 150(a)(1)**	Measures for controlling asbestos emissions by adequate wetting and proper packaging and handling of asbestos-containing material to prevent asbestos fibers from becoming airborne during excavation, land disturbance, or waste handling activities.
Construction and Development Effluent Guidelines **40 CFR 450.21**	Requirements for implementing erosion and sediment control and other best management practices, and effluent limitations that are are relevant and appropriate to remedies that involve disturbing one or more acres of land.

Table 4-1. Comparative Analysis of Alternatives

Former Fort Custer VA Area, Post Cemetery Dump, Augusta, Kalamazoo County, Michigan

Criteria	Alternative 1: No Action	Alternative 2: Land Use Controls with Long-term Management	Alternative 3: Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management
Overall Protection of Human Health and the Environment	■	⦿	⦿
Compliance with Applicable or Relevant and Appropriate Requirements	⦿	⦿[1]	⦿[1]
Long-Term Effectiveness and Permanence	■	⦿	⦿
Reduction of Toxicity, Mobility or Volume Through Treatment	■	○	○
Short-Term Effectiveness	○	**O**	○
Implementability	⦿	⦿	⦿
Cost[2]	$0(2)	$784,603(2)	$3,136,218(2)
State/Support Agency Acceptance	○	⦿	⦿
Community Acceptance[3]	TBD	TBD	TBD

Ranking:

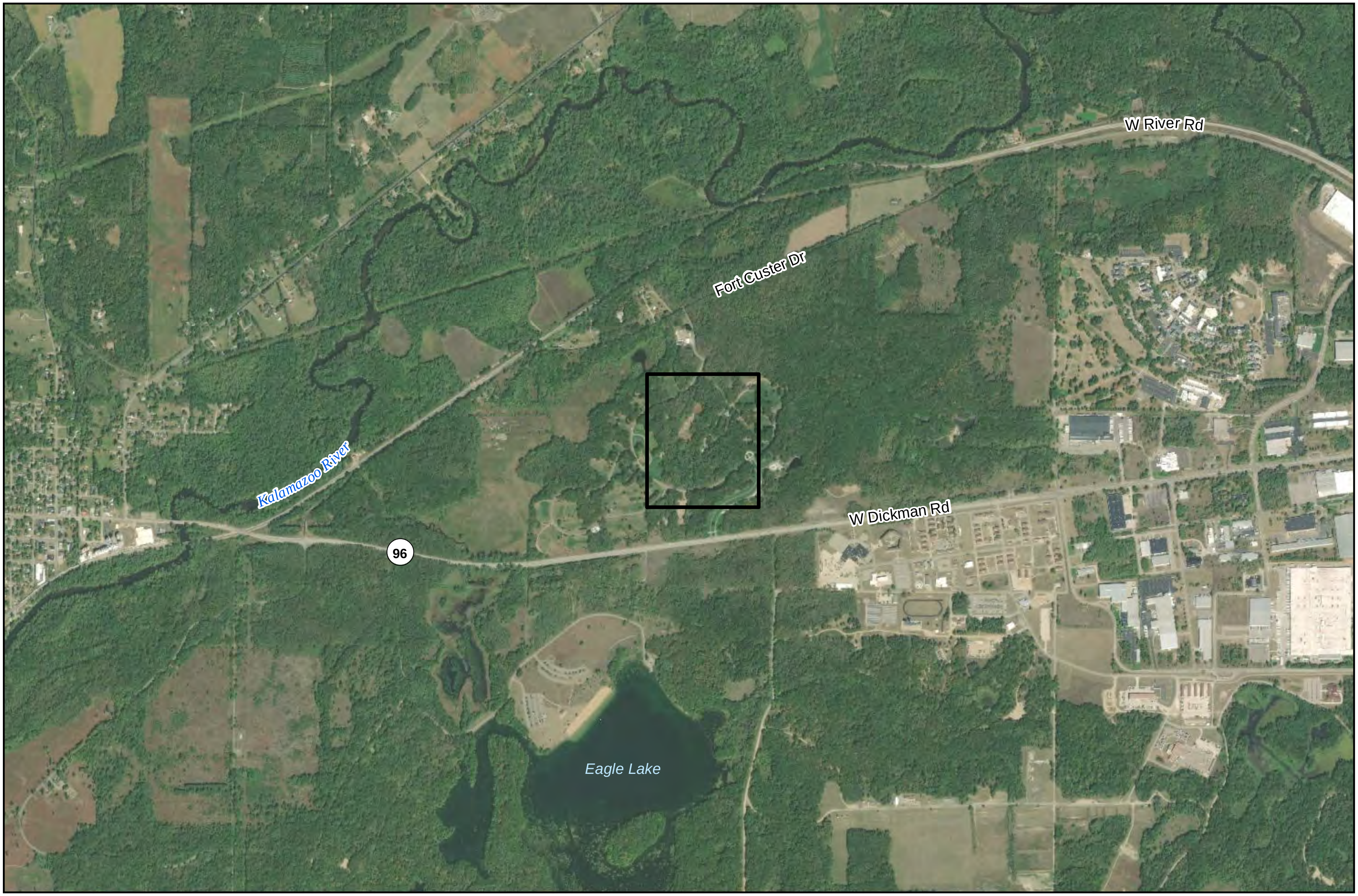
⦿ Well satisfies criterion **O** Moderately satisfies criterion ○ Poorly satisfies criterion ■ Does not meet criterion

[1] There are no chemical-specific ARARs.

[2] Cost is the total present-worth value; cost accuracy ranges from -30% to +50%.

[3] To be determined during public comment period

Figures



Legend

Approximate Site Location

Figure 1-1
Site Location Map
Post Cemetery Dump
Fort Custer VA Area
Kalamazoo County, MI

Aerial Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community (September 23, 2017).

R:\ENBG\00_Proj\U\USACE\Ft_Custer\MapFiles\2018\RI\Figure 1-1_Site Location Map.mxd AESPEJO 9/4/2018

Legend

- Staff Gauge Monitoring Location
- Approximate Extent of Waste (Dashed Where Inferred)

N

0 100 200 400
Feet

Figure 1-2
Fort Custer National Cemetery Layout
Post Cemetery Dump
Fort Custer VA Area
Kalamazoo County, MI

Aerial Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community (September 23, 2017).

R:\ENBG\00_Proj\U\USACE\Ft_Custer\MapFiles\2018\RI\Figure 1-2_Fort Custer National Cemetery Layout.mxd AESPEJO 9/4/2018

ch2m

Figure 1-3
Fill Thickness Map
Post Cemetery Dump
Fort Custer VA Area K
alamazoo County, MI

Aerial Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community (September 23, 2017).

