REVISED FINAL

FOCUSED FEASIBILITY STUDY

FOR THE

WINKLEPECK BURNING GROUNDS AT THE RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

PREPARED FOR

US Army Corps of Engineers®

LOUISVILLE DISTRICT
CONTRACT No. DACA62-00-D-0001
Delivery Order No. CY08

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contributed to the preparation of this document and should not be considered an eligible contractor for its review.

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Science Applications International Corporation (SAIC) has completed this Revised Final Focused Feasibility Study for the Winklepeck Burning Grounds at the U.S. Army Joint Munitions Command, Ravenna Army Ammunition Plant, Ravenna, Ohio. 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. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; 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 law and existing Corps policy.

Larry Tyner, SAIC
Study/Design Team Leader

3-29-05
Date

W. Kevin Jago
Kevin Jago, SAIC
Independent Technical Review Team Leader

3/29/05
Date

Sharon K Robers
Sharon Robers, SAIC
Human Health Risk Assessment Reviewer

03/29/05
Date

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Ecological Risk Assessment Reviewer

March 29, 2005
Date

Significant concerns and the explanation of the resolution are as follows:

Independent technical review comments are recorded on an SAIC Document Review Record, per SAIC quality assurance procedure QAAP 3.1. This Document Review Record is maintained in the project file. Changes to the report addressing the comments have been verified by the Study/Design Team Leader.

As noted above, all concerns resulting from independent technical review of the project have been considered.

William P Keagle
Principal w/ A-E firm

3/29/05
Date

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TABLES

FIGURES

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ACRONYMS

ALM	adult lead model
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
Army	U.S. Army
AT123D	Analytical Transient 1-, 2-, 3-Dimensional model
BA	biological assessment
BAF	bioaccumulation factor
bgs	below ground surface
BHHRA	baseline human health risk assessment
CAA	Clean Air Act of 1970
CAMU	corrective action management unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CMCOPC	contaminant migration contaminant of potential concern
COC	chemical of concern
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSF	cancer slope factor
CSM	conceptual site model
CWA	Clean Water Act
CY	calendar year
DAD	dermally absorbed dose
DDT	dichlorodiphenyltrichloroethane
DERR	Division of Emergency and Remedial Response (Ohio EPA)
DLA	Defense Logistics Agency
DNT	dinitrotoluene
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ESA	Endangered Species Act of 1973
ESL	ecological screening level
ESS	Explosive Safety Submittal
EU	exposure unit
FFS	focused feasibility study
FR	*Federal Register*
FWHHRAM	Facility-Wide Human Health Risk Assessor's Manual
FWS	U.S. Fish and Wildlife Service
GAF	gastrointestinal absorption factor
GDCS	generic direct contact soils standard
GSSL	generic soil screening level
HAP	hazardous air pollutant
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HTRW	hazardous, toxic, and radioactive waste
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System

IRP	Installation Restoration Program
JMC	Joint Munitions Command
LDR	land disposal restriction
LOAEL	lowest-observed-adverse-effect level
LUCIP	Land Use Control Implementation Plan
MCL	maximum contaminant level
MDC	maximum detected concentration
MDL	method detection limit
MEC	munitions and explosives of concern
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MRA	munitions response area
MTR	minimum technological requirement
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NGB	National Guard Bureau
NMFS	National Marine Fisheries Service
NOAEL	no-observed-adverse-effect level
NPL	National Priorities List
OAC	Ohio Administrative Code
O&M	operations and maintenance
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
OSC	Operations Support Command
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEF	particulate emission factor
POTW	Publicly Owned Treatment Works
PRG	preliminary remediation goal
QC	quality control
RAGS	*Risk Assessment Guidance for Superfund*
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfC	reference concentration
RfD	reference dose
RGO	remedial goal option
RI	remedial investigation
RME	reasonable maximum exposure
RTLS	Ravenna Training and Logistics Site
RVAAP	Ravenna Army Ammunition Plant
SESOIL	Seasonal Soil Compartment (model)
SOP	standard operating procedure
SRC	site-related contaminant
SVOC	semivolatile organic compound
SWP3	Storm Water Pollution Prevention Plan
TC	toxicity characteristic
TCE	trichloroethane

TCLP	toxicity characteristic leaching procedure
TEF	toxicity equivalency factor
THI	target hazard index
TNB	trinitrobenzene
TNT	trinitrotoluene
TR	target incremental lifetime cancer risk
TU	treatment unit
UCL_{95}	95% upper confidence limit
UHC	underlying hazardous constituent
USACE	U.S. Army Corps of Engineers
U.S.C.	*United States Code*
UTS	universal treatment standard
UXO	unexploded ordnance
VAP	Voluntary Act Program
VOC	volatile organic compound
WBG	Winklepeck Burning Grounds
WOE	weight of evidence
WWTU	wastewater treatment unit
XRF	X-ray fluorescence

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EXECUTIVE SUMMARY

INTRODUCTION

Three phases of remedial investigation (RI) have been completed for the Winklepeck Burning Grounds (WBG) resulting in a thorough characterization of the extent and magnitude of contamination, human health risks, and ecological risks. Additionally, a field effects study was completed in 2003 wherein the effects of contaminants on ecological receptors (plants and small mammals) were measured. These investigations concluded with the recommendation to move forward with a feasibility study (FS). Due to restricted foreseeable land use for WBG, as described below, under a land transfer Memorandum of Understanding with the National Guard Bureau, the U.S. Army (Army) identified that a focused FS (FFS) specific to reasonable land use was the most desirable option for the path forward on remedial action evaluation and selection. Detailed discussion of the Ravenna Army Ammunition Plant (RVAAP) and WBG operational history, and results of the RI phases of activity, may be found in the Phase I, II, and III RI Reports (USACE 1998, 2001a, 2004a).

The Ohio Army National Guard (OHARNG) plans to construct a Mark 19 Range in WBG. This construction activity is being performed as part of the Army's military mission. The details of the construction and land use have been incorporated into the FFS for completeness of the environmental evaluation of the defined land use. The evaluation of applicable and relevant or appropriate requirements (ARARs), alternatives, and possible remedial actions concerning areas that exceeded remedial goal options (RGOs), for the defined land use scenario, are presented in conjunction with the defined military mission at WBG. The Mark 19 target practice grenade will be fired on this range. The target practice round carries a small bursting charge to allow a visual determination of the impact point. The range will have four fixed firing points, located to the west of Pads 43 and 58 orientated to fire eastward. The Mark 19 Grenade Machinegun will fire 40-mm target practice grenades into a series of five target arrays located 400; 600; 800; 1,100; and 1,500 m east of the firing points. Targets will be a combination of computerized pop-up silhouette-type targets or hard targets. Hard targets are fixed, inoperable, obsolete armored vehicles and tanks. These vehicles will have their engines removed, as well as all petroleum products and lubricants removed. The computerized pop-up targets are remotely operated and display a specific silhouette for a programmed time for target acquisition and engagement.

This FFS addresses the site environmental issues pertaining to soils only. Future potential actions for groundwater and surface water will be addressed under respective facility-wide investigations for these media. This FFS includes an evaluation of human health risks associated with a National Guard Range Maintenance Soldier receptor and development of RGOs for identified chemicals of concern (COCs). An evaluation of the need for ecological RGOs is presented, based on multiple previous assessments at this area of concern. Alternatives for remediation of hazardous, toxic, and radioactive waste (HTRW) contamination above RGOs are presented and evaluated, along with ARARs that would govern the action.

HUMAN HEALTH RISK ASSESSMENT AND REMEDIAL GOAL OPTION DEVELOPMENT

The following process was used to generate conclusions regarding human health risks and hazards associated with contaminated media at WBG:

- identification of chemicals of potential concern (COPCs) via frequency of detection and weight of evidence screening, risk-based (preliminary remediation goal) screening, and background comparisons;

- determination of most likely receptor and pathways;
- determination of toxicity values for COPCs;
- quantification of risks and hazards; and
- identification of COCs.

To support the FFS, risks and hazards were evaluated for the National Guard Range Maintenance Soldier exposed to surface soil [0 to 3 ft below ground surface (bgs)]. One aggregate (the entire WBG) was evaluated in this human health risk assessment (HHRA) for this receptor. Direct contact (ingestion, dermal contact, and inhalation) pathways with surface soil were evaluated. A summary of the HHRA results follows.

- The hazard index across all pathways and COPCs was < 1; thus, there were no noncarcinogenic COCs.
- The total carcinogenic risk across all pathways and COPCs was 5×10^{-5}. Seven chemicals with risks $> 1 \times 10^{-6}$ were identified as soil COCs: arsenic; hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); benz(*a*)anthracene; benzo(*a*)pyrene; benzo(*b*)fluoranthene; dibenz(*a*,*h*)anthracene; and indeno(1,2,3-*cd*)pyrene.
- Although arsenic was identified as a COC in soils, its risk based on background levels (1.5×10^{-6}) is higher than the risk quantified from exposure to the WBG soils (1.3×10^{-6}).
- Lead was identified as a COPC at WBG. The U.S. Environmental Protection Agency (EPA) adult lead model indicated that the probability of exceeding acceptable fetal blood levels was estimated to be less than 1% for the National Guard Range Maintenance Soldier exposed to lead in soils at WBG. Based on these results, lead is not a COC for this HHRA.
- Risk-based RGOs were estimated for all seven soil COCs and compared against the soils data at WBG. An analysis of individual sample results indicated that (1) there was no exceedance of the arsenic RGO, (2) a single location had soil concentrations that exceeded the RGOs for the five polycyclic aromatic hydrocarbons (PAHs), and (3) four locations had RDX concentrations that exceeded its RGO. A removal of the one soil location where PAHs exceed their RGOs, accompanied by replacement with clean fill material, would result in exposure point concentrations less than RGOs for all COCs.

SUMMARY OF ECOLOGICAL RISK AND REMEDIAL GOAL OPTION DEVELOPMENT

Stewardship of the environment will be a major consideration in all phases of planning, design, and construction of the Mark 19 Range. Habitat alteration is expected to be intensive and extensive and resulting in vegetation removal (simpler or missing habitat), shorter food chains (simpler ecosystem), and lower exposure (fewer organisms). Ecological risk is present although many of the re-calculated hazard quotients (HQs) are less than 1. The weight-of-evidence, which encompasses (1) military land-use; (2) ecological field-study results, including revised HQs; (3) consequences of habitat alteration; (4) no known off-site contaminant migration; and (5) partial mitigation from remedial activities involved with human health protection, indicates that there is little need for ecological RGOs at WBG. Finally, there is planned removal of soil at 6 pads; these pads are among the most contaminated of the 70 pads. This removal will reduce the overall concentration of many contaminants and will have the effect of lowering the already low ecological risk.

REMEDIAL ALTERNATIVES

WBG was an operational facility where off-specification munitions, explosives, or explosives-contaminated materials were burned. RVAAP is in the process of transferring the site to OHARNG for use as a Mark 19 Range. This transfer will be completed prior to range construction, and will be implemented under a Department of Defense Explosive Safety Board (DDESB) Explosive Safety Submittal (ESS). . As a precursor to range construction, a density survey and clearance of munitions and explosives of concern (MEC) is planned. The MEC surveys/clearance will be briefly discussed during the description of alternatives, but it is a concurrent activity and; therefore, will not have an associated general response action.

The following general response actions were considered:

- No action,
- Institutional actions,
- Excavation actions,
- Beneficial re-use actions, and
- Disposal actions.

The technologies/process options screened under each general response action were selected for their ability to remove or reduce PAH and RDX contaminants in soil. Site-specific considerations included PAHs at one location at a depth of up to 1.2 m (4 ft) and RDX at four locations near and within the former Burn Pads 61, 66, and 67 at shallow depth [0.3 m (1 ft)]. Because the site contains small volumes of contamination above RGOs, the technologies/process options under the general response actions were evaluated for their applicability to removing or reducing contaminants in a small volume of soil in the shortest time frame. This allows a more equitable comparison of technologies/process options under each general response action, specifically when evaluating cost-effectiveness criteria in the detailed analysis. Another site-specific consideration is the proposed Mark 19 Range construction that will require up to 10 acres of the site to be surveyed and cleared of MEC. The MEC action will not impact the technologies evaluated, but the process used to implement the technologies. The MEC action is considered as an independent, concurrent activity from the HTRW remedial action. However, cost and logistics benefits are gained through evaluation of coordinated MEC and HTRW activities.

Technologies retained under the general response actions were combined into the following two alternatives for detailed analysis.

- Alternative 1: No Action.

  – For this alternative, no action would be taken to reduce the hazards present at the site to potential human or ecological receptors. There would be no reduction in toxicity, mobility, or volume of the contaminated media. Accessibility to contaminants by workers and the public would not be prevented. Consideration of the no action alternative is required under EPA guidance for removal actions under the Comprehensive Environmental Response, Compensation, and Liability Act for baseline comparison with other alternatives.

- Alternative 2: HTRW Contamination Removal Concurrent With MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Soil Disposition Options including Beneficial Re-use or Disposal.

  The details of the construction of the Mark 19 Range are included to clarify the description of proposed remedial action. The Mark 19 Range is being constructed as part of the military mission for the Army and it is not part of installation restoration program (IRP) activities. The IRP action included in this alternative pertains to the soil conditions that exceed the defined RGOs for the specified land use. It is proposed that the Mark 19 Range construction and IRP activities be performed concurrently.

– Under this alternative, the munitions response areas designated for MEC removal, as part of the Mark 19 Range construction would be expanded to include excavation of HTRW points greater than RGOs. Basic construction details include the following.

  1. MEC surveys and clearance (excavation and sifting) of the 1.5-acre firing point area located on the western side of the WBG site to a depth of 4 ft.

  2. MEC clearances of six former Burn Pads (45, 58, 60, 61, 66, and 67). Where the pad or a portion of the pad is located within the firing arrays, the soil would be excavated to a depth of 4 ft bgs and screened for MEC. Where the pad or a portion of the pad is located outside the firing arrays, the soil would be cleared to a depth of 1 ft bgs. Construction would involve surface disturbance across approximately 10 acres, as described below.

  3. MEC clearance of the five target array bands, out to 1,500 m (4,950 ft) from the western edge, running generally north to south across the site. These areas would be surface-cleared of MEC to a depth of 1 ft, except where the array crosses one of the six pads noted above.

Because all the soils exceeding RGOs are within or immediately adjacent to (< 30 ft) the MRAs, these soils would become part of the MEC Contractor's Scope of Work and be addressed concurrent with the MEC removal activities. The contaminated soils exceeding the RGOs would be excavated to a depth of 0.3 to 1.2 m (1 to 4 ft) and screened for potential MEC. Due to past activities at WBG, all areas selected for excavation would have to be surveyed and cleared of potential MEC. This process would include clearing vegetation, geophysical surveys and visual inspections, excavation by layers, and sifting (screening) of the excavated soil for metal debris. Soil greater than RGOs would be excavated, sifted separately, and segregated from soil removed under the MEC action. Disposition of the sifted material would be determined by collecting composite samples for comparison against the RGO values. The disposition of soils after the MEC screening is complete would be based on the composite sampling results. The screened soils below RGO values would be used as backfill in the existing excavation. The screened soils above RGO values would be disposed off-site at an approved facility.

Based on the available risk information, a limited soil removal under Alternative 2 would lower human health risk to an acceptable level for the defined land use. Removal of areas with contaminants above RGOs would result in reduction of exposure point concentrations to below RGOs for all COCs and would also serve to further reduce ecological risk. Excavation of contaminated soil, concurrent with planned MEC removal action, maximizes cost-effectiveness of the alternative while attaining the same protectiveness as a separate soil removal action.

1.0 INTRODUCTION

This report documents the focused feasibility study (FFS) at the Winklepeck Burning Grounds (WBG) at the U.S. Army (Army) Joint Munitions Command (JMC) Ravenna Army Ammunitions Plant (RVAAP), Ravenna, Ohio (Figures 1-1 and 1-2). The FFS was conducted under the U.S. Department of Defense Installation Restoration Program (IRP) by Science Applications International Corporation and their subcontractors, under contract number DACA62-00-D-0001, Delivery Order No. CY08, with the U.S. Army Corps of Engineers (USACE), Louisville District. The FFS was conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 following work plans reviewed and commented on by the Ohio Environmental Protection Agency (Ohio EPA). This document investigates the remedial alternatives for the WBG.

1.1 PURPOSE AND ORGANIZATION OF REPORT

Three phases of remedial investigation (RI) have been completed for WBG resulting in a thorough characterization of the extent and magnitude of contamination, human health risks, and ecological risks. Additionally, a field effects study was completed in 2003 wherein the effects of contaminants on ecological receptors (plants and small mammals) were measured. These investigations concluded with the recommendation to move forward with a feasibility study. Due to restricted foreseeable land use for the WBG, as described below, under a land transfer Memorandum of Understanding (MOU) with the National Guard Bureau (NGB), the Army identified that a FFS specific to reasonable land use was the most desirable option for the path forward on remedial action evaluation and selection. Detailed discussion of the RVAAP and WBG operational history and results of the RI phases of activity may be found in the Phase I, II, and III RI Reports (USACE 1998, 2001a, 2004a).

The Ohio Army National Guard (OHARNG) plans to construct a Mark 19 Range in WBG. The Mark 19 target practice grenade will be fired on this Range. The Mark 19 target practice grenade is not a high explosive round, and has a very small bursting charge that visually indicates the grenade's impact point to the firer. This construction activity is being performed as part of the Army's military mission. The details of the construction and land use have been incorporated into the FFS for completeness of the environmental evaluation of the defined land use. The evaluation of applicable and relevant or appropriate requirements ARARs, alternatives, and possible remedial actions concerning areas that exceeded remedial goal options (RGOs), for the defined land use scenario, are presented in conjunction with the defined military mission at WBG. Details regarding this future land use are presented in the FFS and were used to develop a Range Maintenance Soldier exposure scenario for development of RGOs specific to the land use. As part of this FFS for WBG, data acquired in the Phase I, II, and III RIs were screened against human health RGOs developed for the future WBG land use scenario that has been agreed upon by RVAAP stakeholders. These data were considered during the screening and evaluation of remedial alternatives in the FFS to determine the areas and volumes of soils exceeding applicable RGOs. Evaluation of ecological risks was identified as an objective of the Phase III RI. Ecological risks for WBG have been extensively studied as part of an Ecological Field Effects Study (USACE 2003), which included direct measurements, as well as Phase III RI data in recalculation of hazard quotients (HQs). Results from this study are presented in this FFS, along with considerations for suitable habitat under the future land use, to develop ecological goals for remediation, if applicable.