R:\ENBG\00_Proj\U\USACE\Ft_Custer\MapFiles\2018\RI\Figure 05_Fill Thickness Map.mxd AESPEJO 8/20/2018

ch2m

Drawing Source: Veterans Affairs Administration, February 2019

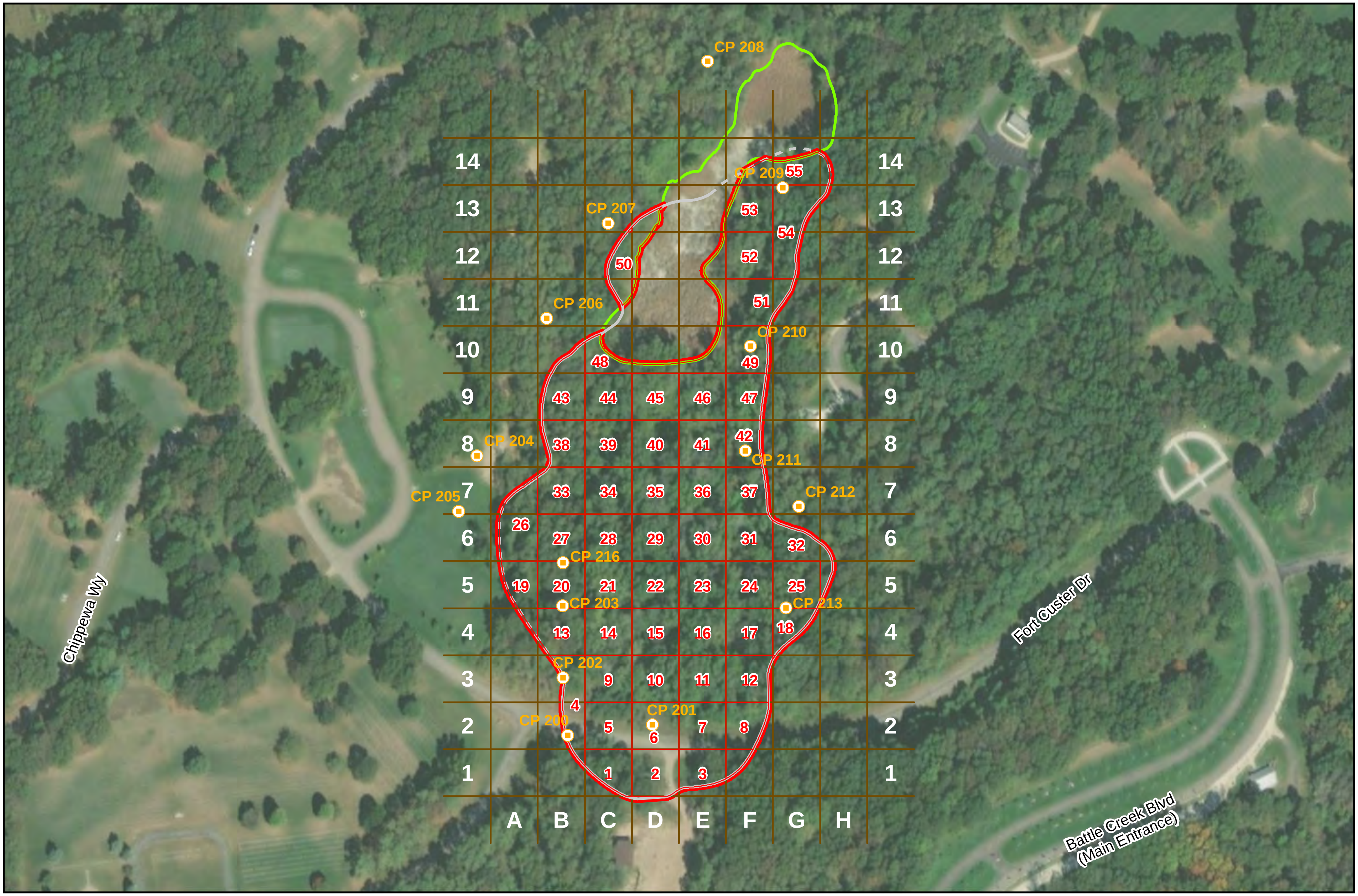
N

0 250 500 1000

Feet

Figure 1-4
FCNC Master Plan
Post Cemetery Dump
Fort Custer VA Area
Kalamazoo County, MI

ch2m



Legend

- Control Point Location
- ISM Grid Line
- ISM Grid Line (Within Decision Unit)
- Extent of Dump Material (Dashed Where Inferred) (Decision Unit 1 Total Area = 404,941.5 Sqft)
- Wetland Area

N

0 62.5 125 250
Feet

Figure 1-5
Decision Unit 1 Surface of Waste Sample Grid
Post Cemetery Dump
Fort Custer VA Area
Kalamazoo County, MI

Aerial Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community (September 23, 2017).

\\Brooksidefiles\gis_share2\ENBG\00_Proj\U\USACE\Ft_Custer\MapFiles\2019\FS\Figure 1-5_DU1 Surface of Waste Sample Grid.mxd AESPEJO 4/3/2019

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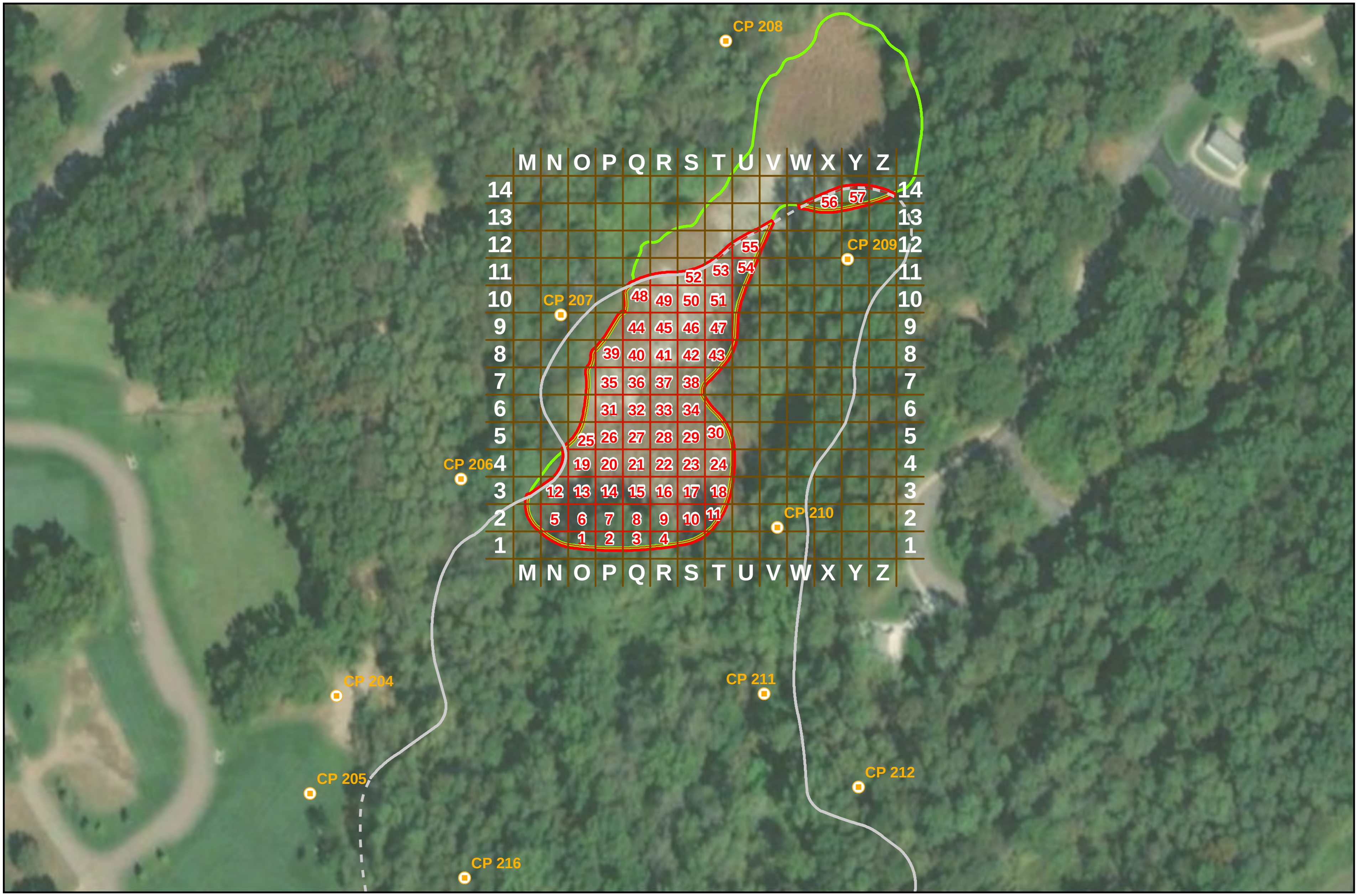


Legend

- Control Point Location
- ISM Grid Line
- ISM Grid Line (Within Decision Unit)
- Extent of Dump Material (Dashed Where Inferred)
- Wetland Area (Decision Unit 2 Total Area = 50,445 Sqft)

N

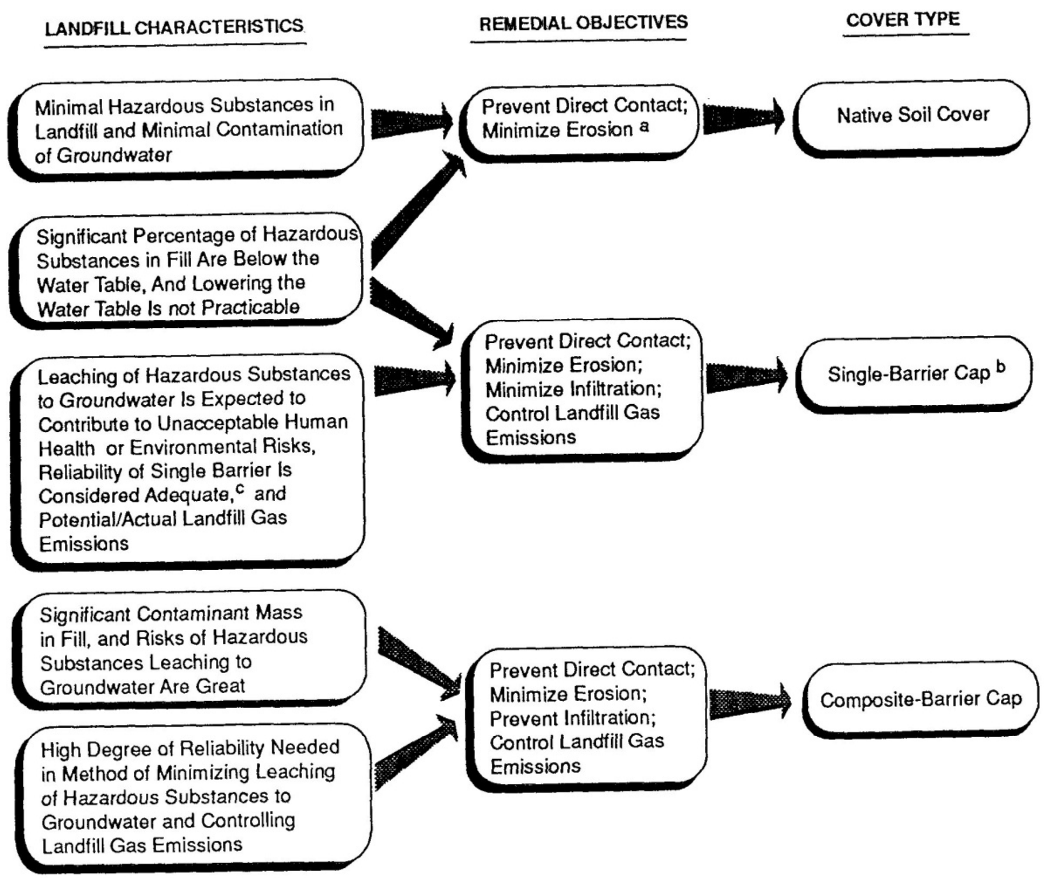
0 37.5 75 150
Feet

Figure 1-6
Decision Unit 2 Surface of Waste Sample Grid
Post Cemetery Dump
Fort Custer VA Area
Kalamazoo County, MI

Aerial Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community (September 23, 2017).

\\Brooksidefiles\gis_share2\ENBG\00_Proj\U\USACE\Ft_Custer\MapFiles\2019\FS\Figure 1-6_DU2 Surface of Waste Sample Grid.mxd AESPEJO 4/3/2019

ch2m



[a] Primary objective is to prevent direct contact, although the soil cover can be designed to reduce infiltration.