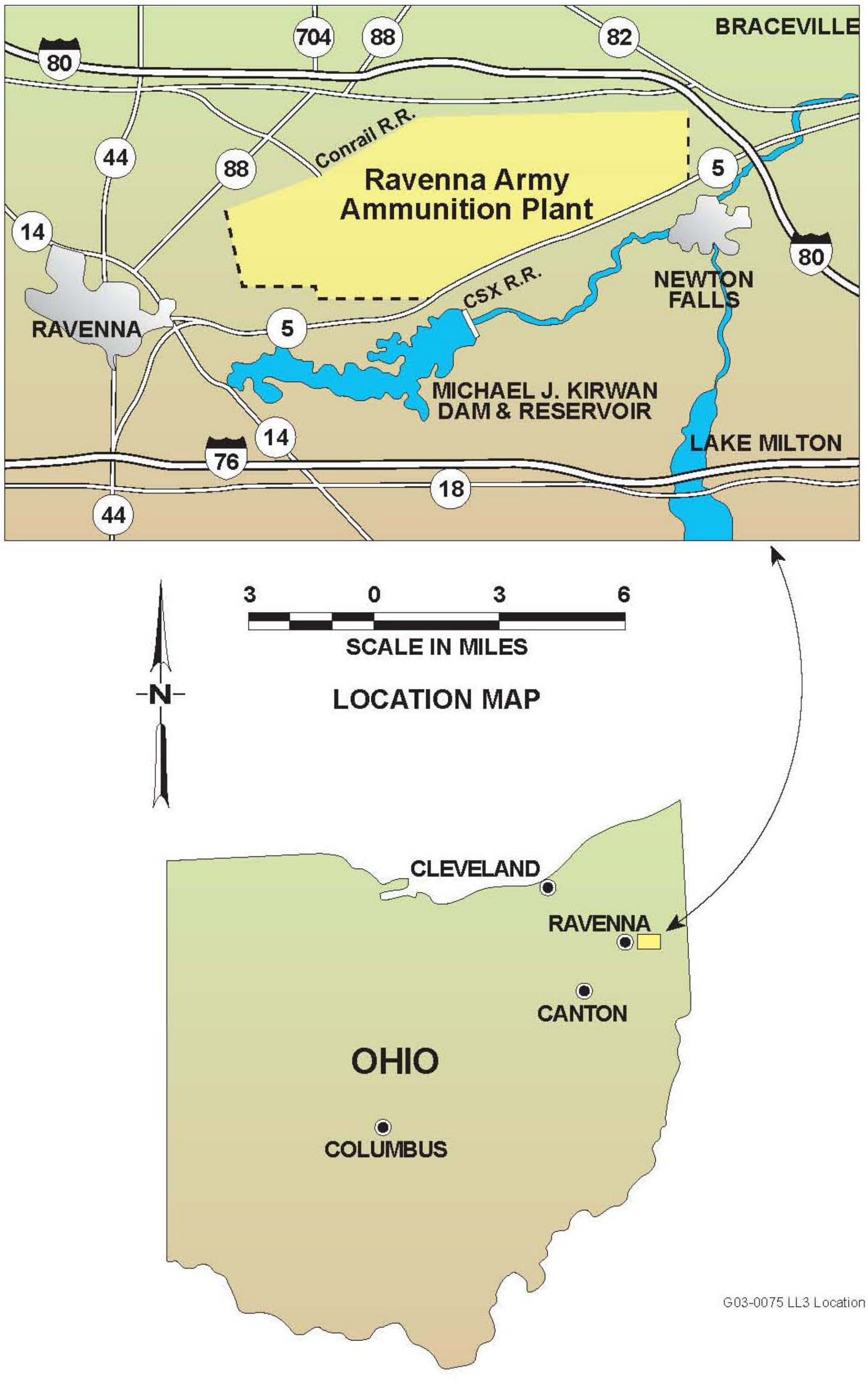

Figure 1-1. General Location and Orientation of RVAAP

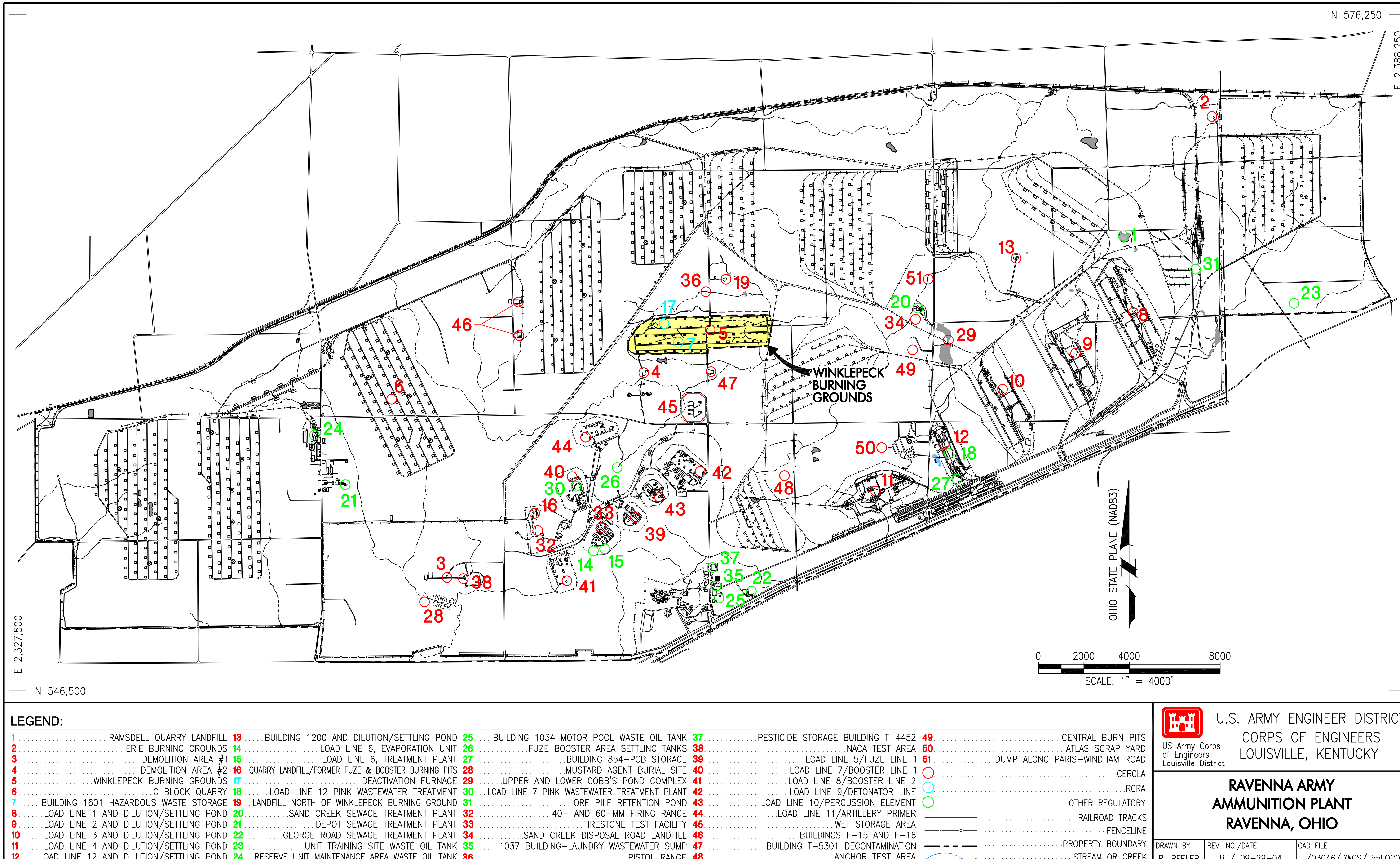

Figure 1-2. RVAAP Facility Map

The report consists of Chapters 1.0 through 7.0, and supporting appendices (A and B). Chapter 1.0 describes the purpose, objectives, and organization of this report; provides a description and history of WBG; and describes the environmental setting at RVAAP and WBG, including the geology, hydrogeology, climate, and ecological resources. Chapter 2.0 describes the generation of RGOs for the defined land use and the ecological and human health risks. Chapter 3.0 presents the ARARs pertinent to the defined land use, the evaluated alternatives, and the resulting remedial actions. Chapter 4.0 defines the range of general response actions applicable to the WBG. Chapter 5.0 identifies and evaluates the proposed remedial alternatives that were retained. Chapter 6.0 provides the summary results of the FFS. Chapter 7.0 provides a list of referenced documents used to support this FFS.

1.2 BACKGROUND INFORMATION

1.2.1 RVAAP Facility Description

RVAAP is a government-owned, contractor-operated facility, located in northeastern Ohio within east-central Portage County and southwestern Trumbull County. The facility is located approximately 37 km (23 miles) east of the city of Akron, 4.8 km (3 miles) east-northeast of the city of Ravenna, and approximately 1.6 km (1 mile) northwest of the town of Newton Falls. The installation consists of 8,668.3 ha (21,419 acres) contained in a 17.7-km (11-miles)-long, 5.6-km (3.5-miles)-wide tract, bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garretsville and Berry Roads on the west; and the CONRAIL Railroad on the north (see Figures 1-1 and 1-2). The installation is surrounded by several less populous communities: Windham directly to the north; Garretsville 9.6 km (6 miles) to the northwest; Charlestown directly to the southwest; and Wayland 4.8 km (3 miles) to the southeast.

RVAAP was constructed in 1940 and 1941 with the primary missions of depot storage and ammunition loading during World War II. Industrial operations at RVAAP consisted of 12 munitions-assembly facilities referred to as “load lines.” Load Lines 1 through 4 were used to melt and load trinitrotoluene (TNT) and Composition B into large-caliber shells and bombs. The operations on the load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically, the floors and walls would be cleaned with water and steam. The liquid containing TNT and Composition B was known as “pink water” for its characteristic pink color. Pink water was collected in concrete holding tanks, filtered, and pumped into unlined ditches for transport to earthen settling ponds. Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Potential contaminants in these load lines include lead compounds, mercury compounds, and explosives. From 1946 to 1949, Load Line 12 was used to produce ammonium nitrate for explosives and fertilizers.

In 1950, the facility was placed on standby status and operations were limited to renovation, demilitarization, and normal maintenance of equipment, along with storage of munitions. Production activities were resumed during the Korean Conflict (July 1954 to October 1957) and again during the Vietnam Conflict (May 1968 to August 1972). In addition to production missions, various demilitarization activities were conducted at facilities constructed at Load Lines 1, 2, 3, and 12. Demilitarization activities included disassembly of munitions and explosives melt-out and recovery operations using hot water and steam processes. Periodic demilitarization of various munitions continued through 1992.

In addition to production and demilitarization activities at the load lines, other facilities at RVAAP include sites that were used for the burning, demolition, and testing of munitions. These burning and demolition grounds consist of large parcels of open space or abandoned quarries. Potential contaminants at these areas of concern (AOCs) include explosives, propellants, metals, waste oils, and sanitary waste. Other types of AOCs present at RVAAP include landfills, an aircraft fuel tank testing facility, and various general industrial support and maintenance facilities. Additionally, beginning in the late 1940s, the Defense Logistics Agency (DLA) initiated a strategic materials storage mission at RVAAP. The storage mission included storage of bulk materials in outdoor locations, dry storage within above-grade steel tanks, and warehouse storage. The major materials stored included silica carbide, antimony sulfide, asbestos, magnesium silicate, magnesium alloy ingots, kyanite, talc, fluorospar, and heavy mineral sands. Stockpile storage included partially processed manganese, chrome, and ferrochrome materials.

In 1992, the status of RVAAP changed from inactive-maintained to modified-caretaker. The only activities still being carried out from the wartime era are the storage of bulk explosives and propellants and the infrequent demolition of unexploded ordnance (UXO) found at the installation. The bulk explosives storage mission at RVAAP is being phased out; transfer of materiel from RVAAP to other facilities is expected to be completed in 2004. Similarly, the DLA mission at RVAAP is being phased out; the only remaining activity related to this mission is completing removal of the outdoor strategic material stockpiles. The Army is also overseeing the reclamation of railroad tracks, telephone lines, and steel for re-use or recycling. The Army has completed the demolition of excess buildings at Load Lines 1 and 12, and is currently conducting demolition activities at Load Lines 2, 3, and 4, which includes the removal of friable asbestos. RVAAP's operations and mission-related activities are directed by Operations Support Command (OSC). Environmental restoration activities at RVAAP are conducted under the auspices of the IRP. As of January 2003, oversight and funding responsibilities for the IRP were transferred from OSC to the U.S. Army Environmental Center.

1.2.2 Surface and Cultural Features at Winklepeck Burning Grounds

The topography at WBG is characterized by gently undulating contours that decrease in elevation from west to east. Elevations at WBG vary from 312.3 to 341.2 m (993.2 to 1084.9 ft) above mean sea level across the AOC. The topography of the site was mapped by USACE in February 1998, on a 2-ft contour interval, with an accuracy of 0.02 ft. This survey is the basis for topography presented in figures in this Phase II RI Report. Data from a March 1998 aerial photographic survey, obtained by USACE, were used to supplement the topographic survey.

Surface water drainage flows mainly from west to east across WBG. The northwest portion of the burning grounds drains to the north, as seen by the stream draining Pads 59 and 60 and flowing towards the pistol range. Three other small streams traverse the AOC, all of which are tributaries to Sand Creek, a major drainage feature at RVAAP. One pond, known as Mack's Pond, is located in the southwest quadrant of WBG, near its southern perimeter. Beaver ponds are located in the southeast quadrant of, as well as north of, WBG, and their extents vary from year to year.

Cultural features at WBG consist mainly of gravel or dirt roads, running east to west, that are tied together by connecting roads at the eastern and western ends of the site. George Road roughly bisects WBG. The burning pads are arrayed along the roads. For each road, burning pads are only located on one side of the road. Many of the pads are clearly visible, because they are typically constructed of a platform of soil and slag that remains partially unvegetated, or they are bordered by earthen berms. However, other pads are more subdued in appearance, with little or no slag visible on the ground surface and no berms to define their boundaries. Pad 70 does not have the typical burning pad features at all, but rather is the site of several large dirt and debris mounds that are 1.89- to 2.51-m (6- to 8-ft) high. WBG is bounded on its eastern end by a railroad spur that runs between several storage blocks.

After 1980, thermal treatment of munitions and explosives was conducted only in a 1-acre Resource Conservation and Recovery Act (RCRA) area at Burning Pad 37. Burning was conducted in metal, refractory-lined trays set on top of a bed of crushed slag in an area approximately 100 x 100 ft in size. Ash residues were drummed and stored in Building 1601 on the west side of WBG pending proper disposition. The burn trays were decontaminated and removed from Burning Pad 37 in 1998, and the site was closed under RCRA.

Two additional closed RCRA-regulated units besides Burning Pad 37 are located within WBG. These two units are the Deactivation Furnace Area and Building 1601. Building 1601 was certified closed by Ohio EPA in 1999. Closure activities at Building 1601 included sampling through the floor and outside the doors of Building 1601 with subsequent decontamination of the structure. The Deactivation Furnace Area has been transferred to the CERCLA program because of the unique technical and programmatic considerations created by its location within a CERCLA AOC. Previous closure activities at the Deactivation Furnace Area included removal of structures and sampling and analysis of the subsurface soils.

Aerial photos dated April 16, 1952, were available from RVAAP's archives and indicate that the eastern half of the site was most intensively used for burning of explosives and other materials. Design and utilities drawings dating from the 1940s show a popping furnace was in use before the present Deactivation Furnace was constructed in the middle 1960s. Portions of the original popping furnace located about 6 m (20 ft) west of the present Deactivation Furnace Area are still present.

1.3 LAND USE

Until May 1999, about 364 ha (900 acres) of land and some existing facilities at RVAAP were used by NGB for training purposes administered by OHARNG. Training and related activities, managed under the Ravenna Training and Logistics Site (RTLS), include field operations and bivouac training, convoy training, equipment maintenance, and storage of heavy equipment. In a Memorandum of Agreement (MOA) dated December 1998, 6,544 ha (16,164 acres) of land were transferred from the Army JMC to NGB, effective May 1999, for expanded training missions. On May 13, 2002, an additional 3,774 acres of land was transferred to from JMC to NGB via an amendment to the MOA. Approximately 1,481 acres of property remain under the control of RVAAP; this acreage includes AOCs and active mission areas (Figure 1-3). As AOCs are remediated, transfer of the remaining acreage to NBG will occur. OHARNG has prepared a comprehensive environmental assessment and an integrated natural resources management plan, which address future uses of the property. These uses include hand grenade practice and qualification ranges, a light demolition range, and armored vehicle maneuver areas. Additional field support and cantonment facilities will be constructed to support future training.

OHARNG plans to construct a Mark 19 Range at WBG within the RTLS. The Mark 19 target practice grenade will be fired on this range. The Mark 19 target practice grenade is not a high explosive round and carries a small bursting charge to allow a visual determination of the impact point. The range will have four fixed firing points, located to the west of Pads 43 and 58 (Figure 1-4) orientated to fire eastward. The Mark 19 will fire 40-mm target practice grenades into a series of five target array bands located 400; 600; 800; 1,100; and 1,500 m east of the firing points. The firing point area will be situated at the west end of the range and encompasses an area of 200 m long by 70 m deep. The target array bands are 10 m wide. The limit of the range or dispersion area is 2,095 m. Targets will be a combination of computerized pop-up silhouette-type targets or hard targets. Hard targets are fixed, inoperable, obsolete armored vehicles and tanks. These vehicles will have their engines removed, as well as all petroleum products and lubricants removed. The computerized pop-up targets are remotely operated and display a specific silhouette for a programmed time for target acquisition and engagement.

1.3.1 Munitions and Explosives of Concern Clearance and Construction Activities

As part of the RVAAP process of transferring the site to OHARNG for use as a Mark 19 Range, a munitions and explosives of concern (MEC) removal action will be conducted under a Department of

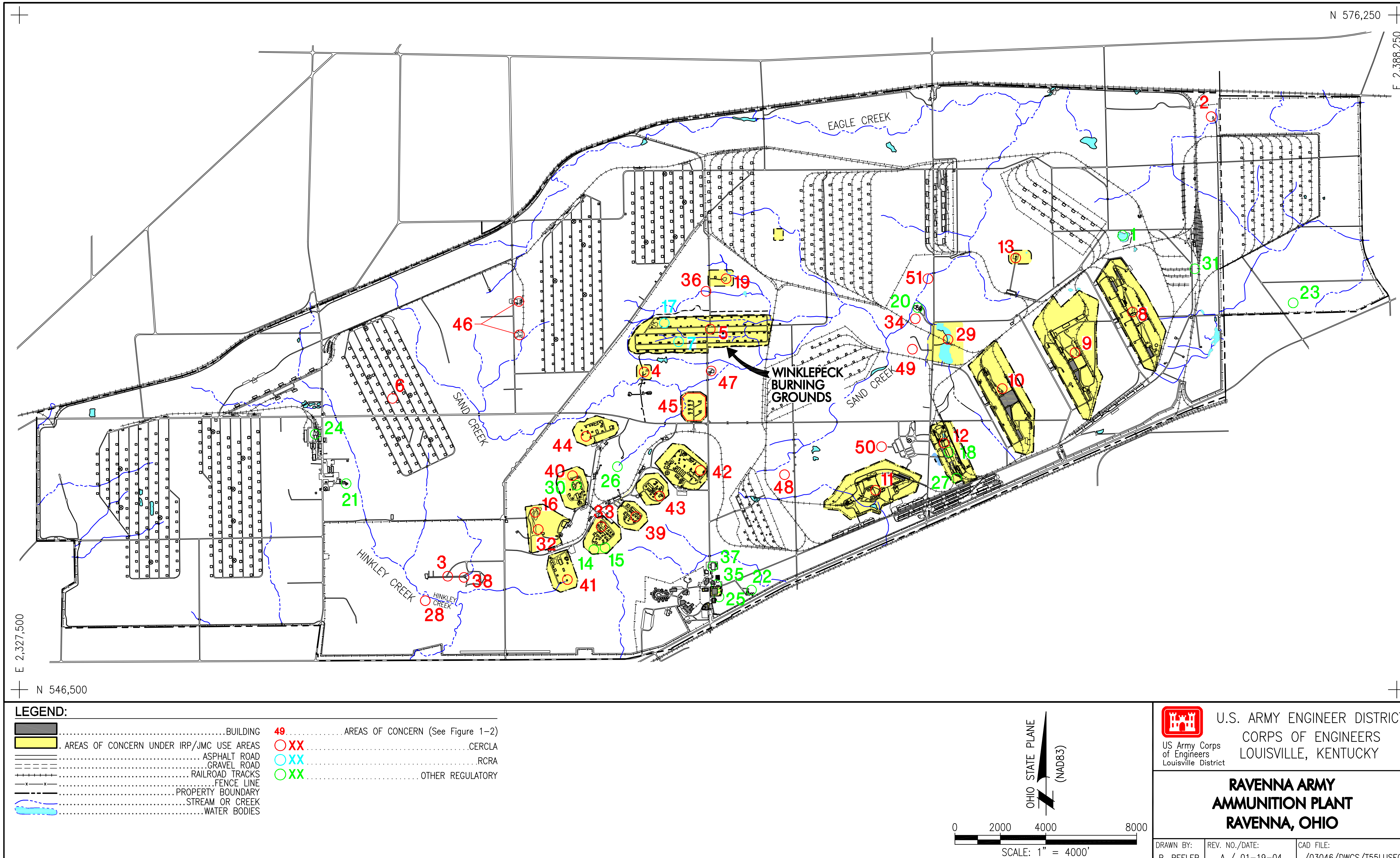

Figure 1-3. Current Land Use at RVAAP

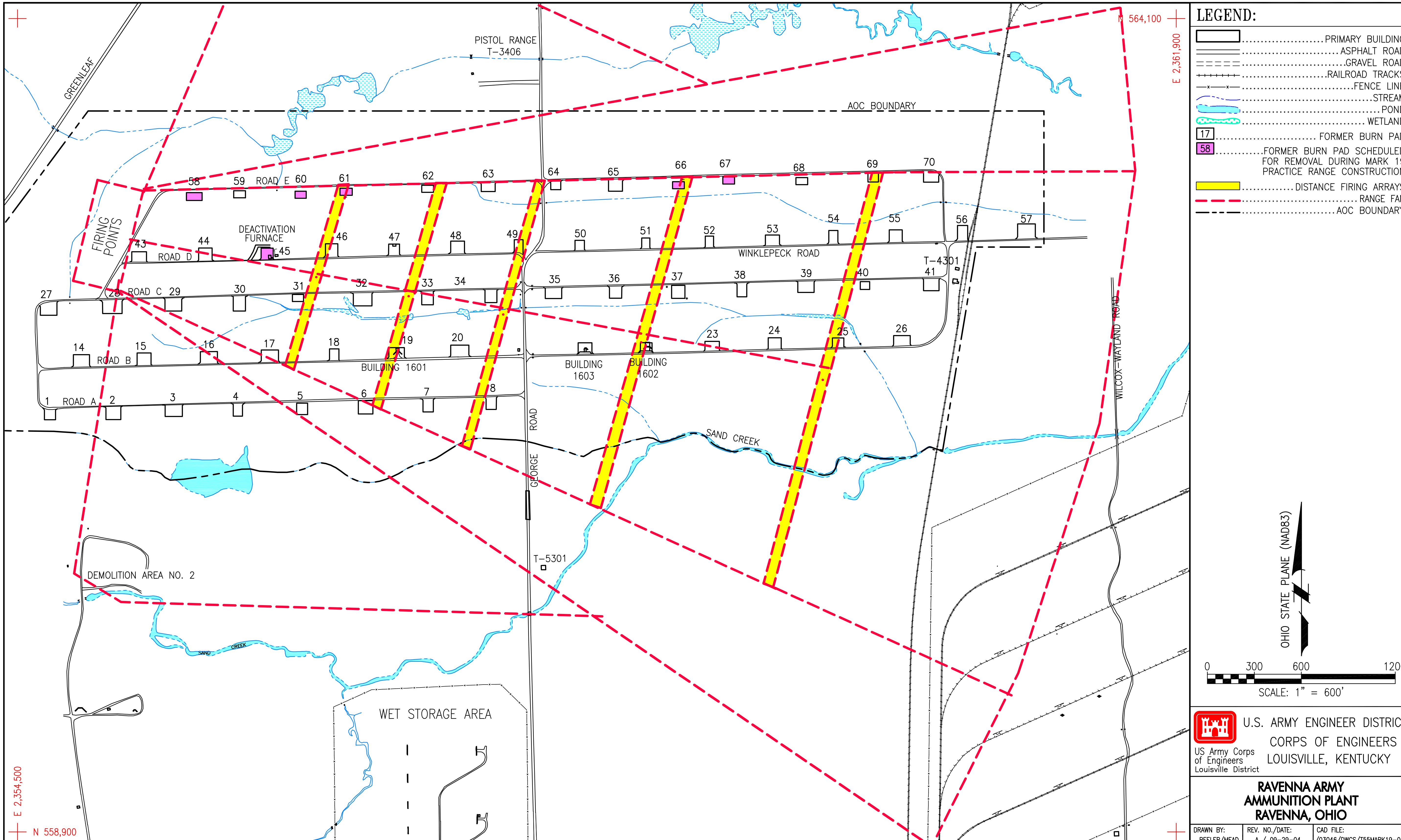

Figure 1-4. Proposed Mark 19 Range, Winklepeck Burning Grounds

Defense Explosive Safety Board (DDESB) Explosive Safety Submittal (ESS) (MKM 2004a) and related project documents, including the Phase I MEC Density Survey (MKM 2004b), the Work Plan for Phase II MEC Clearance and Munitions Response (MKM 2005a), and the Site Safety and Health Plan for Phase III MEC Clearance and Munitions Response (MKM 2005b). The MEC removal action will be conducted by the JMC and is planned to be a separate, but concurrent, activity with respect to any hazardous, toxic, and radioactive waste (HTRW) remedial action conducted under the IRP and CERCLA. The MEC removal action will be governed under the auspices of the ESS; thus, it is not evaluated as component of the HTRW remedial alternatives in this FFS. However, because any soil area within WBG that exceeds RGOs, and consequently must be addressed under the HTRW remedial alternative, would also involve a MEC screening component, the HTRW alternatives presented and evaluated in this FFS are referenced to the logistically and financially beneficial concurrent MEC removal. As a separate construction activity within the AOC, the MEC removal action will be subject to review and will identify ARARs that may apply and incorporate any applicable requirements into its governing documents.