[b] Single-barrier caps may include additional layers that provide protection to that barrier.

[c] Examples include situations where infiltration is not the primary concern and may include sites containing a small volume of contaminant mass, regions with low annual precipitation, or sites where groundwater is not being used as a source of drinking water.

Figure 3-1

Landfill Cover Selection Guide

Source: *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991)

Legend

- 1997 SI Boring Location
- 2012 Boring Location

Trench Locations

- Waste Boundary Identified
- No Waste Material Present
- Waste Boundary Not Delineated
- 2012 Groundwater Monitoring Well
- Approximate Trench Length and Location
- Extent of Waste Material as Defined by PE's Trenches and Soil Borings (Dashed Where Inferred)
- 2 Approximate Fill Thickness Contour Line (in Feet) as Defined by Current/Previous Soil Borings
- Wetland Area (As Defined by Low Water Level in 2012)
- Soil Cover Area
- Soil Excavation Area
- >4 / 4.5 Thickness of Waste (in Feet)

N

0 62.5 125 250
Feet

Figure 3-2
Consolidation Soil Cover Map
Post Cemetery Dump
Fort Custer VA Area
Kalamazoo County, MI

Aerial Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community (September 23, 2017).

ch2m.

\\Brooksidefiles\gis_share2\ENBG\00_Proj\U\USACE\Ft_Custer\MapFiles\2019\FS\Figure 3-2_Consolidation Soil Cover Map.mxd AESPEJO 4/15/2019

Appendix A
Cost Estimate

Fort Custer Post Cemetery Dump		
Cost Type	**Alternative 2**	**Alternative 3**
	LTM with Land Use Controls	**Consolidation, Construction of a Soil Cover, Long-Term Management, and Institutional Controls**
Total Estimated Present Worth Costs		
Capital Cost	$50,266	$2,497,550
O&M Cost	$482,069	$343,108
Periodic Cost	$129,600	$129,600
Total Estimated Costs	$661,935	$2,970,258
Net Present Value	$784,603	$3,136,218
Estimated Range of Costs	From	From
-30%	$463,354	$2,079,181
	To	To
+50%	$992,902	$4,455,387

Fort Custer Post Cemetery Dump			**COST ESTIMATE SUMMARY**
Site:	Fort Custer Post Cemetery Dump	**Description:**	Alternative 2 Land Use Controls with Long-term Management
Location:	Augusta, Kalamazoo County, Michigan		
Base Year:	2019		
Date:	November 2019		

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Land Use Controls					
LUCIP	1	Each	$15,000	$15,000	
Sampling Plan	1	Each	$9,600	$9,600	
HASP	1	Each	$4,800	$4,800	
Install Warning Signs					Perimeter = 3,110 LF, signs installed at 50 ft spacing = 63 signs 2 days to install x 2 people
Technician	40	Hour	$95	$3,800	2 staff x 2 days
Travel Roundtrip	16	Hour	$95	$1,520	
Lodging	4	Day	$94	$376	
Meals	2	Day	$55	$110	
Travel Day Per Diem	4	Day	$41.25	$165	
Vehicle	3	Day	$100	$300	
Misc Field Supplies	2	Day	$150	$300	
Clear Post Alignment	1	LS	$5,000	$5,000	light clearing to allow sign post installation
Signs and Posts	63	EA	$75	$4,725	6' galv. U Channel Post + sign and hardware
SUBTOTAL				$45,696	
Project Management	10%		$45,696	$4,570	EPA 2000, p. 5-13, <$100K
Total Capital Costs				**$50,266**	

OPERATIONS AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Long Term Monitoring/Land Use Controls					
Quarterly Sampling					Years 1, 2, & 3 - 12 events total. Assume landfill inspection concurrent with sampling events
Technician	40	Hour	$95	$3,800	
Travel Roundtrip	32	Hour	$95	$3,040	
Lodging	4	Day	$94	$376	
Meals	0	Day	$55	$0	
Travel Day Per Diem	8	Day	$41.25	$330	
Vehicle	8	Day	$100	$800	
Analytical - Groundwater	4	LOT	$5,265	$21,060	MW's: VOCs, SVOCs, Michigan 10 Metals plus boron, (total and dissolved)
Sampling Supplies	4	Day	$100	$400	
Shipping Samples	4	Each	$125	$500	
Annual LTM/LUC Report	1	Each	$15,000	$15,000	
SUBTOTAL				$45,306	One Year
TOTAL - YEARS	**3**	**EA**	**$45,306**	**$135,918**	
Semi-Annual Sampling					Years 4 & 5 - 4 events total. Assume landfill inspection concurrent with sampling events
Technician	20	Hour	$95	$1,900	
Travel Roundtrip	16	Hour	$95	$1,520	
Lodging	2	Day	$94	$188	
Meals	0	Day	$55	$0	
Travel Day Per Diem	4	Day	$41.25	$165	
Vehicle	4	Day	$100	$400	
Analytical - Groundwater	2	LOT	$5,265	$10,530	MW's: VOCs, SVOCs, Michigan 10 Metals plus boron, (total and dissolved)
Sampling Supplies	2	Day	$100	$200	
Shipping Samples	2	Each	$125	$250	
Annual LTM/LUC Report	1	Each	$15,000	$15,000	
SUBTOTAL				$30,153	One Year
TOTAL - YEARS	**2**	**EA**	**$30,153**	**$60,306**	
Annual Sampling					Years 6 to 30 - 5 events total. Assume landfill inspection concurrent with sampling events
Technician	10	Hour	$95	$950	
Travel Roundtrip	8	Hour	$95	$760	
Lodging	1	Day	$94	$94	
Meals	0	Day	$55	$0	
Travel Day Per Diem	2	Day	$41.25	$83	
Vehicle	2	Day	$100	$200	
Analytical - Groundwater	1	LOT	$5,265	$5,265	MW's: VOCs, SVOCs, Michigan 10 Metals plus boron, (total and dissolved)
Sampling Supplies	1	Day	$100	$100	
Shipping Samples	1	Each	$125	$125	
Annual LTM/LUC Report	1	Each	$15,000	$15,000	
SUBTOTAL				$22,577	One Year
TOTAL - YEARS	**5**	**EA**	**$22,577**	**$112,883**	

Fort Custer Post Cemetery Dump							**COST ESTIMATE SUMMARY**
Site:	Fort Custer Post Cemetery Dump		**Description:**	Alternative 2 Land Use Controls with Long-term Management			
Location:	Augusta, Kalamazoo County, Michigan						
Base Year:	2019						
Date:	November 2019						
	Land Use Controls - Inspection after Storm Events						Assumed 2 additional inspections per year on average after storm event
	Technician		20	Hour	$95	$1,900	
	Travel Roundtrip		16	Hour	$95	$1,520	
	Lodging		2	Day	$94	$188	
	Meals		0	Day	$55	$0	
	Travel Day Per Diem		4	Day	$41.25	$165	
	Vehicle		4	Day	$100	$400	
		SUBTOTAL				$4,173	One Year
		TOTAL - YEARS	**30**	**EA**	**$4,173**	**$125,190**	
		TOTAL - 30 YEARS				**$434,297**	
	Project Management		6%		$434,297	$26,058	EPA 2000, p. 5-13, $500K - $2MM
	Contingency		5%		$434,297	$21,715	
Total Operating O&M Costs						**$482,069**	

PERIODIC COSTS - 5 YEAR REVIEW

DESCRIPTION		**QTY**	**UNIT**	**UNIT COST**	**TOTAL**	**NOTES**
5 Year Review Report		1	Each	$20,000	$20,000	
	SUBTOTAL				$20,000	One Year
	Total 5 Year Review	6	Year	$20,000	$120,000	
Project Management		8%		$120,000	$9,600	EPA 2000, p. 5-13, $100K - $500K
Total Periodic Costs					**$129,600**	

PRESENT VALUE ANALYSIS

Discount Rate = 2.6% Source: USEPA 2000, page 4-5. This rate represents a "real" discount rate approximating interest rates adjusted for inflation.

Fort Custer Post Cemetery Dump — COST ESTIMATE SUMMARY

Site: Fort Custer Post Cemetery Dump
Location: Augusta, Kalamazoo County, Michigan
Base Year: 2019
Date: November 2019
Description: Alternative 3 Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
1 Premobilization					
Contractor Submittals	1	LS	$15,000	$15,000	
Sampling Plan	1	Each	$9,600	$9,600	
HASP	1	Each	$4,800	$4,800	
SUBTOTAL				$29,400	
2 Mobilization/Demobilization					
Mobilization/Site Setup	1	LS	$32,000	$32,000	
Utility Locate	1	DY	$1,600	$1,600	
Surveying	40	DY	$2,200	$88,000	Layout, volume survey for payment, as builts
Quality Control	30	DY	$1,500	$45,000	
Temporary Erosion Controls	1	LS	$20,000	$20,000	
Demob/Site Cleanup	1	LS	$15,000	$15,000	
SUBTOTAL				$201,600	
3 Construct Cap					10.6 AC
Clear and Grub	10.6	AC	$12,000	$127,200	Heavy Clearing
Subgrade Preparation	51,304	SY	$2.00	$102,608	
Excavation	10,010	CY	$25.00	$250,250	60,050 sf x 4.5' bgs
Consolidation	10,010	CY	$15.00	$150,150	419,600 sf
Native Cover Soil (12")	17,101	CY	$22.00	$376,222	
Upper Vegetative Layer (6")	8,551	CY	$35.00	$299,285	
Seeding	10.6	AC	$3,500	$37,100	
Signs and Posts	63	EA	$145	$9,135	Install Signs and Posts
SUBTOTAL				$1,351,950	
4 Final Construction Completion Report					
Final Construction Completion Report	1	LS	$50,000	$50,000	
SUBTOTAL				$50,000	
TOTAL				**$1,632,950**	
Contingency	15%		$1,632,950	$244,900	Scope and bid contingency
TOTAL				**$1,877,850**	
Project Management	8%		$1,877,850	$150,200	EPA 2000, p. 5-13, $500K - $2MM
Remedial Design	15%		$1,877,850	$281,700	EPA 2000, p. 5-13, $500K - $2MM
Construction Management	10%		$1,877,850	$187,800	EPA 2000, p. 5-13, $500K - $2MM
Total Capital Costs				**$2,497,550**	

OPERATIONS AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Long Term Monitoring/Land Use Controls					
Quarterly Sampling					Years 1, 2, & 3 - 12 events total. Assume landfill inspection concurrent with sampling events
Technician	40	Hour	$95	$3,800	
Travel Roundtrip	32	Hour	$95	$3,040	
Lodging	4	Day	$94	$376	
Meals	0	Day	$55	$0	
Travel Day Per Diem	8	Day	$41.25	$330	
Vehicle	8	Day	$100	$800	
Analytical - Groundwater	4	LOT	$5,265	$21,060	MW's: VOCs, SVOCs, Michigan 10 Metals plus boron, (total and dissolved)
Sampling Supplies	4	Day	$100	$400	
Shipping Samples	4	Each	$125	$500	
Annual LTM/LUC Report	1	Each	$15,000	$15,000	
SUBTOTAL				$45,306	One Year
TOTAL - YEARS	**3**	**EA**	**$45,306**	**$135,918**	

Fort Custer Post Cemetery Dump **COST ESTIMATE SUMMARY**

Site: Fort Custer Post Cemetery Dump **Description:** Alternative 3 Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management
Location: Augusta, Kalamazoo County, Michigan
Base Year: 2019
Date: November 2019

Semi-Annual Sampling						Years 4 & 5 - 4 events total. Assume landfill inspection concurrent with sampling events
Technician		20	Hour	$95	$1,900	
Travel Roundtrip		16	Hour	$95	$1,520	
Lodging		2	Day	$94	$188	
Meals		0	Day	$55	$0	
Travel Day Per Diem		4	Day	$41.25	$165	
Vehicle		4	Day	$100	$400	
Analytical - Groundwater		2	LOT	$5,265	$10,530	MW's: VOCs, SVOCs, Michigan 10 Metals plus boron, (total and dissolved)
Sampling Supplies		2	Day	$100	$200	
Shipping Samples		2	Each	$125	$250	
Annual LTM/LUC Report		1	Each	$15,000	$15,000	
	SUBTOTAL				$30,153	One Year
	TOTAL - YEARS	**2**	**EA**	**$30,153**	**$60,306**	
Annual Sampling						Years 6 to 30 - 5 events total. Assume landfill inspection concurrent with sampling events
Technician		10	Hour	$95	$950	
Travel Roundtrip		8	Hour	$95	$760	
Lodging		1	Day	$94	$94	
Meals		0	Day	$55	$0	
Travel Day Per Diem		2	Day	$41.25	$83	
Vehicle		2	Day	$100	$200	
Analytical - Groundwater		1	LOT	$5,265	$5,265	MW's: VOCs, SVOCs, Michigan 10 Metals plus boron, (total and dissolved)
Sampling Supplies		1	Day	$100	$100	
Shipping Samples		1	Each	$125	$125	
Annual LTM/LUC Report		1	Each	$15,000	$15,000	
	SUBTOTAL				$22,577	One Year
	TOTAL - YEARS	**5**	**EA**	**$22,577**	**$112,883**	
	TOTAL - 30 YEARS				**$309,107**	
Project Management		6%		$309,107	$18,546	EPA 2000, p. 5-13, $500K - $2MM
Contingency		5%		$309,107	$15,455	
Total Operating O&M Costs					**$343,108**	