Under the MEC removal action, the target and firing point areas within WBG will be cleared of brush to permit the completion of the land survey and MEC density survey. The firing point area and target arrays that fall within the boundaries of the WBG will be surface-cleared. Where the target arrays cross burn pads, with the exception of Pads 45, 58, 60, 61, and 67, soil will be screened and cleared of MEC to a depth of 1 ft. Where the target arrays cross Pads 45, 58, 60, 61, and 67, the soil will be excavated to a depth of 4 ft and screened for MEC.

It is anticipated that soil removal and screening will occur as described below; however, the Army plans to give allowance in the bid statement of work to use any combination of resources of their choosing to locate, identify, and remove MEC items from the construction areas. Prior to excavation activities, the construction area will be screened using geophysical investigation techniques. Soil will be removed in 12- to 18-in. lifts and passed through a shaker screen to remove metal debris. The screened soil will be stockpiled pending characterization. Soils generated during MEC removal from areas identified as exceeding RGOs will be evaluated for chemicals of concern (COCs) above the RGO threshold criteria developed in this report. At least one multi-incremental sample will be collected from the screened soil excavated from areas with reported results above RGOs. The multi-incremental sample of screened soil will provide the average concentrations of COCs for the excavated and screened soil. The results will be used to verify that soil does not contain COCs above RGOs. Evaluation of the results will be conducted to determine disposition requirements. If soil results are less than RGOs, the soil is subject to beneficial reuse, such as for backfilling of MEC removal excavations. If COC concentrations exceed RGOs, the soil will be stockpiled at a designated location on RVAAP for later treatment or disposal. Disposal of any recovered MEC and characterization of any excavated soil under the MEC removal action are addressed under the scope of the ESS and are not included in the HTRW alternatives evaluated in this FFS.

MEC removal will include verification sampling within excavations consistent with the land use basis (e.g., verification to 4 ft under the Mark 19 Range land use scenario, see Sections 2.1.2.1 and 2.1.2.2) to ensure that no soil remains that would act as a source for receptor exposure. Sampling for COCs identified as presenting a risk to a Range Maintenance Soldier receptor under the Mark 19 Range training scenario will be in accordance with the Ohio EPA letter regarding the use of multi-incremental sampling. One sample from each of the sidewalls and floor of the excavation will be collected from each of the six burn pad excavations. As with characterization of excavated soil, confirmation sampling within MEC removal action excavations is also addressed under the scope of the ESS and is not included in the HTRW alternatives evaluated in this FFS.

All excavations will be restored to original grade. As noted above, excavated soil not exceeding RGOs for the COCs will be used for backfilling. All excavated soils that are determined to be unsuitable for use as backfill will be temporarily stockpiled at a location on RVAAP for later treatment and/or disposal. Proper erosion and sedimentation control measures will be employed to prevent soil erosion from the stockpile in accordance with

Rainwater and Land Development – Ohio's Standards for Storm Water Management, Land Development, and Urban Stream Protection (ODNR and OEPA 1996). All areas disturbed by construction activities will be seeded with a RVAAP-approved seed mix for temporary cover and final site closures.

1.3.2 Range Operations and Maintenance

Users of the Mark 19 Range will be restricted to entry via Greenleaf Road and the eastbound range access road and parking area. When the tactical vehicle has been issued ammunition, it moves forward to its individual fixed firing position. Using target ammunition, the vehicle's personnel fire the course of fire required by Army doctrine. On completion of the course of fire, the vehicle moves back from the firing position to the parking area. No user vehicles or personnel are permitted forward of the forward edge of the firing position. A typical trainee will spend two weekends per year at the Mark 19 Range. The weekend would consist of two, 12-hr days.

Range Maintenance Soldiers will spend an average of 4 hrs in the impact areas of the range prior to use each weekend, and 8 hrs after each weekend use, during an average of 42 scheduled weekends per year. The Range Maintenance Soldier's activity in the impact area is limited to the existing gravel roads, George Road, and the individual target array band access roads. The Range Maintenance Soldier activities will include the following.

- **Target Maintenance:** Maintenance on pop-up targets will involve replacement of worn-out target silhouettes as well as maintenance of wiring and the target lifters. No ground intrusion is involved in these operations.

- **Range Maintenance:** This will include removal of target practice rounds from the surface of all paved and gravel roads within the impact area. Woody growth in the range impact area will be controlled by mowing or controlled burning. The mowing will be performed with tractor-mounted brush hogs and bat-wing mowers. Once annually, the range will be cleared of target practice rounds on the ground surface. Personnel conducting this activity will collect, transport, and dispose of all collected rounds in accordance with Army regulations.

- **Controlled Burns:** Once the range is operational, the impact area will be scheduled for a controlled burn by the RTLS/OHARNG Environmental Supervisor. The annual controlled burn will clear the range impact area of woody growth, and burn off grasses. This will make mowing operations less frequent and much easier, and aid with the location of remaining target practice rounds. Controlled burn personnel activity within the impact area will be focused on paved and graveled roads as much as feasible.

1.3.3 Site Access Control

The Mark 19 Range will be fenced appropriately, in accordance with current Department of Army regulations. The fence will be marked with the appropriate required signage, facing outward, to warn personnel that the fenced area is a live fire range. Gates will be located at the Greenleaf Road access, George Road on the north and south sides of the range, and Winklepeck Road at the east end of the range. During live-fire operations at the range, additional administrative and accountability procedures will be enforced in accordance with the range operations plan.

1.4 SITE HISTORY

A detailed history of process operations and waste processes for each AOC at RVAAP, including WBG, is presented in the *Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio*

(USACE 1996). Operational history, contaminant distribution and extent, and identified contaminants of concern for WBG are described in detail in the Phase I, II, and III RI reports (USACE 1998, 2001a, and 2004a). The following is a summary of the history and related contaminants at WBG.

WBG, designated as AOC RVAAP-05, encompasses approximately 80.9 ha (200 acres) in the central portion of RVAAP (Figure 1-2). A site map for WBG is shown on Figure 1-5. Historical operations at WBG included melting explosives out of heavy artillery projectiles using open burning. In some instances, high-energy material such as black powder and explosives were also laid out in a string along a road and burned. Burning is also known to have occurred along Road D. Prior to 1980, wastes disposed by burning included hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); antimony sulfide; Composition B; lead oxide; lead thiocyanate; 2,4,6-TNT; propellant; black powder; sludge and sawdust from load lines; and domestic wastes. Also, small amounts of laboratory chemicals were routinely disposed of during production periods. Shrapnel and other metallic munitions fragments were allowed to remain on the site after detonation, as were possible residual explosives. Waste oil (hydraulic oils from machines and lubrication oils from vehicles) was disposed in the northeast corner of WBG until 1973.

Prior to 1980, burning was carried out in four burn pits, on burn pads, and sometimes on the roads. The burn pits consisted of areas bermed on three sides, approximately 15.2 to 22.9 m (50 to 75 ft) in width and length. It is suspected (USACE 2001), but not presently confirmed, that the four burn pits correspond to Pads 58, 59, 60, and 61. The burn pads generally consisted of level areas without berms 6 to 12.2 m (20 to 40 ft) in width and length. It is not known how many pads were contained within the AOC. Currently, 70 burn pads have been identified from historical drawings and aerial photographs. Burning was conducted on bare ground. Ash from these areas was not collected (Jacobs Engineering 1989). Scrap metal was reclaimed and taken to the landfill north of Winklepeck (RVAAP-19).

After 1980, thermal treatment of munitions and explosives was conducted only in a 0.4-ha (1-acre) RCRA area at Pad 37. Burning was conducted in metal refractory-lined trays set on top of a bed of crushed slag in an area approximately 30.5 x 30.5 m (100 x 100 ft) in size. Ash residues were drummed and stored in Building 1601 on the west side of WBG pending proper disposition. The burn trays were removed from Pad 37 in 1998, and the site was closed under RCRA.

Two additional RCRA-regulated units besides Pad 37 are located within WBG and have been closed (Figure 1-5). These two units are the Deactivation Furnace Area and Building 1601. Building 1601 has been certified closed. Ohio EPA recently accepted a closure plan for the Deactivation Furnace Area. Additional sampling of surface and subsurface soils at the Deactivation Furnace Area and Building 1601 in support of closure activities was conducted in the fall of 1997. Building 1601 included sampling through the floor and outside the doors of Building 1601 with subsequent decontamination of the structure. Closure activities at the Deactivation Furnace Area included removal of structures and sampling and analysis of the subsurface soils.

1.5 SURFACE FEATURES

1.5.1 Surface Water Hydrology

Most surface water drainage flows from west to east across WBG. Three small streams cross the site, all of which are tributaries to Sand Creek, a major drainage feature at RVAAP. Site construction appears to have modified what was originally a dendritic drainage pattern, with the northern two tributaries being straightened to some degree. Mack’s Pond is located in the southwest quadrant of WBG, near its southern perimeter. The pond is fed by surface water drainage from the higher elevations at the western end of WBG, and drains eastward in a creek that joins Sand Creek east of George Road. Beaver ponds are located in low areas in the central and southeast quadrant of the WBG between Pallet Roads B and C, and

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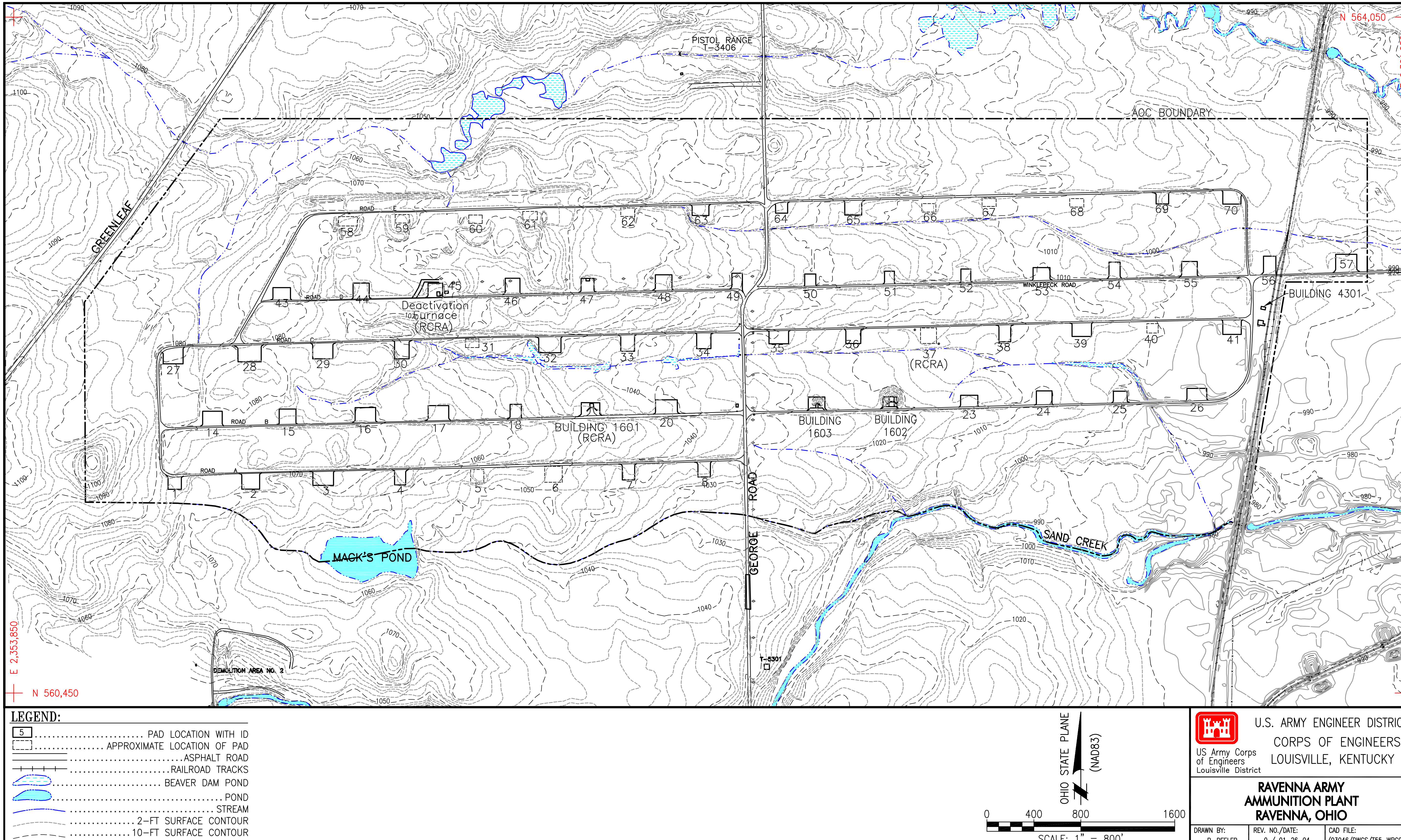

Figure 1-5. Winklepeck Burning Grounds Site Map

their extents vary from year to year. The extreme northwest corner of WBG (Pads 58 through 61) drains northeastward toward the pistol range. The drainage system at RVAAP feeds the West Branch of the Mahoning River. The West Branch is located at the east end of RVAAP, and flows southward to the Michael J. Kirwan (otherwise known as West Branch) Reservoir, immediately south of RVAAP. Surface water flows from west to east across WBG via three small intermittent streams (all tributaries to Sand Creek) and northward in a stream that drains Pads 58 through 61 (Figure 1-6). The southernmost surface water channel drains the western end of WBG and discharges to Mack's Pond, which is located in the southwest quadrant of WBG. The pond drains eastward to an unnamed stream that joins Sand Creek east of George Road. The stream north of Pallet Road B runs south of Pads 29 through 39, in the center of WBG. The northernmost stream exits the AOC east of Pad 63. Beaver ponds are also present in low areas in the southeast quadrant of WBG.

1.5.2 Hydrogeology of the Winklepeck Burning Grounds Site

The general groundwater flow pattern at WBG mimics the site topography and surface water drainage patterns, which indicate an overall flow gradient to the east across the AOC. WBG is elevated from 10 to 30 ft relative to surface water streams to the north and south, which suggests that the AOC is a recharge area. Some northeast and southeast components of shallow groundwater flow towards the surface water features are likely. Phase II and III RI drilling data show that groundwater occurs under unconfined conditions in sandy interbeds within glacial till deposits at the site, which are presumed to be many tens of feet thick. Because of the heterogeneous nature of the unconsolidated glacial deposits beneath the site, these sandy units are likely discontinuous. Localized variants in the overall flow patterns and preferred migration pathways (i.e., gravel or sand stringers) likely exist at the site. Water level data indicate a regional east-southeast flow direction. Steeper gradients are observed in the northeast quadrant of the AOC; however, the sparse distribution of monitoring wells over the large area of WBG allows only general interpretations to be made. Local variations in the flow direction and gradient are likely.

1.5.3 Ecology

The dominant cover types at RVAAP, including WBG, are forests and old fields of various ages. Much of the land at RVAAP was cleared for agriculture before government acquisition of the property in the 1940s. More than 60% of RVAAP is now in forest (OHARNG 2001). Most of the old field cover type is the result of earlier agricultural practices that left these sites with poor topsoil that still limits forest regeneration. Several thousand acres of agricultural fields were planted in trees during the 1950s and 1960s, but these plantings did not take well in areas with poor topsoil. Some fields, leased for cattle grazing during the same time period, were delayed in their reversion to forest. A few fields have been mowed, maintaining them as old field, and 36 ha (90 acres) are leased as hayfield (Morgan 1999).

It is estimated that at least one-third to one-half of RVAAP would meet the criteria for a jurisdictional wetland (OHARNG 2001). Actual wetland acreage identified on U.S. Fish and Wildlife Service National Wetlands Inventory maps is unknown, but is much less than one-third to one-half of the installation acreage. Wetland areas at RVAAP include seasonally saturated wetlands, wet fields, and forested wetlands. Most of these wetland areas exist because of poorly drained and hydric soils. Beaver impoundments contribute to wetland diversification on the site. High potential for negative impacts to wetlands exists simply because of the large areas of wetland.

The flora and fauna present at RVAAP are varied and widespread. A total of 18 plant communities have been identified on facility property including marsh, swamp, and forest communities. State endangered species include the following eight species:

- American Bittern,
- Graceful Underwing,

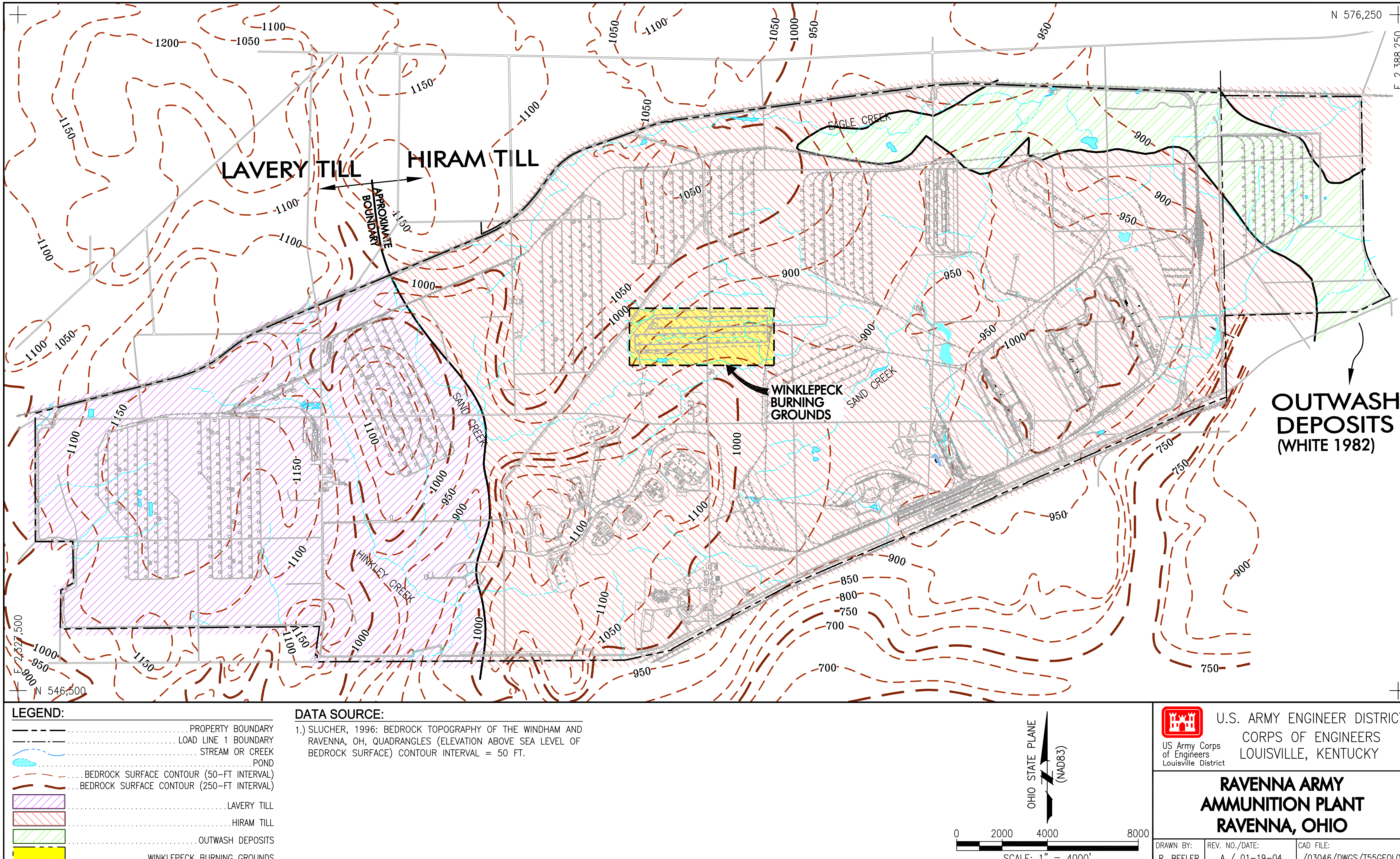

Figure 1-6. Geologic Map of Unconsolidated Deposits on RVAAP

- Mountain Brook Lamprey,
- Northern Harrier,
- Osprey,
- Ovate Spikerush,
- Trumpeter Swan, and
- Yellow-bellied Sapsucker.

and two state threatened species:

- Lurking Leskea, and
- Simple Willow-herb.