PERIODIC COSTS - 5 YEAR REVIEW

DESCRIPTION		**QTY**	**UNIT**	**UNIT COST**	**TOTAL**	**NOTES**
Groundwater Monitoring						9 wells: 3 days x 2 people
5 Year Review Report		1	Each	$20,000	$20,000	
	SUBTOTAL				$20,000	One Year
	Total 5 Year Review	6	Year	$20,000	$120,000	
Project Management		8%		$120,000	$9,600	EPA 2000, p. 5-13, $100K - $500K
Total Periodic Costs					**$129,600**	

PRESENT VALUE ANALYSIS

Discount Rate = 2.6% Source: USEPA 2000, page 4-5. This rate represents a "real" discount rate approximating interest rates adjusted for inflation.

Appendix B
Sustainability Evaluation

Sustainability Analysis for Fort Custer Veterans Affairs Area Post Cemetery Dump

Introduction

This appendix presents the approach taken and results obtained from a sustainability analysis performed for the former Fort Custer Post Cemetery Dump (the Site). A site description and history of the Site is provided within the Focused Feasibility Study (FFS) report. The following alternatives were developed to ensure that appropriate remedial alternatives are developed and evaluated with relevant information concerning the remedial action options to select an appropriate remedy at the Site. A detailed summary of the alternatives is provided in the FFS.

- Alternative 1 – No Action
- Alternative 2 – Land Use Controls with Long-term Management
- Alternative 3 – Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management

The purpose of this analysis is to provide a quantitative assessment of the potential environmental impact of each alternative. The sustainability analysis was performed using SiteWise Version 3.1 (Battelle, 2015) for Alternative 2 (Land Use Controls with Long-term Management) and Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management). Alternative 1 (No Action) does not include any action.

Method and Assumptions

The SiteWise tool consists of a series of Excel-based spreadsheets used to conduct a baseline assessment of sustainability metrics. The assessment is carried out using a spreadsheet-based building block approach, where every removal alternative can be broken down into components for discrete phases of work (such as construction, operation, long-term monitoring), or different systems for more complex removal actions.

SiteWise uses various emission factors from governmental or non-governmental research sources to determine the environmental impact of each activity. The quantitative metrics calculated by the tool include:

1) Greenhouse gases (GHGs) reported as metric tons of carbon dioxide equivalents (CO_2e), consisting of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)
2) Energy usage (expressed as millions of British Thermal Units [MMBTU])
3) Water usage (gallons of water)
4) Air emissions of criteria pollutants consisting of metric tons of nitrogen (NO_x), sulfur oxides (SO_x), and particulate matter (PM_{10})

For the purpose of this discussion, the term “footprint” is used to describe the quantified emissions or quantities for each metric. To estimate the sustainability footprint, only those elements possessing important sustainability impacts were included in the assessment. A lower footprint indicates lower deleterious impacts to environmental metrics, which collectively make up the SiteWise sustainability metrics. Conversely, a higher footprint indicates higher deleterious impacts associated with the SiteWise metrics. The major conclusions of this sustainability analysis are incorporated into the effectiveness criteria evaluation of the FFS. The assumptions used in the SiteWise tool are presented in **Tables B-1** and **B-2.**

Table B-1. SiteWise Input Assumptions for Alternative 2 (Land Use Controls with Long-term Management)

Component	Assumption
Remedial Action Construction	***Install Warning Signs and Posts***
Personnel Transportation - Road	Mobilization to Site: 2 people driving 300 miles round trip, one trip each. Local travel for post installation, 6 people driving 50 miles round trip daily 5 days, 30 trips
Materials	U-channel posts: 63 x 6 foot u-channel posts (1.12 lb per foot) = 423 pounds steel (0.3 tons), transported in personnel vehicle Concrete for posts assume 1 cubic feet per post x 320 posts (1 per 10 ft) = 320 cubic feet
Material Transport	0.3 tons steel, 320 cubic feet concrete x 170 pounds/cubic feet (28 tons) transported 150 miles via on-road diesel truck (29 tons total)
Labor Hours Onsite	320 hours onsite (2 technicians 2 x 10-hour days for sign installation, 6 people 5 days for post installation), assume installation of posts done by manual means
Long-term Management	***Annual inspections, post-storm event inspections, 5-year sampling***
Personnel Transportation - Road	Mobilizations to Site: Annual Inspection: 1 technician driving 300 miles round trip, 30 years, 30 trips Post-Storm Event Inspection (2 events per year): 1 technician driving 300 miles round trip, 30 years, 60 trips Sampling (quarterly for years 1, 2, and 3; semiannual years 4 and 5; annual every 5 years in years 10, 15, 20, 25, and 30): 2 technicians driving 300 miles roundtrip, 21 trips each
Residual transportation/disposal	1 drum of sampling waste generated each event x 5 events. Transported 50 miles to treatment plant.
Labor Hours Onsite	1,920 hours (30 hours per year inspections, 40 hours every sampling event)

Table B-2. SiteWise Input Assumptions for Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management)

Component	Assumption
Remedial Action Construction	***Vegetation Clearing/Grubbing, Waste Consolidation, Soil Cover Construction***
Personnel Transportation - Road	Mobilizations to Site: 6 people driving 300 miles roundtrip, 4 trips Daily travel: average 6 people onsite per day, 20 miles roundtrip per day x 70 days for all work to be completed (420 trips)
Materials	Soil for cover (sand): 17,101 cubic yards x 1.5 tons/cubic yard = 25,651 tons, topsoil (6 inches): 8,551 cubic yards x 1.5 tons/cubic yard = 12,827 tons. U-channel posts: 63 x 6 foot u-channel posts (1.12 lb per foot) = 423 pounds steel (0.3 tons), transported in personnel vehicle Concrete for posts assume 1 cubic feet per post x 320 posts (1 per 10 ft) = 320 cubic feet
Material/Equipment Transport	Soil from borrow pit, estimated 5 miles from site one-way: 38,478 tons/25 tons per load = 1,540 loads, 7,700 miles one way, same empty. 0.3 tons steel posts, 320 cubic feet concrete x 170 pounds/cubic feet (28 tons) transported 150 miles via on-road diesel truck (29 tons total) Veg clear/excavator/roller transport to site each weigh 20 tons x 25 miles one way.

Table B-2. SiteWise Input Assumptions for Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management)

Component	Assumption
Equipment use	Clearing/grubbing: assume similar impact as a 65-horsepower dozer, clearing 1 acre per 8-hour day x 10.6 acres = 84.8 hours Excavator: moves 3,420 cubic yards for consolidation, moves 25,652 cy for cover Roller: prep 51,304 square yards (461,736 square feet)
Labor Hours Onsite	4,200 hours construction labor (70 days x 6 people x 10-hour days)
Long-term Management	***Annual inspections, post-storm event inspections, 5-year sampling***
Personnel Transportation - Road	Mobilizations to Site: Annual Inspection: 1 technician driving 300 miles round trip, 30 years, 30 trips Post-Storm Event Inspection (2 events per year): 1 technician driving 300 miles round trip, 30 years, 60 trips Sampling (quarterly for years 1, 2, and 3; semiannual years 4 and 5; annual every 5 years in years 10, 15, 20, 25, and 30): 2 technicians driving 300 miles roundtrip, 30 years 21 trips each
Residual transportation/disposal	1 drum of sampling waste generated each event x 5 events. Transported 50 miles to treatment plant.
Labor Hours Onsite	1,920 hours (30 hours per year inspections, 40 hours every sampling event)

Results and Conclusions

This section provides a summary of the sustainability footprint for Alternatives 2 and 3. The results of the SiteWise evaluation are presented in **Tables B-3** through **B-5** and **Figure B-1**.

Alternative 2— Land Use Controls with Long-term Management

The following is a summary of the individual sustainability footprints. Results are provided in **Table B-4** and **Figure B-1**.

GHG and Energy Use – The remedial action construction and long-term management footprints were similar to each other for Alternative 2 (Land Use Controls with Long-term Management) but with different activities contributing to them. Material manufacturing (steel for signposts and concrete for signpost installation) during the remedial action construction phase was the primary contributor to the GHG and energy footprints. Transportation was the largest contributor to the long-term management footprint.

Criteria Air Pollutants (NO_X, SO_X, PM_{10}) – The remedial action construction phase had larger criteria air pollutant footprints than the long-term management phase. Material manufacturing during the barrier/sign installation phase was the primary contributor to each footprint. Transportation was the primary contributor during the long-term management phase.

Table B-3. Sustainability Results for Alternative 2 (Land Use Controls with Long-term Management)

Activities		GHG Emissions	Total Energy Used	Water Used	NO_x Emissions	SO_x Emissions	PM_{10} Emissions
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton
Remedial Action Construction	Material Production	14.69	174.8	NA	4.1×10^{-2}	7.1×10^{-2}	1.4×10^{-2}
	Transportation-Personnel	1.16	14.6	NA	4.8×10^{-4}	1.5×10^{-5}	6.9×10^{-5}
	Transportation-Equipment	0.62	8.1	NA	1.9×10^{-4}	3.4×10^{-6}	1.7×10^{-5}
	Equipment Use and Onsite Labor	0	0	NA	0	0	0
	Residual Transport and Disposal	0	0	NA	0	0	0
	Sub Total	16.47	197.5	NA	4.20×10^{-2}	7.07×10^{-2}	1.42×10^{-2}
Long-term Management	Material Production	0	0	NA	0	0	0
	Transportation-Personnel	15.86	200.2	NA	6.6×10^{-3}	2.1×10^{-4}	9.4×10^{-4}
	Transportation-Equipment	0	0	NA	0	0	0
	Equipment Use and Onsite Labor	0	0	NA	0	0	0
	Residual Transport and Disposal	0.85	11	NA	2.7×10^{-4}	4.7×10^{-6}	2.4×10^{-5}
	Sub Total	16.71	211.2	NA	6.86×10^{-3}	2.12×10^{-4}	9.65×10^{-4}
Total		33.18	408.8	NA	4.88×10^{-2}	7.09×10^{-2}	1.52×10^{-2}

NA - Not Applicable

Alternative 3— Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management

The following is a summary of the individual sustainability footprints. Results are provided in **Table B-4** and **Figure B-1**.

GHG and Energy Use – The consolidation and soil cover (remedial action construction) footprint was significantly larger than the long-term management footprint for Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management), primarily from equipment use and material production: fill and topsoil from a borrow pit. Transportation, like Alternative 2 (Land Use Controls with Long-term Management), was the largest contributor to the GHG and energy footprints for the long-term management component.

Criteria Air Pollutants (NO_X, SO_X, PM_{10}) – The remedial action construction phase had significantly larger criteria air pollutant footprints than the long-term management phase. Material production during the LUC installation phase was the primary contributor to each footprint. Transportation was the primary contributor during the long-term management phase.

Table B-4. Sustainability Results for Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management)

Activities		GHG Emissions	Total Energy Used	Water Used	NO_x Emissions	SO_x Emissions	PM_{10} Emissions
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton
Remedial Action Construction	Material Production	414	7,626	NA	1.6	2.1	8.1×10^{-1}
	Transportation-Personnel	6	71	NA	2.3×10^{-3}	7.3×10^{-5}	3.3×10^{-4}
	Transportation-Equipment	28	369	NA	8.9×10^{-3}	1.6×10^{-4}	7.9×10^{-4}
	Equipment Use and Onsite Labor	617	1,596	NA	1.1	2.6×10^{-1}	8.7×10^{-2}
	Residual Transport and Disposal	0	0	NA	0	0	0
	Sub Total	1,065	9,663	NA	2.72	2.33	9.01×10^{-1}
Long-term Management	Material Production	0	0	NA	0	0	0
	Transportation-Personnel	15.86	200.2	NA	6.6×10^{-3}	2.1×10^{-4}	9.4×10^{-4}
	Transportation-Equipment	0	0	NA	0	0	0
	Equipment Use and Onsite Labor	0	0	NA	0	0	0
	Residual Transport and Disposal	0.85	11	NA	2.7×10^{-4}	4.7×10^{-6}	2.4×10^{-5}
	Sub Total	16.71	211.2	NA	6.86×10^{-3}	2.12×10^{-4}	9.65×10^{-4}
Total		1,082	9,874	NA	2.73	2.33	9.02×10^{-1}

Comparative Evaluation of Sustainability Results

Alternative 2 (Land Use Controls with Long-term Management) had a lower overall sustainability footprint in all categories because Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) contains all components of Alternative 2 (Land Use Controls with Long-term Management) with the addition of the waste consolidation and soil cover. The total footprints for each alternative are presented in **Table B-5**. It should be noted that while this analysis compares the environmental footprints of each of the alternatives, the alternatives may differ with respect to other evaluation criteria. Therefore, a comparison of the results of the alternatives needs to be made in the context of the benefits (e.g., ARAR compliance, contaminant reduction, site reuse, cost effectiveness, and etc.) of each of the alternatives.