Eleven plant species listed as state potentially threatened have been identified at RVAAP. These include

- Butternut,
- Gray Birch,
- Hobblebush,
- Long Beech Fern,
- Northern Rose Azalea,
- Shining Ladies'-tresses,
- Straw Sedge,
- Swamp Oats,
- Tall St. John's Wort,
- Water Avens, and
- Woodland Horsetail.

A complete list of all Ohio rare species (plants and animals) can be found on the websites of the Ohio Department of Natural Resources at http://www.dnr.state.oh.usa large number of animal species have been identified on facility property, including 26 species of mammals, 143 species of birds, and 41 species of fish. Animal species listed as Ohio State Endangered (2002 inventory) include the Northern Harrier, Yellow-bellied Sapsucker, Mountain Brook Lamprey, Graceful Underwing, American Bittern, Osprey, and the Trumpeter Swan. Several animal species present at RVAAP also are listed as Ohio State Special Concern. These include

- Cerulean Warbler,
- Common Moorhen,
- Eastern Box Turtle,
- Four-toed Salamander,
- Henslow's Sparrow,
- Pygmy Shrew,
- Sharp-shinned Hawk,
- Sora,
- Star-nosed Mole,
- Virginia Rail, and
- Woodland Jumping Mouse,

Restricted land use and sound forest management practices have preserved and enabled large forest tracts to mature. Habitat conversion at RVAAP, unlike most other habitat conversions occurring nationwide, has been towards restoration of the forests that covered the area prior to its being cleared for agriculture.

The reversion of these agricultural fields to mature forest provides a diversity of habitats from old field through several successional stages. Overall, the trend towards forest cover enhances the area for use by forest species, both plant and animal. Future IRP activities will require consideration of these species to ensure that detrimental effects on threatened or endangered RVAAP flora and fauna do not occur. This will be discussed in the ecological risk assessment (ERA) presented in Chapter 2.0. There are no federal, state, or local parks or protected areas on RVAAP facility property.

1.6 PREVIOUS INVESTIGATIONS AT WINKLEPECK BURNING GROUNDS

WBG was the subject of a Phase I RI (USACE 1998), a Phase II RI (USACE 2001a), an Ecological Field Effects Study (USACE 2003), and a Phase III RI (USACE 2004a). The purpose of the investigations was to confirm whether contamination was present at the site, and to determine the nature and extent of chemicals of potential concern (COPCs). The Phase I RI investigated soils only. During the Phase II RI, surface and subsurface soils, sediment, surface water, and groundwater were characterized at the burning pads and features that exhibited the highest contaminant levels in the Phase I RI. The ecological study was a “ground truthing” investigation of actual ecological impacts to the flora and fauna that populate WBG, designed to refine the screening ERA performed in the Phase II RI. The Phase III RI involved further testing and characterization of the sediment, surface and subsurface soil, and groundwater.

In addition, two historical investigations have been conducted at WBG: (1) *Hazardous Waste Management Study No. 37-26-0442-84 Phase II of AMC Open Burning/Open Detonation Grounds Evaluation, Ravenna Army Ammunition Plant* (USAEHA 1983); and (2) *Soil Sample Analysis, Winklepeck Burning Grounds* (USACE 1997). A comprehensive overview of all locations previously sampled within WBG is contained in the Phase II and III RI Reports (USACE 2001a and 2004a).

1.6.1 Groundwater Contamination

Eight new monitoring wells were installed for the Phase III RI, and were sampled along with the nine previously existing wells. All groundwater samples were analyzed for total and dissolved target analyte list metals (inorganics), cyanide, explosives, propellants, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). Data from the Phase I and II RIs were compared to the Phase III data and were used for determination of site-related contaminants (SRCs) in groundwater.

During the Phase III investigation, 15 of the 17 wells were found to have low concentrations of one or more explosives. Concentrations ranged from 0.05 μg/L of 2,4-dinitrotoluene (DNT) in well WBGmw-005 to a maximum concentration of 52 μg/L of RDX in well WBGmw-006. The highest concentrations of explosives in the groundwater at WBG were at WBGmw-006, where two of the 5 detections of explosives in excess of 1 μg/L occurred, and 2,4-DNT was the most frequently detected explosive, occurring in 11 out of 17 samples. Overall, contaminant concentrations in wells sampled in both the Phase II and III events remained constant.

The occurrences of metals above background values in the Phase III RI were generally limited to three or fewer per monitoring well. Metals occurred at concentrations exceeding secondary maximum contaminant levels (MCLs), but there were no occurrences of concentrations above primary MCLs. In the Phase III study, eight metals were found above background levels, the largest exceedance being 500 μg/L of zinc at well WBGmw-015. Also detected above background were aluminum, arsenic, barium, cadmium, cobalt, manganese, and nickel. Copper, lead, mercury, and cyanide had all previously been determined as SRCs, although they were not detected in the Phase III sampling. The overall concentrations of metals were similar between the Phase II and III RIs, although the distributions of background exceedances shifted.

All Phase III groundwater samples were analyzed for organic compounds, and a total of four compounds were detected. They were the pesticides 4,4’-dichlorodiphenyltrichloroethane (DDT) and heptachlor epoxide, the SVOC bis(2-ethylhexyl)phthalate, and the VOC chloroform. The SVOC was the most commonly detected organic, and well WBGmw-010 was the most contaminated, with detections of three of the four contaminants. As in previous studies, the organic compounds detected in the groundwater are not known to be specifically related to activities associated with burning grounds and are sporadically distributed among the monitoring wells. There were no detectable concentrations of PCBs or polycyclic aromatic hydrocarbons (PAHs) in the wells.

1.6.2 Surface Soil Contamination

Surface soil samples collected during the Phase III RI were analyzed for field explosives, propellants, metals, and organics. In total, 96 surface soil samples were collected; 59 from originally planned locations, 30 from random grid sampling locations, and 7 contingency samples were collected. The surface soil sampling was biased toward areas known or suspected to have the greatest soil contamination based on data from the Phase II RI, and the random grid sampling investigated areas thought to be uncontaminated outside of former burn pads.

All surface soil samples were screened for explosives in the field, and 18 were submitted to the fixed-base laboratory for confirmation sampling. 2,4,6-TNT was the most commonly detected explosive, found in 10 surface soil samples, followed by 2-amino-4,6-DNT and 4-amino-2,6-DNT with 6 and 7 detects, respectively. Overall, 10 explosives and the propellant nitroguanidine were identified as Phase III SRCs. In the random grid samples, explosives were not detected or were detected in very low concentrations, while Pads 60, 61, 66, and 67 demonstrated the greatest number and highest concentrations of explosives in surface soil.

All surface soil samples were field screened, either in situ or using bench top units, for X-ray fluorescence (XRF) metals. Five compounds were screened out due to their nature as essential nutrients, leaving 20 compounds as SRCs for surface soil in Phase III. The compounds identified as SRCs either exceeded background criteria in at least 5% of all samples, or did not have background data to compare against. Eleven of the 20 metals were detected in every sample analyzed, but many exceeded background only a few times. The random grid sampling showed that maximum concentrations were generally less than twice the background value, indicating pervasive but low levels of contaminants in surface soil across the site.

Twenty-one organic compounds were detected and identified as Phase III SRCs from the nine surface soil samples submitted for analysis. Three samples, from Pads 45, 62, and 67, did not have any detections of organics. The pesticide dieldrin was detected once at Pad 37 and once at Pad 66, and the pesticide heptachlor epoxide was detected once at Pad 38. The remaining three samples, two from Pad 61 and one from Building 4301, contained several organic compounds including PCBs, pesticides, SVOCs, and VOCs. At Building 4301, 14 SVOCs, all PAHs, were detected, as well as PCB-1254 and trichloroethane (TCE). Both samples taken from Pad 61 had detections of PCB-220, sample WBG-218 contained one detection of 4,4’-DDT, and sample WBG-220 had a single detection of heptachlor epoxide. There were 17 SVOCs detected at WBG-218 and 14 detected at WBG-220. Most of the SVOC’s detected were PAHs, and most of the concentrations of compounds among the three samples were estimated values at or below the detection limit.

1.6.3 Subsurface Soil Contamination

Subsurface sampling was biased toward areas that were known or suspected to have the greatest surface soil contamination, and samples were not collected from random grid sampling locations, Pad 32, or Building 4301. The subsurface soil samples were analyzed for field explosives and propellants, metals, and organics. A minimum of one 2- to 4- ft sample was collected at Pads 37, 38, 45, 58, 59, 61, 62, 66, 67, and 68 for determination of the vertical extent of contamination. Based on these results, further sampling to depths of 10 ft was conducted for a total of 54 subsurface soil samples.

All subsurface soil samples were field analyzed for TNT and RDX, and 37 samples were then submitted to the fixed-base laboratory for confirmation sampling. 2,4,6-TNT was the most commonly detected explosive compound, with detectible concentrations in 16 samples. Also found were RDX, with six detects; 2,4-DNT and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine, with five detects each; 1,3,5-trinitrobenzene (TNB), with four detects; and 2-amino-4,6-DNT and 4-amino-2,6-DNT, with four and three detects, respectively. Overall, 11 different explosives were detected at least once, in concentrations ranging from 0.05 to 5,200 mg/kg, and Pads 58, 59, 61, 66, and 67 exhibited the greatest number and concentration of explosive compounds. There were some explosives present in the 6- to 8-ft interval at Pad 38, but most contaminants were identified in the 2- to 4-ft interval.

Sixteen inorganic compounds were determined to be SRCs for subsurface soils in the Phase III investigation, and the results indicate that inorganic contamination extends beyond the pad boundary in subsurface soils at eight pads. All samples collected were field screened for XRF metals, with 8 of the 16 SRCs present in every sample analyzed. Of the 16 SRCs, 4 were retained because no background value exists. Many of the metals had high detection rates, but exceeded background criteria very infrequently. For example, aluminum was present in 54 of 54 samples, but above background only once. Most contamination decreased with depth, but in some cases contamination was greater in the 6- to 8-ft interval than the 4- to 6-ft interval.

Four samples, collected from Pads 58, 59, 61, and 68, and from the 2- to 4- or 4- to 6-ft interval, were submitted for organics analysis. Occurrences of organic compounds were sporadic and concentrations were generally low. A total of 26 organic compounds were detected and determined to be Phase III SRCs. Two pesticides, heptachlor epoxide and endrin ketone, were found once each, as were the VOCs dimethylbenzene, ethylbenzene, toluene, TCE, acetone, and methylene chloride. In addition, 18 PAH compounds were detected in between one to three samples each. All detections of VOCs came from the 2- to 4-ft interval, while the SVOCs (PAHs) were found in the 2- to 4- and 4- to 6-ft intervals.

1.6.4 Sediment

Two dry sediment samples were collected in the Phase III investigation, WBG-294 and WBG-295, from a drainage ditch between Pads 59 and 60. Sampling along the ditch was intended to characterize sediment transport off the AOC from two of the most heavily used pads, and samples were analyzed for explosives, propellants, metals, and organics.

Both sediment sample collected during the Phase III sampling tested negative in the field laboratory for explosives and, therefore, neither was analyzed for explosives in the fixed-base laboratory. Nitrocellulose and nitroguanidine were the only propellants analyzed for, with sample WBG-294 having a low estimated concentration of nitroguanidine. Overall, seven analytes are considered explosives SRCs from sediment sampling in the Phase I, II, and III investigations, with 2,4,6-TNT having the highest detected concentration.

Field screening for XRF metals took place for both sediment samples. Screening of fixed-base laboratory analytical data from Phase I, II, and III indicated that 15 metals were determined to be sediment SRCs for the entire AOC. Sediment SRCs detected above background criteria in the Phase III samples included antimony, beryllium, cadmium, lead, chromium, copper, nickel, selenium, and vanadium. Hexavalent chromium was detected in sample WBG-294 at an estimated concentration of 5 mg/kg in the Phase III sampling. Metals determined to be SRCs that were detected in the Phase I and II investigations, but not in Phase III, included aluminum, barium, cobalt, cyanide, mercury, and thallium.

During Phase III, sediment sample WBG-265 contained a very low, estimated detection of TCE, and no PCBs or SVOCs. Sediment sample WBG-264 contained a low, estimated concentration of PCB-1260, as well as the SVOCs di-n-butyl phthalate and n-nitrosodiphenylamine. No VOCs were detected in sample WBG-264 in Phase III. In total, 18 organics were determined to be SRCs based on data from the Phase I, II, and III investigations.

1.6.5 Surface Water

No surface water sampling was performed during the Phase III investigation. Data collected from Phases I and II determined that acetone was the only SRC detected in surface water, and that this may be attributed to probable laboratory contamination.

1.7 FATE AND TRANSPORT ANALYSIS

Contaminant fate and transport modeling performed as part of the Phase III RI included leachate modeling [Seasonal Soil Compartment (SESOIL)] at selected source areas demonstrating the highest levels of process-related contaminants. Where leaching was predicted to occur, groundwater modeling [Analytical Transient 1-, 2-, 3-Dimensional (AT123D)] was conducted from the source to selected receptors or exit points from the AOC. The receptor and exit points selected for groundwater transport modeling included the AOC boundary, Sand Creek, and stream north of WBG (Pads 58, 60, 61, and 62 only) at their closest points downgradient of each source area.

Antimony, arsenic, and RDX were identified at multiple pads as exceeding MCLs or risk-based concentrations (RBCs) in the leaching model. These constituents were identified as contaminant migration constituents of potential concern (CMCOPCs). The following compounds were identified as CMCOPCs at only one source pad: 1,3-dinitrobenzene and 2,6-DNT (Pad 66); 1,3,5-TNB (Pad 67); barium (Pad 68); cadmium (Pad 38); carbazole (Pad 61); and chromium (Pad 58). The timeframe for explosive compounds to reach predicted peak concentrations ranged from 2 to 12 years, which suggests that maximum concentrations have already occurred relative to the cessation of operations at WBG. Predicted timeframes for peak concentrations of inorganics ranged from 311 to the model maximum of 1,000 years. Although the leaching modeling is conservative, the presence of arsenic; barium; cadmium; 2,6-DNT; 1,3,5-TNB; and RDX in groundwater indicate leaching processes are ongoing near some of the source pads.

Modeling of contaminant transport in shallow groundwater was conducted for identified CMCOPCs from the source pads to the three endpoints noted above. No metals were predicted to reach any receptor points at concentrations greater than MCLs or RBCs within the 1,000-year modeling period. RDX and carbazole were the only compounds predicted to reach one or more of the selected receptor locations at concentrations exceeding their respective RBCs. RDX from Pad 37 was the only CMCOPC predicted to reach Sand Creek above its RBC (peak concentration estimated at 10 years). Peak RDX concentrations were predicted to occur at the AOC boundary from 6 to 11 years depending on pad location. For Pads 60, 61, and 62, RDX was also predicted to exceed its RBC at the stream north of WBG with peak concentrations occurring from 6 to 11 years. Concentrations of carbazole were also predicted to exceed its RBC at the AOC boundary and the stream north of WBG; however, the timeframe to achieve peak concentrations was the model maximum of 1,000 years and this compound was not detected in groundwater during the Phase III RI.

1.8 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) for WBG was initially developed during the Phase II RI and was revised based on new Phase III RI data. Elements of the CSM include the following:

- primary contaminant source areas and release mechanisms,
- contaminant migration pathways and exit points, and
- data gaps and uncertainties.

1.8.1 Source-Term and Release Mechanisms

Results of the Phase III RI soil sampling indicate that Pads 58, 59, 60, 61, 66, and 67 generally contain the greatest numbers and concentrations of contaminants. Metals and explosives are the primary contaminants present in these areas at concentrations greater than background. Soil contamination by explosives is present to the maximum depths sampled (6 to 10 ft) at Pads 58, 59, 61, and 67. Metals SRCs substantially above background also were observed at Pads 37, 38, 45, 62, and 68. Samples from the Building 4301 vicinity also showed concentrations of inorganics well above background values.

Two primary mechanisms for release of contaminants from the source areas are identified: (1) erosional and/or dissolved phase transport of contaminants from soil sources with transport into drainage ditches and Sand Creek, and (2) leaching of constituents to groundwater via infiltration of rainwater through surface and subsurface soils. Evaluation of these release mechanisms was done through sampling of ditches and monitoring wells installed downgradient of the burn pads, and numerical modeling of soil leaching processes. Airborne dispersion of contaminants was not quantified or modeled. The chemical characteristics of the SRCs present, high annual precipitation levels, and heavy vegetation cover at WBG likely preclude any substantial dispersion of contaminants via air dispersion pathways.

1.8.2 Contaminant Migration Pathways and Exit Points

1.8.2.1 Surface water pathways

Migration of contaminants from soil sources via surface water occurs primarily by: (1) movement of particle-bound (e.g., clays or colloids) contaminants in surface water runoff, and (2) transport of dissolved constituents in surface water. Surface runoff is directed to drainage ditches and tributaries to Sand Creek, and to a ditch that drains the northwest portion of WBG and exits the AOC between Pads 58 through 61 to a surface drainage conveyance north of WBG.

Upon reaching quiescent portions of surface water conveyances, flow velocities decrease and particle-bound contaminants are expected to settle out as sediment accumulation. Sediment-bound contaminants may be re-mobilized during storm events. Sediment-bound contaminants may also partition to surface water and be transported in dissolved phase. Previous sampling of sediment and surface water was deemed adequate to characterize potential contaminant transport along conveyances to Sand Creek. Modeling of surface water transport pathways in the Phase II RI indicated that erosional transport mechanisms are not expected to contribute substantial flux of contaminants to Sand Creek. Biased sampling of sediment in the ditch flowing north out of WBG indicates that the drainage is not an exit point for contaminants.

1.8.2.2 Leaching and groundwater pathways

Evaluation of leaching potential for soil source areas indicates that explosives, metals, and carbazole may be expected to leach from the contaminated surface soil into the groundwater and reach concentrations exceeding groundwater MCLs or RBCs. The presence of some of these constituents in groundwater near source areas suggests that leaching processes are ongoing near the source areas. Timeframes for leaching of the explosive compounds are relatively short (2 to 12 years), indicating that peak concentrations in groundwater beneath the source areas may have already passed. Timeframes to attain predicted peak concentrations for metals are much longer (approximately 300 to 1,000 years), indicating that concentrations may increase in the future.

Shallow groundwater flow follows stream drainage and topographic patterns with flow east-southeast across the AOC. Evidence exists that the AOC acts as a recharge area with shallow groundwater flow to the stream northeast of WBG and to Sand Creek. Modeling of contaminant transport in shallow groundwater showed that no metals CMCOPCs were predicted to reach any receptor points at concentrations greater than MCLs or RBCs within the modeling period. RDX can be expected to reach certain receptor locations, depending on the source area modeled, at concentrations exceeding its RBC. However, as with the leaching results, the predicted timeframes to attain peak concentrations (6 to 11 years) suggest that most migration has already occurred.

1.8.3 Uncertainties

The CSM is developed based on available site characterization and chemical data. Uncertainties are inherent in the CSM where selected data do not exist or are sparse. The uncertainties within the CSM for WBG include the following.

- Leachate and transport modeling are limited by uncertainties in the behavior and movement of contaminants in the presence of multiple solutes. In addition, heterogeneity, anisotropy, and spatial distributions of more permeable zones could not be fully characterized during the field investigation nor addressed in the modeling. Therefore, effects of these features on contaminant transport at WBG are uncertain and modeling results are considered as conservative representations.

The exact source(s) of some inorganics in soil and sediment in the AOC is unknown. Data evaluated in the nature and extent and risk evaluations address all constituents measured within the burning grounds whether from natural or anthropogenic sources. Results of the evaluations may reflect, in part, contributions from sources other than WBG operations (e.g., slag or pre-RVAAP activities).

2.0 RISK ASSESSMENT

2.1 HUMAN HEALTH RISK ASSESSMENT

This human health risk assessment (HHRA) documents the potential health risks to humans resulting from exposure to contamination within WBG at RVAAP. Previously, a baseline HHRA (BHHRA) was performed at WBG as part of the Final Phase II RI report (USACE 2001a). The BHHRA (found in USACE 2001a) evaluated exposures to multiple receptors at WBG and media (soils, groundwater, surface water, and sediment). Receptors evaluated in the BHHRA included a security guard/maintenance worker, OHARNG personnel, an open industrial worker, a child trespasser, a hunter/trapper, a recreational user, and an on-site resident farmer as the baseline.

This HHRA is a new risk assessment, whose objective is to evaluate and document the potential risks to human health associated with current and predicted future exposures to contaminants at WBG in support of the FFS. The Army and OHARNG have a MOU that identifies future land use for RVAAP. This MOU identifies the land use for WBG as the Mark 19 Range (see Chapter 1.0 for specific details on this land use); this specific land use is what is evaluated for this FFS.

This HHRA is conducted per the *RVAAP's Facility-Wide Human Health Risk Assessor's Manual* (FWHHRAM) (USACE 2004b). The methodology presented in the FWHHRAM is based on *Risk Assessment Guidance for Superfund* (RAGS) (EPA 1989, 1991, and 2002a) and additional methodology taken from *Dermal Exposure Assessment: Principles and Applications* (EPA 1992a); *Exposure Factors Handbook* (EPA 1997a); Integrated Risk Information System (IRIS) (EPA 2004, updated approximately monthly); and Health Effects Assessment Summary Tables (HEAST) (EPA 1997b). The inorganic and organic chemicals found in the various environmental media are quantitatively analyzed (when possible) to characterize the potential risks to human health from exposure to these contaminants. The results of the HHRA are used to: (1) document and evaluate risks to human health; (2) determine the need, if any, for remedial action; and (3) identify COCs that may require the development of chemical-specific remediation levels. The HHRA evaluates potential risks from surface soil; groundwater is also evaluated, but no risks are quantified for this medium (see Section 2.1.1).

This risk assessment is organized into six major sections. The data evaluation process used to identify COPCs is discussed in Section 2.1.1. The exposure assessment, which is performed to identify the exposure pathways by which receptors may be exposed to contaminants and calculate potential intakes, is presented in Section 2.1.2. The toxicity assessment for the COPCs is presented in Section 2.1.3. The results of the risk characterization are presented in Section 2.1.4. An assessment of the uncertainties associated with the risk characterization is provided in Section 2.1.5, and the conclusions of the HHRA are summarized in Section 2.1.6.

2.1.1 Data Evaluation

This section provides a description of the data evaluation process used to identify COPCs for WBG. The purpose of the HHRA data evaluation screening process is to eliminate chemicals for which no further risk evaluation is needed. Data collected at WBG are aggregated by environmental medium (i.e., deep surface soil and groundwater). For this HHRA, deep surface soil data are defined as soils coming from 0 to 0.9 m (0 to 3 ft) below ground surface (bgs). This interval is the assumed maximum depth of exposure for the pertinent human receptor at the WBG (see Section 2.1.2 for more details on this receptor). All pertinent WBG surface soil data are grouped into one aggregate. Groundwaterdata from both Phase II and Phase III wells are evaluated. Table 2-1 illustrates COPCs using the most recent available data (Phase III

Table 2-1. Summary of COPC Screening for Winklepeck Burning Grounds Unconsolidated Groundwater

Analyte	CAS Number	Units	Results > Detection Limit	Average Result	Minimum Detect	Maximum Detect	UCL_{95} of Mean	Exposure Concentration	Site Backgd. Criteria	Region 9 Tap Water Criteria	COPC?
Phase II Monitoring Wells											
Explosives											
1,3,5-Trinitrobenzene	99-35-4	µg/L	1/ 5	1.0E-01	1.1E-01	1.1E-01	1.1E-01	1.1E-01	NA	1.1E+03	No
2,4,6-Trinitrotoluene	118-96-7	µg/L	2/ 5	3.3E-01	5.2E-01	8.5E-01	6.6E-01	6.6E-01	NA	2.2E+00	No
2,4-Dinitrotoluene	121-14-2	µg/L	4/ 5	2.4E-01	5.3E-02	9.5E-01	6.2E-01	6.2E-01	NA	9.9E-02	Yes
2,6-Dinitrotoluene	606-20-2	µg/L	1/ 5	1.0E-01	2.5E-01	2.5E-01	1.8E-01	1.8E-01	NA	9.9E-02	Yes
2-Nitrotoluene	88-72-2	µg/L	1/ 5	1.4E-01	3.1E-01	3.1E-01	2.3E-01	2.3E-01	NA	6.1E+01	No
4-Nitrotoluene	99-99-0	µg/L	2/ 5	1.7E-01	1.6E-01	3.8E-01	2.8E-01	2.8E-01	NA	6.1E+01	No
HMX	2691-41-0	µg/L	2/ 5	2.5E+00	7.4E-01	1.1E+01	7.0E+00	7.0E+00	NA	1.8E+03	No
RDX	121-82-4	µg/L	2/ 5	1.2E+01	5.3E+00	5.2E+01	3.3E+01	3.3E+01	NA	6.1E-01	Yes
Tetryl	479-45-8	µg/L	1/ 5	1.5E-01	3.6E-01	3.6E-01	2.6E-01	2.6E-01	NA	3.6E+02	No
Metals											
Arsenic	7440-38-2	µg/L	2/ 5	7.9E+00	8.0E+00	2.4E+01	1.7E+01	1.7E+01	1.2E+01	4.5E-02	Yes
Barium	7440-39-3	µg/L	5/ 5	3.5E+01	1.0E+01	6.0E+01	5.2E+01	5.2E+01	8.2E+01	2.6E+03	No
Cadmium	7440-43-9	µg/L	1/ 5	2.1E+00	3.0E-01	3.0E-01	3.0E+00	3.0E-01	NA	1.8E+01	No
Calcium	7440-70-2	µg/L	5/ 5	6.7E+04	4.4E+04	8.1E+04	8.1E+04	8.1E+04	1.2E+05	NA	No
Cobalt	7440-48-4	µg/L	2/ 5	1.6E+01	1.8E+00	4.5E+00	2.8E+01	4.5E+00	NA	7.3E+02	No
Iron	7439-89-6	µg/L	4/ 5	1.8E+03	2.1E+02	7.3E+03	1.7E+07	7.3E+03	2.8E+02	1.1E+04	No
Magnesium	7439-95-4	µg/L	5/ 5	1.9E+04	1.3E+04	2.2E+04	2.2E+04	2.2E+04	4.3E+04	NA	No
Manganese	7439-96-5	µg/L	5/ 5	4.4E+02	6.3E+01	1.3E+03	1.9E+04	1.3E+03	1.0E+03	8.8E+02	Yes
Nickel	7440-02-0	µg/L	1/ 5	1.7E+01	6.2E+00	6.2E+00	2.3E+01	6.2E+00	NA	7.3E+02	No
Potassium	7440-09-7	µg/L	5/ 5	1.1E+03	5.6E+02	1.3E+03	1.4E+03	1.3E+03	2.9E+03	NA	No
Sodium	7440-23-5	µg/L	5/ 5	8.5E+03	4.8E+03	1.8E+04	2.1E+04	1.8E+04	4.6E+04	NA	No
Zinc	7440-66-6	µg/L	1/ 5	1.1E+01	1.3E+01	1.3E+01	1.2E+01	1.2E+01	6.1E+01	1.1E+04	No
Organics - Pesticide/PCB											
4,4'-DDT	50-29-3	µg/L	1/ 5	3.2E-02	5.8E-02	5.8E-02	4.6E-02	4.6E-02	NA	2.0E-01	No
Organics - Semivolatile											
Bis(2-ethylhexyl)phthalate	117-81-7	µg/L	1/ 5	1.4E+01	4.9E+01	4.9E+01	3.3E+01	3.3E+01	NA	4.8E+00	Yes
Phase III Monitoring Wells											
Explosives											
1,3,5-Trinitrobenzene	99-35-4	µg/L	2/ 8	2.8E-01	3.0E-01	1.3E+00	5.6E-01	5.6E-01	NA	1.1E+03	No
2,4,6-Trinitrotoluene	118-96-7	µg/L	2/ 8	2.3E-01	3.2E-01	9.4E-01	4.3E-01	4.3E-01	NA	2.2E+00	No

Table 2-1. Summary of COPC Screening for Winklepeck Burning Grounds Unconsolidated Groundwater (continued)

Analyte	CAS Number	Units	Results > Detection Limit	Average Result	Minimum Detect	Maximum Detect	UCL_{95} of Mean	Exposure Concentration	Site Backgd. Criteria	Region 9 Tap Water Criteria	COPC?
2,4-Dinitrotoluene	121-14-2	µg/L	4/ 8	1.1E-01	6.8E-02	2.8E-01	1.6E-01	1.6E-01	NA	9.9E-02	Yes
2,6-Dinitrotoluene	606-20-2	µg/L	2/ 8	9.9E-02	1.0E-01	1.1E-01	1.3E-01	1.1E-01	NA	9.9E-02	Yes
2-Amino-4,6-dinitrotoluene	35572-78-2	µg/L	2/ 8	2.8E-01	3.3E-01	1.3E+00	5.6E-01	5.6E-01	NA	NA	Yes
2-Nitrotoluene	88-72-2	µg/L	5/ 8	5.2E-01	2.0E-01	2.6E+00	2.6E+00	2.6E+00	NA	6.1E+01	No
3-Nitrotoluene	99-08-1	µg/L	1/ 8	1.3E-01	3.1E-01	3.1E-01	1.8E-01	1.8E-01	NA	6.1E+01	No
4-Amino-2,6-dinitrotoluene	19406-51-0	µg/L	1/ 8	1.6E-01	5.4E-01	5.4E-01	2.6E-01	2.6E-01	NA	NA	Yes
4-Nitrotoluene	99-99-0	µg/L	4/ 8	2.6E-01	1.7E-01	8.5E-01	4.3E-01	4.3E-01	NA	6.1E+01	No
RDX	121-82-4	µg/L	2/ 8	2.7E-01	2.5E-01	2.7E-01	3.0E-01	2.7E-01	NA	6.1E-01	No
Tetryl	479-45-8	µg/L	2/ 8	2.6E-01	5.9E-01	9.2E-01	4.8E-01	4.8E-01	NA	3.6E+02	No
Metals											
Aluminum	7429-90-5	µg/L	1/ 8	6.3E+02	4.7E+03	4.7E+03	1.7E+03	1.7E+03	NA	3.6E+04	No
Barium	7440-39-3	µg/L	8/ 8	3.3E+01	1.3E+01	7.3E+01	6.7E+01	6.7E+01	8.2E+01	2.6E+03	No
Calcium	7440-70-2	µg/L	8/ 8	7.2E+04	3.2E+04	1.1E+05	8.8E+04	8.8E+04	1.2E+05	NA	No
Chromium	7440-47-3	µg/L	2/ 8	3.6E+00	1.4E+00	1.7E+00	4.9E+00	1.7E+00	7.3E+00	NA	No
Iron	7439-89-6	µg/L	1/ 8	9.8E+01	4.3E+02	4.3E+02	1.9E+02	1.9E+02	2.8E+02	1.1E+04	No
Magnesium	7439-95-4	µg/L	8/ 8	2.0E+04	9.3E+03	3.4E+04	3.1E+04	3.1E+04	4.3E+04	NA	No
Manganese	7439-96-5	µg/L	8/ 8	1.9E+02	3.2E+01	5.4E+02	9.9E+02	5.4E+02	1.0E+03	8.8E+02	No
Nickel	7440-02-0	µg/L	3/ 8	1.3E+01	2.2E+00	2.8E+00	2.0E+01	2.8E+00	NA	7.3E+02	No
Potassium	7440-09-7	µg/L	8/ 8	1.7E+03	8.4E+02	3.8E+03	2.7E+03	2.7E+03	2.9E+03	NA	No
Sodium	7440-23-5	µg/L	8/ 8	6.7E+03	3.4E+03	1.4E+04	9.7E+03	9.7E+03	4.6E+04	NA	No
Zinc	7440-66-6	µg/L	5/ 8	7.9E+01	1.4E+01	5.0E+02	1.9E+02	1.9E+02	6.1E+01	1.1E+04	No
Organics - Pesticide/PCB											
Heptachlor Epoxide	1024-57-3	µg/L	1/ 8	3.2E-02	5.6E-02	5.6E-02	4.1E-02	4.1E-02	NA	7.4E-03	Yes
Organics - Semivolatile											
Bis(2-ethylhexyl)phthalate	117-81-7	µg/L	2/ 8	4.7E+00	3.4E+00	3.9E+00	5.1E+00	3.9E+00	NA	4.8E+00	No
Organics - Volatile											
Chloroform	67-66-3	µg/L	1/ 8	2.4E+00	1.4E+00	1.4E+00	2.6E+00	1.4E+00	NA	6.2E+00	No

CAS = Chemical Abstracts Service.
COPC = Chemical of potential concern.
DDT = Dichlorodiphenyltrichloroethane.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
NA = No background criterion available.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
UCL = Upper confidence limit.

RI data collected in 2000) for wells installed during the Phase II RI (Area 7) and wells installed during the Phase III RI (Area 8).

Section 2.1.1.1 provides a summary of the COPC selection process and the data assumptions used during that process. Section 2.1.1.2 presents the assumptions for COPC screening and Section 2.1.1.3 presents the results of the COPC screening process.

2.1.1.1 Chemical of potential concern screening process

This subsection provides a description of the screening process used to identify COPCs and the data assumptions used in the process. Per the FWHHRAM (USACE 2004b), this data evaluation consists of five steps: (1) a data quality assessment, (2) frequency-of-detection/weight-of-evidence (WOE) screening, (3) screening of essential human nutrients, (4) risk-based screening, and (5) background screening.

1. **Data Quality Assessment** – Analytical results were reported by the laboratory in electronic form and loaded into a WBG database. Site data were extracted from the database so that only one result is used for each station and depth sampled. Quality control (QC) data, such as sample splits and duplicates, and laboratory re-analyses and dilutions, were not included in the determination of COPCs for this risk assessment. Field-screening data that are typically used in the evaluation of nature and extent of contamination at WBG are not included in the dataset for the risk assessment. Samples rejected in the validation process are also excluded from the risk assessment. The percentage of rejected data was less than 1%. A complete summary of data quality issues was presented in the Quality Control Summary Report (Appendix E) of the Final Phase II RI Report for WBG (USACE 2001a).

2. **Frequency-of-Detection/Weight-of-Evidence Screen** – Each chemical for each environmental medium is evaluated to determine its frequency of detection. Chemicals that were never detected are eliminated as COPCs. For sample aggregations with at least 20 samples and a frequency of detection of 5% or more (1 in 20 samples), a chemical is considered as site related. This screen is applied to all organic and inorganic chemicals with the exception of explosives and propellants. All detected explosives and propellants are included in the initial list of COPCs regardless of their frequency of detection. If a chemical has a frequency of detection of less than 5%, a WOE approach is used to determine if the chemical is site-related. For these infrequently detected chemicals, the magnitudes and locations (clustering) of the detections and potential source of the chemical were evaluated. If the detected results showed no clustering, the chemical is not a COPC in another medium at that location, the concentrations are not substantially elevated relative to the detection limit, and the chemical was not used in the area under investigation, then the chemical is considered spurious and is eliminated from further consideration. This conservative approach is applied in order not to eliminate an infrequently detected chemical if it indeed may represent a hotspot of contamination.

3. **Essential Nutrients** – Chemicals that are considered essential nutrients (i.e., calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the human food supply and are often added to foods as supplements. The U.S. Environmental Protection Agency (EPA) recommends that these chemicals not be evaluated as COPCs so long as they are (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and (2) toxic at very high doses (i.e., much higher than those that could be associated with contact at the site). Recommended daily allowance (RDA) and recommended daily intake (RDI) values are available for seven of these metals. Based on these RDA/RDI values, a receptor ingesting 100 mg of soil per day would receive less than the RDA/RDI of calcium, magnesium, phosphorus, potassium, and sodium, even if the soil consisted of the pure mineral (i.e., soil concentrations > 1,000,000 mg/kg). Receptors ingesting 100 mg of soil per day would require soil concentrations of 1,500 mg/kg of iodine and 100,000 to

180,000 mg/kg of iron to meet their RDA/RDI for these metals. Concentrations of essential nutrients do not exceed these levels at WBG; thus, these constituents are not addressed as COPCs.

4. **Risk-based Screen** – The objective of this evaluation is to identify COPCs that may pose a potentially significant risk to human health. The risk-based screening values are conservative values published by EPA. The maximum detected concentration (MDC) of each chemical in each environmental medium is compared against the appropriate risk-based screening value. Chemicals detected below these concentrations are screened from further consideration. Detected chemicals without risk-based screening values are not eliminated from the COPC list.

   The risk-based screening values are conservative values published by EPA.

   – For deep surface soil, a conservative screen is performed using the most current residential preliminary remediation goals (PRGs) published by EPA Region 9 (EPA 2002b). To account for the potential effects of multiple chemicals, PRGs based on non-cancer endpoints are divided by 10. These screening values are very conservative (based on a 10^{-6} risk level and an HQ of 0.1). For information purposes only, data from these same media are also compared against the Region 9 industrial soil PRGs. Region 9 PRGs can be found on the EPA Region 9 World Wide Web site (http://www.epa.gov/region09/waste/sfund/prg/index.html).

   – Groundwater data are screened using the EPA Region 9 tap water PRGs, which are also available at http://www.epa.gov/region09/waste/sfund/prg/index.html.

5. **Background Screen** – For each inorganic constituent detected, concentrations in WBG samples are screened against available, naturally occurring background levels. This screening step, which applies only to the inorganics, is used to determine if detected inorganics are site-related or naturally occurring. If the MDC of a constituent exceeds the background value, the constituent is considered site-related. All detected organic compounds are considered to be above background. Inorganic chemicals whose MDCs are below background levels are eliminated from the COPC list.

   Background data for evaluation of soils and groundwater at RVAAP are published in the Draft Final version of the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). Background values for soil are available for two soil depths: surface (0 to 1 ft bgs) and subsurface (1 to 12 ft bgs). Because this HHRA evaluates data over the 0-3 ft bgs range, the background screen for soils is performed using background values for either surface soil (0 to 1 ft bgs) or subsurface soil (1 to 12 ft bgs), whichever is lower.

2.1.1.2 Chemical of potential concern screening assumptions

The dataset used to determine COPCs includes data collected from Phases I and II, as well as data collected during the ecological field-truthing study. The following assumptions, used in the development of COPCs for this HHRA, are noted.

- Chemicals not detected in a medium are not considered to be COPCs.

- Physical chemical data (e.g., alkalinity, pH, etc.) are not considered to be COPCs for WBG.

- Alpha-chlordane and gamma-chlordane are evaluated by screening against the EPA Region 9 PRGs for chlordane.

- Endosulfan I, endosulfan II, and endosulfan sulfate are evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for endosulfan.

- Endrin aldehyde and endrin ketone are evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for endrin.

- 1,2-Dichloroethene is evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for *cis*-1,2-dichloroethene.

- *cis*-1,3-Dichloropropene and *trans*-1,3-dichloropropene are evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for 1,3-dichloropropene.

- Because groundwater samples had high turbidity, filtered metals data for groundwater are used in this risk assessment (Mohr 1998). See the Final Phase III RI report (USACE 2001a) for a detailed discussion on filtered groundwater data.

2.1.1.3 Chemical of potential concern screening results

The COPC screening process and results are summarized in Tables 2-1 and 2-2 for groundwater and deep surface soil, respectively. These tables include

- summary statistics, including frequency of detection, range of detected concentrations, arithmetic average concentration, and 95% upper confidence limit (UCL_{95}) on the mean concentration;

- all screening values (background concentrations and PRGs, as appropriate); and

- final COPC status.

The COPCs are classified as quantitative COPCs or qualitative COPCs based on the availability of EPA-approved toxicity information. COPCs are classified as quantitative if EPA-approved toxicity information is available; hence, risks and hazards can be quantified for these COPCs. COPCs are classified as qualitative if no EPA-approved toxicity information is available; risks and hazards cannot be calculated for these COPCs. Note, however, that toxicity profiles are provided in the BHHRA for WBG, found in the Final Phase II RI Report for WBG (USACE 2001a), for both quantitative and qualitative COPCs. The results of the COPC selection process for each medium are provided in Table 2-3. The chemicals determined to be qualitative COPCs are discussed in Section 2.1.3.5. Quantitative COPCs are evaluated quantitatively (i.e., by calculating risks and/or hazards) for deep surface soil in Section 2.1.5. Groundwater COPCs are not evaluated further.

2.1.2 Exposure Assessment

The objectives of the exposure assessment are to estimate the magnitude, frequency, and duration of potential human exposure to COPCs. The four primary steps of the exposure assessment are listed below.

1. Identify the exposure setting, including the proposed Mark 19 Range, and the human receptors associated with that land use.