Table B-5. Comparison of Sustainability Results

Alternatives	GHG Emissions	Total Energy Used	Water Used	NO_x Emissions	SO_x Emissions	PM_{10} Emissions
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton
Alternative 2	33.18	408.8	NA	4.88×10^{-2}	7.09×10^{-2}	1.52×10^{-2}
Alternative 3	1,082	9,874	NA	2.73	2.33	9.02×10^{-1}

Uncertainty

The SiteWise tool calculates environmental and potential accident footprints based on industry averages, published emissions factors, and generalized data sources. The footprint results are not representative of actual emissions and should be used for comparative purposes only.

Recommendations

The inventory from the SiteWise tool were used to estimate the environmental footprint of the alternatives. Once the alternative is selected, it is recommended that the footprint of the selected alternative be further evaluated in the design phase of the projects to explore opportunities to optimize the environmental footprint of the project and integrate sustainable remediation best practices in the design, construction, and operation of the alternative.

If Alternative 2 (Land Use Controls with Long-term Management) is selected, potential best practices may include use of green concrete mix for signpost installation or using recycled barriers or fencing.

If Alternative 3 (Consolidation, Construction of a Soil Cover, and Land Use Controls with Long-term Management) is selected, in addition to suggested best practices for Alternative 2 (Land Use Controls with Long-term Management), potential best practices may be using onsite fill for the cover or a portion of the cover.

References

Battelle. 2015. *SiteWise Version 3.1*. NAVFAC Engineering Service Center. September.

Figure

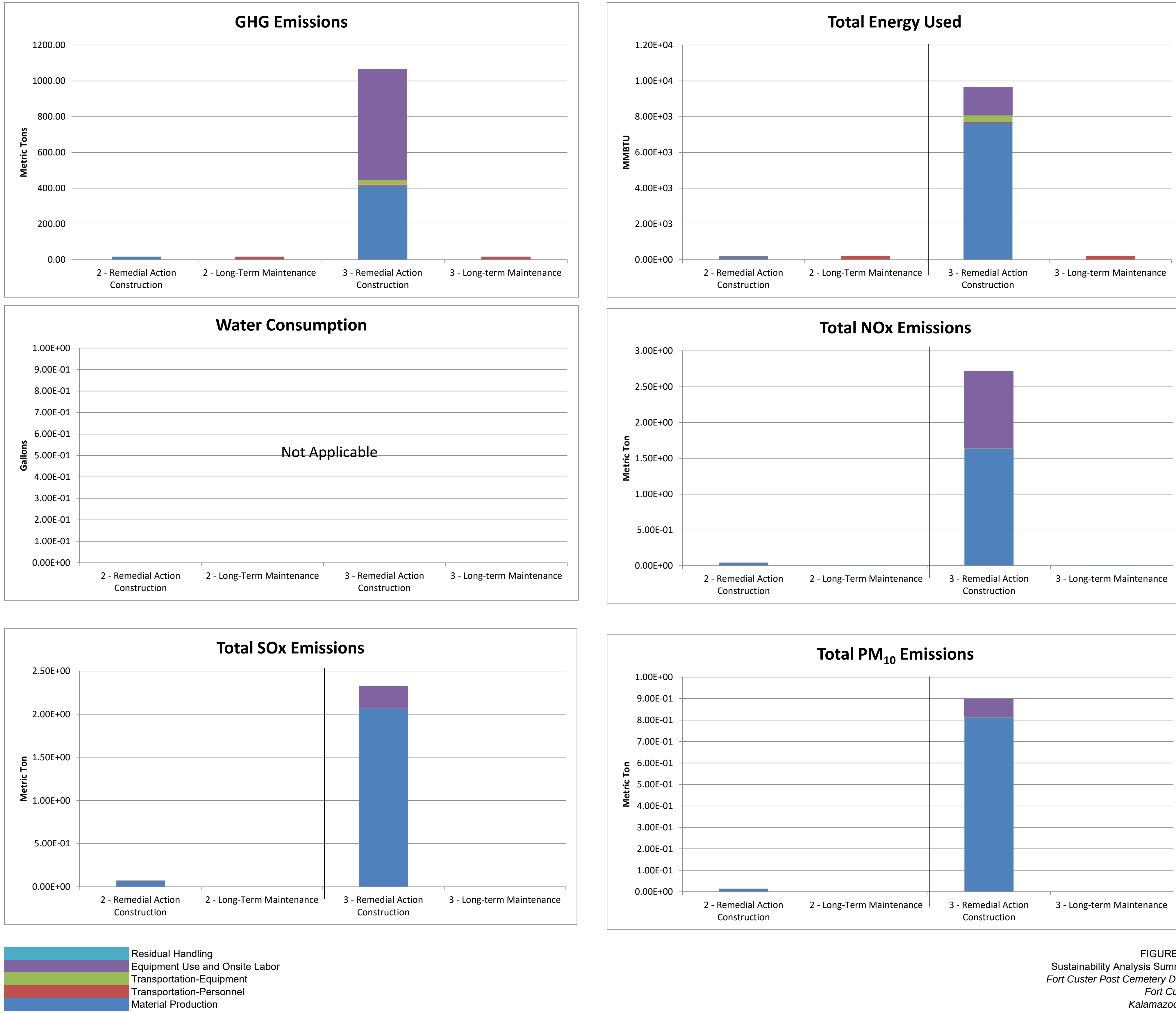


FIGURE B-1
Sustainability Analysis Summary
Fort Custer Post Cemetery Dump
Fort Custer
Kalamazoo, MI