2. Identify exposure pathways associated with the Mark 19 Range at WBG.

3. Quantify the Mark 19 Range receptor's potential intake of each COPC.

4. Identify the concentrations of COPCs to which the receptor may be exposed.

Table 2-2. Summary of COPC Screening for Winklepeck Burning Grounds Soil

Analyte	CAS Number	Units	Results > Detection Limit	Average Result	Minimum Detect	Maximum Detect	UCL_{95} of Mean	Exposure Concentration	Site Backgd. Criteria	Region 9 Residential PRG	Region 9 Industrial PRG	COPC?
Winklepeck Burning Grounds												
Explosives												
1,3,5-Trinitrobenzene	99-35-4	mg/kg	41/ 176	4.8E+00	2.7E-02	4.9E+02	9.5E+00	9.5E+00	NA	1.8E+02	1.8E+03	Yes
1,3-Dinitrobenzene	99-65-0	mg/kg	10/ 176	4.7E-01	3.6E-02	2.6E-01	7.9E-01	2.6E-01	NA	6.1E-01	6.2E+00	No
2,4,6-Trinitrotoluene	118-96-7	mg/kg	77/ 176	9.1E+01	3.0E-02	3.8E+03	1.5E+02	1.5E+02	NA	3.1E+00	3.1E+01	Yes
2,4-Dinitrotoluene	121-14-2	mg/kg	30/ 176	1.8E-01	3.2E-02	1.5E+00	2.4E-01	2.4E-01	NA	7.2E-01	2.5E+00	Yes
2,6-Dinitrotoluene	606-20-2	mg/kg	8/ 176	8.6E-01	7.5E-02	6.2E-01	1.4E+00	6.2E-01	NA	7.2E-01	2.5E+00	No
2-Amino-4,6-dinitrotoluene	35572-78-2	mg/kg	8/ 28	1.1E+00	9.9E-02	1.4E+01	2.0E+00	2.0E+00	NA	NA	NA	Yes
2-Nitrotoluene	88-72-2	mg/kg	4/ 176	4.7E-01	7.4E-02	4.8E+00	8.0E-01	8.0E-01	NA	3.7E+01	1.8E+02	No
3-Nitrotoluene	99-08-1	mg/kg	6/ 176	4.2E-01	8.6E-02	2.1E+01	6.6E-01	6.6E-01	NA	3.7E+01	1.8E+02	No
4-Amino-2,6-dinitrotoluene	19406-51-0	mg/kg	9/ 28	5.4E+00	9.2E-02	9.3E-01	1.0E+01	9.3E-01	NA	NA	NA	Yes
4-Nitrotoluene	99-99-0	mg/kg	7/ 176	4.8E-01	8.4E-02	1.9E-01	8.0E-01	1.9E-01	NA	3.7E+01	1.8E+02	No
HMX	2691-41-0	mg/kg	42/ 176	1.8E+01	1.0E-01	1.7E+03	3.4E+01	3.4E+01	NA	3.1E+02	3.1E+03	Yes
Nitrobenzene	98-95-3	mg/kg	8/ 176	4.7E-01	3.3E-02	3.6E-01	8.0E-01	3.6E-01	NA	2.0E+00	1.0E+01	No
Nitrocellulose	9004-70-0	mg/kg	9/ 29	2.3E+01	2.5E+00	3.2E+02	4.4E+01	4.4E+01	NA	NA	NA	Yes
Nitroglycerin	55-63-0	mg/kg	3/ 98	1.9E+00	5.5E+00	1.2E+01	2.2E+00	2.2E+00	NA	3.5E+01	1.2E+02	No
Nitroguanidine	556-88-7	mg/kg	1/ 29	1.2E-01	9.1E-02	9.1E-02	1.3E-01	9.1E-02	NA	6.1E+02	6.2E+03	No
RDX	121-82-4	mg/kg	34/ 176	9.8E+01	1.4E-01	9.5E+03	1.9E+02	1.9E+02	NA	4.4E+00	1.6E+01	Yes
Tetryl	479-45-8	mg/kg	8/ 176	1.2E+00	5.4E-02	4.8E-01	2.1E+00	4.8E-01	NA	6.1E+01	6.2E+02	No
Metals												
Aluminum	7429-90-5	mg/kg	319/ 319	1.3E+04	1.4E+03	5.0E+04	1.3E+04	1.3E+04	1.8E+04	7.6E+03	9.2E+04	Yes
Antimony	7440-36-0	mg/kg	140/ 248	5.2E+00	3.4E-01	2.4E+02	7.2E+00	7.2E+00	9.6E-01	3.1E+00	4.1E+01	Yes
Arsenic	7440-38-2	mg/kg	320/ 320	1.3E+01	3.1E-01	3.8E+01	1.3E+01	1.3E+01	1.5E+01	3.9E-01	1.6E+00	Yes
Barium	7440-39-3	mg/kg	318/ 319	3.5E+02	1.2E+01	1.0E+04	4.4E+02	4.4E+02	8.8E+01	5.4E+02	6.7E+03	Yes
Beryllium	7440-41-7	mg/kg	153/ 246	5.1E-01	1.4E-01	1.1E+01	6.1E-01	6.1E-01	8.8E-01	1.5E+01	1.9E+02	No
Cadmium	7440-43-9	mg/kg	219/ 318	6.9E+00	6.0E-02	8.8E+02	1.2E+01	1.2E+01	NA	3.7E+00	4.5E+01	Yes
Calcium	7440-70-2	mg/kg	240/ 247	9.4E+03	1.3E+02	2.5E+05	1.1E+04	1.1E+04	1.6E+04	NA	NA	No
Chromium	7440-47-3	mg/kg	319/ 319	2.0E+01	3.4E+00	1.9E+02	2.1E+01	2.1E+01	1.7E+01	2.1E+02	4.5E+02	No
Chromium, hexavalent	18540-29-9	mg/kg	18/ 46	2.7E+00	2.0E+00	1.2E+01	3.5E+00	3.5E+00	NA	2.2E+01	6.4E+01	No
Cobalt	7440-48-4	mg/kg	245/ 247	8.9E+00	9.2E-01	2.5E+01	9.3E+00	9.3E+00	1.0E+01	1.4E+02	1.3E+03	No
Copper	7440-50-8	mg/kg	245/ 247	2.0E+02	5.8E+00	1.7E+04	3.1E+02	3.1E+02	1.8E+01	3.1E+02	4.1E+03	Yes
Cyanide	57-12-5	mg/kg	20/ 136	4.3E-01	6.4E-02	4.6E+00	5.0E-01	5.0E-01	NA	1.2E+02	1.2E+03	No
Iron	7439-89-6	mg/kg	247/ 247	2.6E+04	1.4E+03	1.6E+05	2.7E+04	2.7E+04	2.3E+04	2.3E+03	3.1E+04	No

Table 2-2. Summary of COPC Screening for Winklepeck Burning Grounds Soil (continued)

Analyte	CAS Number	Units	Results > Detection Limit	Average Result	Minimum Detect	Maximum Detect	UCL_{95} of Mean	Exposure Concentration	Site Backgd. Criteria	Region 9 Residential PRG	Region 9 Industrial PRG	COPC?
Lead	7439-92-1	mg/kg	319/ 320	1.4E+02	5.6E+00	2.8E+03	1.7E+02	1.7E+02	1.9E+01	4.0E+02	7.5E+02	Yes
Magnesium	7439-95-4	mg/kg	247/ 247	3.5E+03	9.4E+02	5.4E+04	4.0E+03	4.0E+03	3.0E+03	NA	NA	No
Manganese	7439-96-5	mg/kg	319/ 319	6.2E+02	6.5E+01	4.3E+03	6.7E+02	6.7E+02	1.5E+03	1.8E+02	1.9E+03	Yes
Mercury	7487-94-6	mg/kg	223/ 320	7.4E-02	1.3E-02	1.4E+00	8.7E-02	8.7E-02	3.6E-02	2.3E+00	3.1E+01	No
Nickel	7440-02-0	mg/kg	245/ 247	2.1E+01	7.0E+00	1.3E+02	2.2E+01	2.2E+01	2.1E+01	1.6E+02	2.0E+03	No
Potassium	7440-09-7	mg/kg	247/ 247	1.3E+03	2.2E+02	3.7E+03	1.4E+03	1.4E+03	9.3E+02	NA	NA	No
Selenium	7782-49-2	mg/kg	213/ 320	9.0E-01	3.4E-01	5.0E+00	9.7E-01	9.7E-01	1.4E+00	3.9E+01	5.1E+02	No
Silver	7440-22-4	mg/kg	58/ 319	1.0E+00	2.0E-01	3.3E+01	1.3E+00	1.3E+00	NA	3.9E+01	5.1E+02	No
Sodium	7440-23-5	mg/kg	109/ 240	2.2E+02	1.9E+01	2.3E+03	2.4E+02	2.4E+02	1.2E+02	NA	NA	No
Thallium	6533-73-9	mg/kg	152/ 248	4.7E-01	1.7E-01	3.1E+00	5.1E-01	5.1E-01	NA	5.2E-01	6.7E+00	Yes
Vanadium	7440-62-2	mg/kg	246/ 247	2.2E+01	4.8E+00	4.5E+01	2.3E+01	2.3E+01	3.1E+01	5.5E+01	7.2E+02	No
Zinc	7440-66-6	mg/kg	317/ 319	3.5E+02	2.9E+01	2.5E+04	4.8E+02	4.8E+02	6.2E+01	2.3E+03	3.1E+04	Yes
Organics - Pesticide/PCB												
4,4'-DDT	50-29-3	mg/kg	1/ 19	1.6E-02	1.3E-01	1.3E-01	3.0E-02	3.0E-02	NA	1.7E+00	7.0E+00	No
Dieldrin	60-57-1	mg/kg	2/ 19	1.0E-02	2.4E-03	5.4E-03	1.9E-02	5.4E-03	NA	3.0E-02	1.1E-01	No
Endrin Ketone	53494-70-5	mg/kg	1/ 19	9.8E-03	4.3E-03	4.3E-03	1.9E-02	4.3E-03	NA	1.8E+00	1.8E+01	No
Heptachlor Epoxide	1024-57-3	mg/kg	2/ 19	1.5E-02	5.1E-02	8.1E-02	2.7E-02	2.7E-02	NA	5.3E-02	1.9E-01	Yes
PCB-1254	11097-69-1	mg/kg	1/ 19	3.7E-02	1.4E-01	1.4E-01	4.9E-02	4.9E-02	NA	1.1E-01	7.4E-01	Yes
PCB-1260	11096-82-5	mg/kg	2/ 19	5.7E-02	1.7E-01	4.6E-01	9.8E-02	9.8E-02	NA	2.2E-01	7.4E-01	Yes
Organics - Semivolatile												
2-Methylnaphthalene	91-57-6	mg/kg	13/ 59	2.8E+00	4.7E-02	1.7E+01	6.2E+00	6.2E+00	NA	NA	NA	Yes
Acenaphthene	83-32-9	mg/kg	5/ 59	1.6E+00	1.4E-01	6.5E+01	3.4E+00	3.4E+00	NA	3.7E+02	2.9E+03	No
Anthracene	120-12-7	mg/kg	9/ 59	7.2E+00	5.4E-02	4.0E+02	1.9E+01	1.9E+01	NA	2.2E+03	2.4E+04	No
Benz(*a*)anthracene	56-55-3	mg/kg	13/ 59	1.0E+01	4.3E-02	5.7E+02	2.6E+01	2.6E+01	NA	6.2E-01	2.1E+00	Yes
Benzo(*a*)pyrene	50-32-8	mg/kg	13/ 59	9.2E+00	4.0E-02	5.1E+02	2.4E+01	2.4E+01	NA	6.2E-02	2.1E-01	Yes
Benzo(*b*)fluoranthene	205-99-2	mg/kg	14/ 59	1.1E+01	5.4E-02	6.2E+02	2.9E+01	2.9E+01	NA	6.2E-01	2.1E+00	Yes
Benzo(*g*,*h*,*i*)perylene	191-24-2	mg/kg	10/ 59	5.2E+00	1.1E-01	2.8E+02	1.3E+01	1.3E+01	NA	NA	NA	Yes
Benzo(*k*)fluoranthene	207-08-9	mg/kg	10/ 59	5.2E+00	6.5E-02	2.8E+02	1.3E+01	1.3E+01	NA	6.2E+00	2.1E+01	Yes
Bis(2-ethylhexyl)phthalate	117-81-7	mg/kg	3/ 59	2.5E+00	3.4E-02	1.4E-01	5.9E+00	1.4E-01	NA	3.5E+01	1.2E+02	No
Carbazole	86-74-8	mg/kg	6/ 59	3.7E+00	5.7E-02	1.9E+02	9.0E+00	9.0E+00	NA	2.4E+01	8.6E+01	Yes
Chrysene	218-01-9	mg/kg	12/ 59	9.7E+00	5.0E-02	5.4E+02	2.5E+01	2.5E+01	NA	6.2E+01	2.1E+02	Yes
Di-n-butyl phthalate	84-74-2	mg/kg	6/ 59	2.9E+00	5.3E-02	2.6E+01	6.4E+00	6.4E+00	NA	6.1E+02	6.2E+03	No

Table 2-2. Summary of COPC Screening for Winklepeck Burning Grounds Soil (continued)

Analyte	CAS Number	Units	Results > Detection Limit	Average Result	Minimum Detect	Maximum Detect	UCL_{95} of Mean	Exposure Concentration	Site Backgd. Criteria	Region 9 Residential PRG	Region 9 Industrial PRG	COPC?
Dibenz(*a*,*h*)anthracene	53-70-3	mg/kg	8/ 59	1.4E+00	5.4E-02	5.9E+01	3.1E+00	3.1E+00	NA	6.2E-02	2.1E-01	Yes
Dibenzofuran	132-64-9	mg/kg	5/ 59	2.3E+00	4.5E-02	1.1E+02	5.4E+00	5.4E+00	NA	2.9E+01	3.1E+02	Yes
Fluoranthene	206-44-0	mg/kg	18/ 59	2.6E+01	4.0E-02	1.5E+03	6.9E+01	6.9E+01	NA	2.3E+02	2.2E+03	Yes
Fluorene	86-73-7	mg/kg	5/ 59	2.7E+00	1.8E-01	1.3E+02	6.3E+00	6.3E+00	NA	2.7E+02	2.6E+03	No
Indeno(1,2,3-*cd*)pyrene	193-39-5	mg/kg	10/ 59	5.9E+00	1.3E-01	3.2E+02	1.5E+01	1.5E+01	NA	6.2E-01	2.1E+00	Yes
N-Nitrosodiphenylamine	86-30-6	mg/kg	2/ 59	2.5E+00	6.6E-01	1.5E+00	5.9E+00	1.5E+00	NA	9.9E+01	3.5E+02	No
Naphthalene	91-20-3	mg/kg	10/ 59	1.5E+00	4.1E-02	6.2E+01	3.3E+00	3.3E+00	NA	5.6E+00	1.9E+01	Yes
Phenanthrene	85-01-8	mg/kg	19/ 59	2.3E+01	5.2E-02	1.3E+03	5.9E+01	5.9E+01	NA	NA	NA	Yes
Pyrene	129-00-0	mg/kg	16/ 59	1.9E+01	3.6E-02	1.1E+03	5.0E+01	5.0E+01	NA	2.3E+02	2.9E+03	Yes
Organics - Volatile												
1,2-Dimethylbenzene	95-47-6	mg/kg	1/ 10	4.4E-03	2.0E-02	2.0E-02	7.5E-03	7.5E-03	NA	NA	NA	Yes
Acetone	67-64-1	mg/kg	2/ 24	7.8E-03	4.9E-03	5.2E-02	1.1E-02	1.1E-02	NA	1.6E+02	6.0E+02	No
Benzene	71-43-2	mg/kg	1/ 28	4.0E-03	3.2E-02	3.2E-02	5.7E-03	5.7E-03	NA	6.0E-01	1.3E+00	No
Chloroform	67-66-3	mg/kg	4/ 28	3.6E-03	2.0E-03	2.3E-02	4.8E-03	4.8E-03	NA	3.6E-01	1.2E+00	No
Dimethylbenzene	1330-20-7	mg/kg	2/ 28	4.4E-03	2.0E-02	2.6E-02	6.1E-03	6.1E-03	NA	2.7E+01	9.0E+01	No
Ethylbenzene	100-41-4	mg/kg	2/ 28	9.2E-03	2.1E-02	1.6E-01	1.9E-02	1.9E-02	NA	8.9E+00	2.0E+01	No
Methylene Chloride	75-09-2	mg/kg	2/ 28	5.2E-03	6.6E-03	1.2E-02	7.2E-03	7.2E-03	NA	9.1E+00	2.1E+01	No
Styrene	100-42-5	mg/kg	1/ 28	4.1E-03	3.6E-02	3.6E-02	6.1E-03	6.1E-03	NA	4.4E+02	1.8E+03	No
Toluene	108-88-3	mg/kg	13/ 28	2.1E-02	4.3E-04	1.9E-01	3.6E-02	3.6E-02	NA	6.6E+01	2.2E+02	No
Trichloroethene	79-01-6	mg/kg	2/ 28	3.2E-03	1.1E-03	1.2E-03	4.0E-03	1.2E-03	NA	5.3E-02	1.1E-01	No

CAS = Chemical Abstracts Service.
COPC = Chemical of potential concern.
DDT = Dichlorodiphenyltrichloroethane.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
NA = No background criterion available.
PCB = Polychlorinated biphenyl.
PRG = Preliminary remediation goal
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine..
UCL = Upper confidence limit.

Table 2-3. Summary of Human Health COPCs at Winklepeck Burning Grounds[a]

COPC	Groundwater	Deep Surface Soil
Quantitative COPCs[b]		
Explosives		
1,3,5-Trinitrobenzene		WBG
2,4,6-Trinitrotoluene		WBG
2,4-Dinitrotoluene	7,8	WBG
2,6-Dinitrotoluene	7,8	
HMX		WBG
RDX	7	WBG
Metals		
Aluminum		WBG
Antimony		WBG
Arsenic	7	WBG
Barium		WBG
Cadmium		WBG
Copper		WBG
Lead[c]		WBG
Manganese	7	WBG
Thallium		WBG
Zinc		WBG
Pesticides/PCBs		
Heptachlor Epoxide	8	WBG
PCB-1254		WBG
PCB-1260		WBG
Semivolatile Organic Compounds		
2-Methylnaphthalene		WBG
Benz(*a*)anthracene		WBG
Benzo(*a*)pyrene		WBG
Benzo(*b*)fluoranthene		WBG
Benzo(*k*)fluoranthene		WBG
Bis(2-ethylhexyl)phthalate	7	
Carbazole		WBG
Chrysene		WBG
Dibenz(*a,h*)anthracene		WBG
Dibenzofuran		WBG
Fluoranthene		WBG
Indeno(1,2,3-*cd*)pyrene		WBG
Naphthalene		WBG
Pyrene		WBG
Volatile Organic Compounds		
1,2-Dimethylbenzene		WBG
Qualitative COPCs[d]		
Explosives		
2-Amino-4,6-dinitrotoluene	8	WBG
4-Amino-2,6-dinitrotoluene	8	WBG
Nitrocellulose		WBG

Table 2-3. Summary of Human Health COPCs at Winklepeck Burning Grounds[a] (continued)

COPC	Groundwater	Deep Surface Soil
Semivolatile Organic Compounds		
Benzo(*g,h,i*)perylene		WBG
Phenanthrene		WBG

[a]COPC codes are as follows:
7 = Groundwater COPC for Area 7 - Existing Monitoring Wells.
8 = Groundwater COPC for Area 8 - New Monitoring Wells.
WBG = Surface soil COPC for Winklepeck Burning Grounds.
[b]COPCs are classified as quantitative when toxicity values from the U.S. Environmental Protection Agency (EPA) are available to quantify risks and hazards.
[c]Although lead does not have toxicity values from EPA, this COPC is evaluated quantitatively using EPA's adult lead model.
[d]COPCs are classified as qualitative when toxicity values from EPA are not available to quantify risks and hazards.
COPC = Chemical of potential concern.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

The output of the exposure assessment is used in conjunction with the output of the toxicity assessment (Section 2.1.3) to quantify risks and hazards to receptors in the risk characterization (Section 2.1.4).

2.1.2.1 Land use and potential receptors

The Army and OHARNG now have a MOU that identifies future land use for RVAAP. This MOU identifies the Mark 19 Range as the land use for WBG. There is one potential human receptor for this land use: the National Guard Range Maintenance Soldier, the only receptor evaluated in this HHRA for this FFS.

The Range Maintenance Soldier is described as follows (see also Chapter 1.0).

- This receptor is responsible for both routine maintenance of the range and targets and annual clearance of practice rounds.
- The soldier performs these duties using a combination of walking over the range, driving over the range in an all-terrain-vehicle-style vehicle, and driving on access roads in a closed vehicle, such as a pickup truck.
- At a minimum, the soldier wears a short-sleeved shirt, long pants, and boots.
- The receptor is present at the range 85 days/year, for 6 hrs/day (i.e., 42 weekends per year, 4 hrs before use and 8 hrs after use, plus 1 day for annual clearance). This equates to 12 hrs over 2 days (4 hrs, 1 day before use plus 8 hrs, 1 day after use = 12 hrs), or an average of 6 hrs/day. The Range Maintenance Soldier spends the rest of the workday performing other duties at RTLS. This scenario assumes the same soldier (or soldiers) performs these duties all year for a 25-year enlistment.
- The Range Maintenance Soldier is assumed to have an inhalation rate of 27.6 m^3/day. This assumes the receptor spends 75% of their time in light activities and 25 % of their time in moderate activities.
- The receptor may spend a given day in a small area of the range, but over the course of the year, the receptor will conduct activities over the entire range.

- This scenario will be protective of users of the range who are present for a much shorter time (i.e., 4 days/year for 12 hrs/day for training). This is based on an individual National Guard Trainee who may train at the range a maximum of 4 days/year with a normal training day of 8 to 12 hrs (i.e., trainees will not bivouac at the range).

The Range Maintenance Soldier is a more conservative exposure scenario than the National Guard Trainee described in the FWHHRAM (USACE 2004). The National Guard Trainee is present for his routing training (one weekend/month and 2 weeks/year). The Range Maintenance Soldier is stationed full time at RTLS and conducts maintenance at the Mark 19 Range every weekend that it is used (42 weekends/year). The same trainees are not at the range each of these 42 weekends but the same Range Maintenance Soldier is. Other receptors will not be on-site at WBG other than the National Guard Trainee; thus, they are not applicable and are not evaluated. The National Guard Trainee exposure is much lower than the Range Maintenance Soldier; therefore, only the Range Maintenance Soldier is analyzed in the risk assessment and is the basis for RGO development. If land use changes for WBG, then risk, RGOs, and the protectiveness of the remedy will require re-evaluation. The Land Use Control Implementation Plan (LUCIP) will provide administrative controls over future land uses within WBG.

2.1.2.2 Exposure pathways

An exposure pathway is made up of the following components:

- source,
- release mechanism (e.g., volatilization),
- transport pathway,
- exposure point,
- exposure route, and
- receptor.

Potential exposure pathways associated with the National Guard Range Maintenance Soldier are shown in Figure 2-1.

Pathway	National Guard Range Maintenance Soldier
Deep Surface Soils (0 to 3 ft bgs)	
Incidental soil ingestion	l
Dermal contact with soil	l
Inhalation of VOCs and dust	l

bgs = Below ground surface.
VOC = Volatile organic compound.
= Pathway is evaluated in this human health risk assessment.

Figure 2-1. Conceptual Exposure Model for National Guard Range Maintenance Soldier at Winklepeck Burning Grounds

A discussion of the Range Maintenance Soldier is provided below. The exposure parameters for each pathway are provided in Table 2-4.

Table 2-4. Exposure Parameters for National Guard Range Maintenance Soldier

	Units	Value	Source
Incidental Ingestion			
Soil ingestion rate	kg/day	0.0001	RAGS Part B (EPA 1991)[a]
Exposure time	hrs/day	6	Site-specific per Col. Tadsen[b]
Exposure frequency	days/year	85	Site-specific per Col. Tadsen[b]
Exposure duration	years	25	Assumed enlistment period[a]
Body weight	kg	70	RAGS Part B (EPA 1991)[a]
Carcinogen averaging time	days	25,550	RAGS Part B (EPA 1991)[a]
Noncarcinogen averaging time	days	9,125	RAGS Part B (EPA 1991)[a]
Fraction ingested	Unitless	1	Conservative assumption[a]
Conversion factor	days/hr	0.042	
Dermal Contact			
Skin area	m^2/event	0.33	Head, hands, and forearms, *Exposure Factors Handbook* (EPA 1997a)[a]
Adherence factor	mg/cm^2	0.3	Value for construction worker (95th percentile); values from RAGS Part E (EPA 2002a)[a]
Absorption fraction	Unitless	Chemical-specific	Chemical-specific absorption fraction values from RAGS Part E (EPA 2002a) or default values from the FWHHRAM (USACE 2004b): SVOCs = 10%; VOCs = 1%; and inorganics = 0.1.[a]
Exposure frequency	Events/year	85	Site-Specific per Col. Tadsen[b]
Exposure duration	years	25	Assumed enlistment period[a]
Body weight	kg	70	RAGS Part B (EPA 1991)[a]
Carcinogen averaging time	days	25550	RAGS Part B (EPA 1991)[a]
Noncarcinogen averaging time	days	9125	RAGS Part B (EPA 1991)[a]
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	0.01	
Inhalation of VOCs and Dust			
Inhalation rate	m^3/day	27.6	Site-specific per Col. Tadsen[c]
Exposure time	hrs/day	6	Site-specific per Col. Tadsen[b]
Exposure frequency	days/year	85	Site-specific per Col. Tadsen[b]
Exposure duration	years	25	Assumed enlistment period[a]
Body weight	kg	70	RAGS Part B (EPA 1991)[a]
Carcinogen averaging time	days	25,550	RAGS Part B (EPA 1991)[a]
Noncarcinogen averaging time	days	9,125	RAGS Part B (EPA 1991)[a]
Particulate emission factor	m^3/kg	9.24E+08	Default value for Cleveland, OH, assuming a 0.5-acre source area[d]
Conversion factor	days/hr	0.042	

[a]Value is the same as that cited in the Facility-wide Work Plan and Supplemental Baseline Human Health Risk Assessment for Load Line 1 for National Guard Trainee.
[b]The Range Maintenance Soldiers will spend 4 hrs in the impact area of the range prior to use each weekend, and 8 hrs after use, during 42 scheduled weekends each year. This is the equivalent of 84 days/year for 6 hrs/day. The soldiers will also spend 1 additional day/year conducting annual range clearance.
[c]The Range Maintenance Soldiers will be engaged in light activity 75% of the time and moderate activity 25% of the time.
[d]Value is the same as that cited in Facility-wide Work Plan and Supplemental Baseline Human Health Risk Assessment for Load Line 1 for all receptors except the National Guard Trainee. The lower National Guard Trainee value is not used because this receptor will not be generating large quantities of dust (i.e., there will be no tanks).
FWHHRAM = *RVAAP's Facility-Wide Human Health Risk Assessor's Manual* (USACE 2004b).
RAGS = Risk Assessment Guidance for Superfund.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.

The Range Maintenance Soldier will be exposed to the following media.

- Deep surface soil – defined as 0 to 3 ft bgs. Exposure to 3 ft bgs in target array areas is the assumed maximum depth of exposure based on construction assumptions for target array foundations. Exposure in all other areas will be to approximately 6 in. bgs due to disturbance by target practice rounds. Clean soil from an approved borrow area will be used to build the berms needed to protect target tracks and monitoring wells.

- Groundwater – may be pumped at some time at Building T5301 for non-potable (e.g., vehicle washing) use by this and other receptors. OHANRG is working to install potable water supply from public sources (and sanitary sewer) so long-term use of groundwater is unlikely. Therefore, groundwater is not evaluated further in this HHRA. Note: groundwater COPCs were identified in Section 2.1.1 and are listed in Tables 2-1 and 2-3.

- The Range Maintenance Soldier will not be exposed to subsurface soil (below 3 ft bgs), surface water, or sediment. Maintenance of drainage will prevent surface impoundments.

Best management practices that have been determined to be protective of human health and environment will be employed to ensure that range activities minimize impacts to environmental media (e.g., soil and sediment).

2.1.2.3 Quantification of intake

Intake is defined as the amount of contaminant that could be in contact with the body (e.g., lungs and gut) per unit body weight per unit time. Dose is defined as the amount of contaminant that could be absorbed into the bloodstream per unit body weight per unit time. For this HHRA, the intakes (for inhalation and ingestion exposures) and doses (for dermal exposures) were quantified for the National Guard Range Maintenance Soldier using methods presented in the FWHHRAM (USACE 2004b). The equations used to estimate intake and dose are presented in the following subsections. The exposure parameters used in these equations are provided in Table 2-4; chemical-specific factors used in these equations are shown in Table 2-5. Parameter values were selected based on site-specific receptor activity pattern information provided by OHARNG and RVAAP facility staff with input from Ohio EPA.

Soil exposure pathways

Incidental ingestion of soils was estimated for chemicals using Equation 2-1:

$$Chemical\ Intake\ (mg/kg\text{-}day) = \frac{C_S \times IR_S \times EF \times ED \times FI \times ET \times CF}{BW \times AT}, \qquad \textbf{(2-1)}$$

where

C_s	=	chemical concentration in soils (mg/kg),
IR_s	=	ingestion rate (kg/day),
EF	=	exposure frequency (days/year),
ED	=	exposure duration (years),
FI	=	fraction ingested (value of 1, unitless),
ET	=	exposure time adjustment (hr/day),
CF	=	conversion factor for ET (day/hr),
BW	=	body weight (kg),
AT	=	averaging time (days) for carcinogens or noncarcinogens.

Table 2-5. Chemical-Specific Exposure Parameters

COPC	Dermal Absorption Factor[a] (unitless)	Soil Volatilization Factor[b] (m^3/kg)
Aluminum	0.001	
Antimony	0.001	
Arsenic	0.03	
Barium	0.001	
Cadmium	0.001	
Copper	0.001	
Manganese	0.001	
Thallium	0.001	
Zinc	0.001	
1,2-Dimethylbenzene	0.01	8.07E+03
1,3,5-Trinitrobenzene	0.1	
2,4,6-Trinitrotoluene	0.1	
2,4-Dinitrotoluene	0.1	
2-Methylnaphthalene	0.1	2.59E+05
Benz(*a*)anthracene	0.13	
Benzo(*a*)pyrene	0.13	
Benzo(*b*)fluoranthene	0.13	
Benzo(*k*)fluoranthene	0.13	
Carbazole	0.1	
Chrysene	0.13	
Dibenz(*a*,*h*)anthracene	0.13	
Dibenzofuran	0.1	
Fluoranthene	0.13	
HMX	0.1	
Heptachlor Epoxide	0.1	
Indeno(1,2,3-*cd*)pyrene	0.13	
Naphthalene	0.13	6.40E+04
PCB-1254	0.14	
PCB-1260	0.14	
Pyrene	0.13	
RDX	0.1	

[a]Chemical-specific absorption factor values from RAGS Part E (EPA 2002a). When chemical-specific values are not available, the following default values from the FWHHRAM (USACE 2004b) are used:
SVOCs = 0.1, VOCs = 0.01, inorganics = 0.001.
[b]Volatilization factors (VFs) calculated using methods from the *Soil Screening Guidance: User's Guide* (EPA 1996), using site-specific parameter values for Cleveland, OH. Only used for VOCs.
COPC = Chemical of potential concern.
FWHHRAM = *RVAAP's Facility Wide Human Health Risk Assessor's Manual* (USACE 2004b).
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazoxine.
PCB = Polychlorinated biphenyl.
RAGS = Risk Assessment Guidance for Superfund.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.

The dermally absorbed dose (DAD) from chemicals in soils was calculated by using Equation 2-2.

$$Chemical\ DAD\ (mg/kg - day) = \frac{C_s \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}, \qquad \textbf{(2-2)}$$

where

C_s = chemical concentration in soils (mg/kg),
CF = conversion factor [$(10^{-6}$ kg/mg$) \times (10^4$ cm^2/m$^2)$],
SA = skin surface area exposed to soil (m^2/event),
AF = soil to skin adherence factor (1 mg/cm^2),
ABS = chemical-specific absorption factor (Table 2-5; when chemical-specific values are not available, the following defaults are used: 0.1% for inorganics, 1.0% for VOCs, and 10% for SVOCs),
EF = exposure frequency (events/year),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or noncarcinogens.

Inhalation of soils was calculated using Equation 2-3:

$$Chemical\ Intake\ (mg/kg-day) = \frac{C_s \times IR_a \times EF \times ED \times (VF^{-1} + PEF^{-1}) \times ET \times CF}{BW \times AT}\ , \qquad \textbf{(2-3)}$$

where

C_s = chemical concentration in soils (mg/kg),
IR_a = inhalation rate (m^3/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
VF = volatilization factor [chemical-specific (Table 2-5), m^3/kg],
PEF = particulate emission factor (m^3/kg),
ET = exposure time adjustment (hr/day),
CF = conversion factor for ET (day/hr),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or noncarcinogens.

The general particulate emission factor (PEF) value used for the National Guard Range Maintenance Soldier is the default value for Cleveland, Ohio, assuming a 0.5-acre source area (9.24E+08 m^3/kg). This PEF value was calculated using the EPA Soil Screening Guidance on-line at http://risk.lsd.ornl.gov/epa/ssl1.htm (EPA 1996). Contamination tends to be limited to small areas; therefore, a 0.5-acre contaminated source area is considered appropriate.

Chemical-specific parameters used in this HHRA (the dermal absorption factor and the soil volatilization factor) are shown in Table 2-5.

2.1.2.4 Exposure point concentrations

The exposure point concentration (EPC) represents the chemical concentration a receptor is likely to come in contact with over the duration of exposure. Exposure concentrations from direct contact with environmental media (e.g., soils) are based on the sampling results of the media as described below.

Exposure from the three direct contact pathways (ingestion, dermal contact, and inhalation) represents exposure to media at the source, and the EPC is based on data collected at the source. Current measured concentrations of chemicals were used to represent future concentrations in the medium or media of interest.

The EPCs developed for each COPC represent a UCL_{95} on the mean or the maximum detected value for all locations within the exposure unit (EU), whichever is smaller. EPCs were calculated using EPA guidance, *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA 1992b). The data were tested using the Shapiro-Wilk test to determine distribution, normal or lognormal, of the concentrations. The UCL_{95} on the mean was calculated using the normal distribution equation (see Equation 2-4) when the concentrations are normally distributed, when concentrations are not judged to be normally or lognormally distributed, when the dataset contains fewer than five detections, or when the frequency of detection is less than 50%. For these situations, the UCL_{95} on the mean is calculated using the following equation:

$$UCL_{95}(normal) = \bar{x}_n + \frac{(t)(s_x)}{\sqrt{n}}, \qquad \textbf{(2-4)}$$

where

$\bar{x}_n$	=	mean of the untransformed data,
t	=	student-t statistic,
s_x	=	standard deviation of the untransformed data,
n	=	number of sample results available.

For lognormally distributed concentrations, the UCL_{95} on the mean is calculated using the following equation:

$$UCL_{95}(lognormal) = e^{\left(\bar{x}_l + 0.5(s_l^2) + \frac{(S_l)(H)}{\sqrt{n-1}}\right)} \qquad \textbf{(2-5)}$$

where

e	=	constant (base of the natural log, equal to 2.718),
$\bar{x}_l$	=	mean of the transformed data [l = log (x)],
s_l	=	standard deviation of the transformed data,
H	=	H-statistic,
n	=	number of sample results available.

2.1.2.5 Intake results

Results of the exposure assessment are presented in tabular format in Section 2.1.4. These results are combined with information presented in Section 2.1.3 (Toxicity Assessment) to estimate risks and hazards for the National Guard Range Maintenance Soldier in Section 2.1.4.

2.1.3 Toxicity Assessment

The purpose of the toxicity assessment is to evaluate the potential for COPCs to cause adverse health effects in exposed individuals. Where possible, it provides an estimate of the relationship between the intake or dose of a COPC and the likelihood or severity of adverse health effects as a result of that exposure. Toxic effects have been evaluated extensively by EPA. This section provides the results of the EPA evaluation of the chemicals identified as COPCs in deep surface soil at WBG.

2.1.3.1 Toxicity information and EPA guidance for noncarcinogens

Noncarcinogenic effects are evaluated by comparing an exposure or intake/dose with a reference dose (RfD) or reference concentration (RfC). The RfD and RfCs are determined using available dose-response data for individual chemicals. Scientists determine the exposure concentration or intake/dose below which no adverse effects are seen and add a safety factor (from 10 to 1,000) to determine the RfD or RfC. RfDs and RfCs are identified by scientific committees supported by EPA. The RfDs available for the COPCs present in WBG media are listed in Table 2-6 (EPA 1997b and 2004). In this HHRA, RfCs, measured in milligrams per cubic meter, were converted to RfDs expressed in units of milligrams per kilogram body weight per day by using the default adult inhalation rate and body weight [i.e., (RfC × 20 m^3/day)/70 kg = RfD] (EPA 1989).

Chronic RfDs are developed for protection from long-term exposure to a chemical (from 7 years to a lifetime); subchronic RfDs are used to evaluate short-term exposure (from 2 weeks to 7 years) (EPA 1989). Since the one potential receptor at WBG is not considered to have short-term exposures, this HHRA uses only chronic RfDs.

Toxic effects are diverse and measured in various target body organs (e.g., they may range from eye irritation to kidney or liver damage). EPA is currently reviewing methods for accounting for the difference in severity of effects; however, existing RfDs do not address this issue.

2.1.3.2 Toxicity information and EPA guidance for carcinogens

For carcinogens, risks are estimated as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as excess cancer risk, which is cancer occurrence in addition to normally expected rates of cancer development. Excess cancer risk is estimated using a cancer slope factor (CSF). The CSF is defined as a plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime (EPA 1989).

EPA expresses inhalation cancer potency as unit risk based on chemical concentration in air (i.e., risk per µg of chemical per m^3 of ambient air). These unit risks were converted to CSFs expressed in units of risk per mg of chemical per kg body weight per day by using the default adult inhalation rate and body weight [i.e., (Unit Risk × 70 kg × 1,000 µg/mg)/ 20 m^3/day].

CSFs used in the evaluation of risk from carcinogenic COPCs are listed in Table 2-7 (EPA 1997b and 2004).

2.1.3.3 Estimated toxicity values for dermal exposure

Oral and inhalation RfDs and CSFs are currently available. Dermal RfDs and CSFs were estimated from oral toxicity values using chemical-specific gastrointestinal absorption factors (GAFs) to calculate total absorbed dose. This conversion is necessary because most oral RfDs and CSFs are expressed as the amount of chemical administered per time and body weight; however, dermal exposure is expressed as an absorbed dose. Dermal toxicity factors are calculated from oral toxicity factors as shown below (EPA 1992a):

$$RfD_{dermal} = RfD_{oral} \times GAF$$

$$CSF_{dermal} = CSF_{oral}/GAF$$

Table 2-6. Noncarcinogenic RfDs for Winklepeck Burning Grounds Risk Characterization

Analyte	Oral Chronic RfD (mg/kg-day)	Confidence Level	% GI Absorption[a]	Dermal Chronic RfD (mg/kg-day)	Inhalation Chronic RfD (mg/kg-day)	RfD Basis (vehicle)	Critical Effect	Uncertainty/ Modifying Factor
Aluminum	1.0E+00	NA	1	1.0E+00	1.4E-03	NA		
Antimony	4.0E-04	Low	0.15	6.0E-05		Oral, oral-water	Gastrointestinal, liver, cardiovascular, and developmental toxicity	(O) UF = 1,000
Arsenic	3.0E-04	Medium (O)	0.95	3.0E-04		Oral, oral-water	Hyperpigmentation and keritosis and possible vascular complication	(O) UF = 3
Barium	7.0E-02	Medium (O)	0.07	4.9E-03	1.4E-04	Oral, oral-water, inhalation	(O) Increased blood pressure (human) (I) Baritosis (human)	(O) UF = 3 (I) UF = 1,000
Cadmium	1.0E-03	High	0.025	2.5E-05		Oral, oral-water	Renal toxicity, osteomalacia, osteoporosis, and significant proteinuria	(O) UF = 1,000
Copper	4.0E-02	NA	1	4.0E-02		NA		
Manganese	4.6E-02	NA	0.04	1.8E-03	1.4E-05	Oral: water, inhalation	(O) Lethargy, tremors, mental disturbance, muscle tonus, and central nervous system effects	(O) UF = 1 (O) MF = 3 (I) UF = 1,000
Thallium (as thallium carbomate)	8.0E-05	Low	1	8.0E-05		Oral (rat)	Increased levels of SGOT and LDH	UF = 3,000
Zinc	3.0E-01	Medium	0.3	9.0E-02		Oral	(O) Copper deficiency and hypochromic microcytic anemia (human) (I) Pulmonary and gastrointestinal effects (human)	UF = 100
1,2-Dimethylbenzene	2.0E+00	NA	1	2.0E+00		NA	Hyperactivity	
1,3,5-Trinitrobenzene	3.0E-02	Medium	1	3.0E-02		Oral (rat)	Methemoglobinemia and spleen-erythroid cell hyperplasia	UF = 100
2,4,6-Trinitrotoluene	5.0E-04	Medium	1	5.0E-04		Oral (dog)	Liver effects	UF = 1,000
2,4-Dinitrotoluene	2.0E-03	High	1	2.0E-03		Oral (dog)	Neurotoxicity, biliary tract hyperplasia	UF = 100
2-Methylnaphthalene	4.0E-03	Low	1	4.0E-03		Oral (mouse)	Pulmonary alveolar proteinosis	UF = 1,000
Dibenzofuran	4.0E-03	NA	1	4.0E-03		NA		

Table 2-6. Noncarcinogenic RfDs for Winklepeck Burning Grounds Risk Characterization (continued)

Analyte	Oral Chronic RfD (mg/kg-day)	Confidence Level	% GI Absorption[a]	Dermal Chronic RfD (mg/kg-day)	Inhalation Chronic RfD (mg/kg-day)	RfD Basis (vehicle)	Critical Effect	Uncertainty/ Modifying Factor
Fluoranthene	4.0E-02	Low	0.58	4.0E-02		Oral (mouse)	Nephropathy, increased liver weights, hematological alterations	UF = 3,000
HMX	5.0E-02	Low	1	5.0E-02		Oral (rat)	Hepatic lesions	UF = 1,000
Heptachlor Epoxide	1.3E-05	Low	1	1.3E-05		Oral (dog)	Increased liver weight	UF = 1,000
Naphthalene	2.0E-02	(O) Low (I) Low to Medium	0.58	2.0E-02	8.6E-04	Oral (rat) Inhal. (mouse)	(O) Decreased body weight (I) Hyperplasia and metaplasia in respiratory and olfactory epithelium	(O) UF = 3,000 (I) UF = 3,000
PCB-1254	2.0E-05	NA	0.8	2.0E-05		Oral: capsule (monkey)	Immune system toxicity (monkey)	UF = 300
Pyrene	3.0E-02	Low	0.58	3.0E-02		Oral (mouse)	Kidney effects (renal tubular pathology, decreased kidney weights)	UF = 3,000
RDX	3.0E-03	High	1	3.0E-03		Oral (rat)	Inflamed prostate	UF = 100

[a]% Gastrointestinal (GI) absorption values from EPA 2002a.
(O) indicates oral.
(I) indicates inhalation.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
NA = Not available.
MF = Modifying factor (the default modifying factor is 1).
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RfD = Reference dose.
UF = Uncertainty factor.

Table 2-7. Cancer Slope Factors for Winklepeck Burning Grounds Risk Characterization

Analyte	Oral Slope Factor (mg/kg-day)$^{-1}$	% GI Absorption[a]	Dermal Slope Factor (mg/kg-day)$^{-1}$	Inhalation Slope Factor (mg/kg-day)$^{-1}$	EPA Class	TEF	Type of Cancer
Arsenic	1.5E+00	0.95	1.5E+00	1.5E+01	A		Respiratory system tumors
Cadmium (soil)		0.025		6.3E+00	B1		Respiratory tract and lung tumors
2,4,6-Trinitrotoluene	3.0E-02	1	3.0E-02		C		Bladder transitional cell papilloma
2,4-Dinitrotoluene	6.8E-01	1	6.8E-01		B2		Liver carcinoma, mammary adenomas, fibromas (mouse)
Benz(*a*)anthracene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Stomach tumors (mouse)
Benzo(*a*)pyrene	7.3E+00	0.58	7.3E+00	3.1E+00	B2	1.0	Stomach, nasal cavity, larynx, tracheak, and pharynx
Benzo(*b*)fluoranthene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Tumors
Benzo(*k*)fluoranthene	7.3E-02	0.58	7.3E-02	3.1E-02	B2	0.01	Tumors (mouse)
Carbazole	2.0E-02	1	2.0E-02		B2		Liver tumors (mouse)
Chrysene	7.3E-03	0.58	7.3E-03	3.1E-03	B2	0.001	Carcinomas and malignant lymphoma (mouse)
Dibenz(*a,h*)anthracene	7.3E+00	0.58	7.3E+00	3.1E+00	B2	1.0	Immunodepressive effects (mouse)
Heptachlor Epoxide	9.1E+00	1	9.1E+00	9.1E+00	B2		Hepatocellular carcinoma (mouse)
Indeno(1,2,3-*cd*)pyrene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Tumors
PCB-1254	2.0E+00	0.8	2.0E+00	2.0E+00	B2		Liver hepatocellular adenomas, carcinomas, cholangiomas, or cholangiocarcinomas (rat)
PCB-1260	2.0E+00	0.8	2.0E+00	2.0E+00	B2		Liver tumors (rat)
RDX	1.1E-01	1	1.1E-01		C		Liver hepatocellular carcinomas/adenomas (mouse)

[a]% Gastrointestinal (GI) absorption values from EPA 2002a.
EPA = United States Environmental Protection Agency.
PAH = Polycyclic aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TEF = Toxicity equivalence factor - based on the relative potency of each carcinogenic PAH relative to that of benzo(*a*)pyrene.

Per the FWHHRAM (USACE 2004b), dermal CSFs and RfDs are estimated from the oral toxicity values using chemical-specific GAFs to calculate the total absorbed dose only for chemicals with GAF values < 0.5. Chemical-specific GAF values available from EPA's *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA 2002a) are used whenever possible. Not all COPCs have specific GAF values. When quantitative data are insufficient, a default GAF is used. A default value of 1.0 for organic and inorganic chemicals is used (EPA 2002a).

The GAF and resulting dermal toxicity values used in this HHRA are listed in Tables 2-6 and 2-7.

2.1.3.4 Assumptions used in the toxicity assessment

Assumptions made in assigning toxicity values for COPCs at WBG are listed below.

- Thallium as a metal is evaluated using the toxicity values for thallium carbonate. This is the form of thallium with the most conservative toxicity values.

- Toxicity equivalency factors (TEFs) are applied to carcinogenic PAHs (cPAHs) (EPA 1993a). The following TEFs are used to convert the cPAHs identified as COPCs at WBG to an equivalent concentration of benzo(*a*)pyrene.

cPAH	TEF
Benzo(*a*)pyrene	1
Benz(*a*)anthracene	0.1
Benzo(*b*)fluoranthene	0.1
Benzo(*k*)fluoranthene	0.01
Chrysene	0.001
Dibenz(*a*,*h*)anthracene	1
Indeno(1,2,3-*c*,*d*)pyrene	0.1

2.1.3.5 Chemicals without EPA toxicity values

No RfDs or CSFs are available for some detected chemicals at WBG because the noncarcinogenic and/or carcinogenic effects of these chemicals have not yet been determined. Although these chemicals may contribute to health effects from exposure to contaminated media at WBG, their effects cannot be quantified at the present time. In addition, epidemiological studies have indicated that several chemicals are not carcinogenic; consequently, these species do not have CSFs. A qualitative summary of toxicity information for WBG COPCs is presented in the Toxicity Profiles Section of the Final RI Report for WBG (USACE 2001a). As seen from Table 2-3, COPCs evaluated qualitatively in this HHRA for WBG include three explosives (2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose) and two PAHs [benzo(*g*,*h*,*i*)perylene and phenanthrene].

Previously withdrawn or provisional toxicity values are used for one COPC at WBG: benzo(*a*)pyrene uses a provisional inhalation CSF. Without this provisional value, the inhalation pathway could not be quantitatively evaluated for this chemical.

No RfDs or CSFs are available for lead. EPA (2003) recommends the use of the Interim Adult Lead Methodology (ALM) to support its goal of limiting risk of elevated fetal blood lead concentrations due to lead exposures to women of child-bearing age. This ALM is used to estimate the probability that the fetal blood lead level will exceed 10 μg/dL as a result of maternal exposure. Two equations are available to evaluate blood lead levels. The first requires only a soil ingestion rate and was considered most appropriate for the analysis at WBG. Complete documentation of the ALM is available at http://www.epa.gov/superfund/programs/lead/prods.htm. The model-supplied default values were used for all parameters with the exception of the site-specific media concentration and exposure frequency. Input parameters and results of this ALM are provided in Table 2-8; results of this model are discussed in Section 2.1.4.2.

2.1.4 Risk Characterization

The purpose of the HHBRA is to evaluate the information obtained through the exposure and toxicity assessments to estimate potential risks and hazards. Potential carcinogenic effects are characterized by using projected intakes and chemical-specific dose-response data (i.e., CSFs) to estimate the probability that an individual will develop cancer over a lifetime. Potential noncarcinogenic effects are characterized by comparing projected intakes of contaminants to toxicity values (i.e., RfDs). The numerical risk and hazard estimates presented in this chapter must be interpreted in the context of the uncertainties and assumptions associated with the risk assessment process and with the data upon which the risk estimates are based (see Section 2.1.5).

Table 2-8. Winklepeck Burning Grounds Deep Surface Soil[a] Calculations of Blood Lead Concentrations (PbBs)

EPA Technical Review Workgroup for Lead, Adult Lead Committee

Exposure Variable	PbB Equation[b]		Description of Exposure Variable	Units	National Guard Range Maintenance Soldier	
	1*	2**			GSDi = 1.8	GSDi = 2.1
PbS	X	X	Soil lead concentration	mg/kg or ppm	169.2	169.2
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	X	X	Biokinetic slope factor	µg/dL per µg/day	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1
PbB_0	X	X	Baseline PbB	µg/dL	2.2	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	gal/day	0.1	0.1
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	gal/day	--	--
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--
$AF_{S, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S, D}$	X	X	Exposure frequency (same for soil and dust)	days/year	85	85
$AT_{S, D}$	X	X	Averaging time (same for soil and dust)	days/year	365	365
PbB_{adult}	PbB of adult worker, geometric mean			µg/dL	2.4	1.9
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers			µg/dL	5.7	5.8
PbB_t	Target PbB level of concern (e.g., 10 µg/dL)			µg/dL	10.0	10.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB > PbB_t, assuming lognormal distribution			%	0.4%	0.8%

[a]Deep surface soil defined as 0 to 3 ft below ground surface.
[b]Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.
EPA = U. S. Environmental Protection Agency.
ppm = Part per million.

The risk characterization methodology is discussed in Section 2.1.4.1; results are presented in Section 2.1.4.2; and estimation of RGOs for COCs are presented in Section 2.1.4.3.

2.1.4.1 Methodology

Risk characterization integrates the findings of the exposure and toxicity assessments to estimate the potential for receptors to experience adverse effects as a result of exposure to contaminated media at WBG.

Risk characterization methodology for carcinogens

For carcinogens, risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as the incremental lifetime cancer risk (ILCR), or the increased chance of cancer above the normal background rate of cancer. In the United States, the background chance of contracting cancer is approximately 3 in 10, or 3×10^{-1} (American Cancer Society 2003). The calculated ILCRs are compared to the range specified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) of 10^{-6} to 10^{-4}, or 1 in 1 million to 1 in 10,000 exposed persons developing cancer (EPA 1990). ILCRs below 10^{-6} are considered acceptable. ILCRs above 10^{-4} are considered unacceptable. The range between 10^{-6} and 10^{-4} is an AOC, and any decisions to address ILCRs further in this range, either through additional study or engineered control measures, should account for the uncertainty in the risk estimates. The Clean Ohio Fund, written in January 2001, uses 10^{-5} as the official target risk goal for development of clean-up goals.The ILCR is calculated using the equation below (EPA 1989):

$$ILCR = I \times CSF \qquad \textbf{(2-6)}$$

where

I	=	chronic daily intake or DAD calculated in the exposure assessment (mg/kg-day),
CSF	=	cancer slope factor $(mg/kg\text{-}day)^{-1}$.

For a given exposure pathway, the total risk to a receptor exposed to several carcinogenic COPCs is the sum of the ILCRs for each carcinogen as shown below:

$$ILCR_{total} = \Sigma ILCR_i \qquad \textbf{(2-7)}$$

where

$ILCR_{total}$	=	total probability of cancer incidence associated with all carcinogenic COPCs,
$ILCR_i$	=	ILCR for the i^{th} COPC.

Risk characterization methodology for noncarcinogens

In addition to developing cancer from exposure to contaminants, an individual may experience other toxic effects. The term “toxic effects” is used here to describe a wide variety of systemic effects ranging from minor irritations, such as eye irritation and headaches, to more substantial effects such as kidney or liver disease and neurological damage. The risks associated with toxic (i.e., noncarcinogenic) chemicals are evaluated by comparing an estimated exposure (i.e., intake or dose) from site media to an acceptable exposure expressed as an RfD. The RfD is the threshold level below which no toxic effects are expected to occur in a population, including sensitive subpopulations. The ratio of intake over the RfD is the HQ (EPA 1989) and is calculated as:

$$HQ = I/RfD \tag{2-8}$$

where

I	=	daily intake of a COPC (mg/kg-day),
RfD	=	reference dose (mg/kg-day).

The HQs for each COPC are summed to obtain a hazard index (HI) as shown below:

$$HI = \Sigma HQ_i \tag{2-9}$$

where

HI	=	hazard index for all toxic effects,
HQ_i	=	hazard quotient for the i^{th} COPC.

An HI greater than 1 has been defined as the level of concern for potential adverse noncarcinogenic health effects (EPA 1989). This approach differs from the probabilistic approach used to evaluate carcinogens. An HQ of 0.01 does not imply a 1 in 100 chance of an adverse effect, but indicates only that the estimated intake is 100 times less than the threshold level at which adverse health effects may occur.

Identification of chemicals of concern

COCs are defined as those contaminants that have an ILCR greater than 10^{-6} and/or an HI greater than 1 for a given land use scenario and that are not eliminated by the uncertainty analysis.

2.1.4.2 Risk characterization results

Risks are characterized for the National Guard Range Maintenance Soldier exposed to soils at WBG. WBG is evaluated as a single EU to provide an estimate of risk from a reasonable maximum exposure (RME). The RME incorporates a reasonable estimate of the concentration to which a receptor may be exposed (UCL_{95} on the mean). The use of the UCL_{95} on the mean as the EPC implies that a receptor may come into contact with contaminants throughout the EU.

COCs are identified if the total ILCR for a chemical exceeds 10^{-6} or if the total HI exceeds 1 for this receptor exposed to deep surface soil (0 to 3 ft bgs).

Risk and hazard results for direct contact with COPCs in surface soil are presented in Tables 2-9 and 2-10, respectively, and summarized in Table 2-11. Direct contact includes incidental ingestion of soil, inhalation of VOCs and particulates *(*i.e., dust), and dermal contact with soil.

Arsenic was identified as a soil COC at WBG. Arsenic is also naturally present in soils in the Ravenna area. The estimated risks from exposure of the National Guard Range Maintenance Soldier receptor to the background concentration of arsenic (15.4 mg/kg) is 1.5E-06. Risk to this receptor from arsenic at WBG (1.3E-06) is below the risk associated with the background concentration of this metal.

Table 2-9. Carcinogenic Intakes and Risks for National Guard Range Maintenance Soldier Exposed to Deep Surface Soil

COPC	Frequency of Detection	EPC (mg/kg)	Daily Intake (mg/kg-day)			Risk			Total Risk Across all Pathways	COC[a]
			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
Winklepeck Burning Grounds										
Arsenic	320/320	1.3E+01	4.0E-07	4.8E-07	1.2E-10	6.0E-07	7.1E-07	1.8E-09	1.3E-06	R
Cadmium	219/318	1.2E+01	3.5E-07	1.4E-08	1.0E-10			6.6E-10	6.6E-10	
Inorganics Pathway Total						6.0E-07	7.1E-07	2.5E-09	1.3E-06	R
2,4,6-Trinitrotoluene	77/176	1.5E+02	4.3E-06	1.7E-05	1.3E-09	1.3E-07	5.1E-07		6.4E-07	
2,4-Dinitrotoluene	30/176	2.4E-01	7.1E-09	2.8E-08	2.1E-12	4.8E-09	1.9E-08		2.4E-08	
Benz(*a*)anthracene	13/59	2.6E+01	7.8E-07	4.0E-06	2.3E-10	5.7E-07	2.9E-06	7.2E-11	3.5E-06	R
Benzo(*a*)pyrene	13/59	2.4E+01	7.0E-07	3.6E-06	2.1E-10	5.1E-06	2.6E-05	6.5E-10	3.1E-05	R
Benzo(*b*)fluoranthene	14/59	2.9E+01	8.5E-07	4.4E-06	2.5E-10	6.2E-07	3.2E-06	7.9E-11	3.8E-06	R
Benzo(*k*)fluoranthene	10/59	1.3E+01	3.9E-07	2.0E-06	1.2E-10	2.8E-08	1.5E-07	3.6E-12	1.8E-07	
Carbazole	6/59	9.0E+00	2.7E-07	1.1E-06	8.0E-11	5.4E-09	2.1E-08		2.7E-08	
Chrysene	12/59	2.5E+01	7.4E-07	3.8E-06	2.2E-10	5.4E-09	2.8E-08	6.9E-13	3.3E-08	
Dibenz(*a,h*)anthracene	8/59	3.1E+00	9.2E-08	4.7E-07	2.8E-11	6.7E-07	3.5E-06	8.5E-11	4.1E-06	R
Heptachlor Epoxide	2/19	2.7E-02	8.0E-10	3.2E-09	2.4E-13	7.3E-09	2.9E-08	2.2E-12	3.6E-08	
Indeno(1,2,3-*cd*)pyrene	10/59	1.5E+01	4.4E-07	2.3E-06	1.3E-10	3.2E-07	1.7E-06	4.1E-11	2.0E-06	R
PCB-1254	1/19	4.9E-02	1.5E-09	8.1E-09	4.4E-13	2.9E-09	1.6E-08	8.8E-13	1.9E-08	
PCB-1260	2/19	9.8E-02	2.9E-09	1.6E-08	8.7E-13	5.8E-09	3.2E-08	1.7E-12	3.8E-08	
RDX	34/176	1.9E+02	5.7E-06	2.3E-05	1.7E-09	6.3E-07	2.5E-06		3.1E-06	R
Organics Pathway Total						8.1E-06	4.1E-05	9.4E-10	4.9E-05	R
Pathway Total - Chemicals						8.7E-06	4.2E-05	3.4E-09	5.0E-05	R

[a] COPCs are identified as chemicals of concern (COCs) if the total risk across all pathways is > 1E-06 (R).
COPC = Chemical of potential concern.
EPC = Exposure point concentration.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

Table 2-10. Noncarcinogenic Intakes and Hazards for National Guard Range Maintenance Soldier Exposed to Deep Surface Soil

COPC	Frequency of Detection	EPC (mg/kg)	Daily Intake (mg/kg-day)			HQ			Total HI Across all Pathways	COC[a]
			Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
Winklepeck Burning Grounds										
Aluminum	319/319	1.3E+04	1.1E-03	4.3E-05	3.3E-07	1.1E-03	4.3E-05	2.3E-04	1.4E-03	
Antimony	140/248	7.2E+00	6.0E-07	2.4E-08	1.8E-10	1.5E-03	4.0E-04		1.9E-03	
Arsenic	320/320	1.3E+01	1.1E-06	1.3E-06	3.3E-10	3.7E-03	4.4E-03		8.2E-03	
Barium	318/319	4.4E+02	3.7E-05	1.5E-06	1.1E-08	5.2E-04	3.0E-04	7.7E-05	9.0E-04	
Cadmium	219/318	1.2E+01	9.8E-07	3.9E-08	2.9E-10	9.8E-04	1.6E-03		2.5E-03	
Copper	245/247	3.1E+02	2.6E-05	1.0E-06	7.8E-09	6.5E-04	2.6E-05		6.8E-04	
Manganese	319/319	6.7E+02	5.6E-05	2.2E-06	1.7E-08	1.2E-03	1.2E-03	1.2E-03	3.6E-03	
Thallium	152/248	5.1E-01	4.2E-08	1.7E-09	1.3E-11	5.3E-04	2.1E-05		5.5E-04	
Zinc	317/319	4.8E+02	4.0E-05	1.6E-06	1.2E-08	1.3E-04	1.8E-05		1.5E-04	
Inorganics Pathway Total						1.0E-02	8.0E-03	1.5E-03	2.0E-02	
1,2-Dimethylbenzene	1/10	7.5E-03	6.3E-10	2.5E-10	2.1E-08	3.1E-10	1.2E-10		4.4E-10	
1,3,5-Trinitrobenzene	41/176	9.5E+00	7.9E-07	3.1E-06	2.4E-10	2.6E-05	1.0E-04		1.3E-04	
2,4,6-Trinitrotoluene	77/176	1.5E+02	1.2E-05	4.8E-05	3.6E-09	2.4E-02	9.6E-02		1.2E-01	
2,4-Dinitrotoluene	30/176	2.4E-01	2.0E-08	7.9E-08	6.0E-12	1.0E-05	4.0E-05		5.0E-05	
2-Methylnaphthalene	13/59	6.2E+00	5.1E-07	2.0E-06	1.5E-10	1.3E-04	5.1E-04		6.4E-04	
Dibenzofuran	5/59	5.4E+00	4.5E-07	1.8E-06	1.3E-10	1.1E-04	4.5E-04		5.6E-04	
Fluoranthene	18/59	6.9E+01	5.7E-06	2.9E-05	1.7E-09	1.4E-04	7.3E-04		8.8E-04	
HMX	42/176	3.4E+01	2.9E-06	1.1E-05	8.6E-10	5.7E-05	2.3E-04		2.8E-04	
Heptachlor Epoxide	2/19	2.7E-02	2.2E-09	8.9E-09	6.7E-13	1.7E-04	6.8E-04		8.5E-04	
Naphthalene	10/59	3.3E+00	2.7E-07	1.4E-06	8.1E-11	1.4E-05	7.0E-05	9.5E-08	8.3E-05	
PCB-1254	1/19	4.9E-02	4.1E-09	2.3E-08	1.2E-12	2.1E-04	1.1E-03		1.3E-03	
Pyrene	16/59	5.0E+01	4.2E-06	2.2E-05	1.3E-09	1.4E-04	7.2E-04		8.6E-04	
RDX	34/176	1.9E+02	1.6E-05	6.3E-05	4.8E-09	5.3E-03	2.1E-02		2.6E-02	
Organics Pathway Total						3.1E-02	1.2E-01	9.5E-08	1.5E-01	
Pathway Total - Chemicals						4.1E-02	1.3E-01	1.5E-03	1.7E-01	

[a] COPCs are identified as chemicals of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Chemical of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

Table 2-11. Total Hazards/Risks and COCs for Direct Contact with Surface Soil by National Guard Range Maintenance Soldier

Noncarcinogens		Carcinogens	
HI	**COCs**	**ILCR**	**COCs**
0.2	None	5E-05	Arsenic RDX Benz(*a*)anthracene Benzo(*a*)pyrene Benzo(*b*)fluoranthene Dibenz(*a*,*h*)anthracene Indeno(1,2,3-*cd*)pyrene

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.

Other COCs identified for the National Guard Range Maintenance Soldier exposed to soils at WBG include one explosive (RDX) and five PAHs [benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a*,*h*)anthracene, and indeno(1,2,3-*cd*)pyrene].

Lead Screening Results

Lead was identified as a COPC in deep surface soil at WBG (see Tables 2-2 and 2-3). For the National Guard Range Maintenance Soldier exposed to deep surface soil, the ALM indicated that the estimated probability of fetal blood lead concentrations exceeding acceptable levels was less than 1% (see Table 2-8). Based on these results, lead was not considered a COC in this HHRA.

Summary of COCs

Table 2-11 presents a summary of the seven COCs for the National Guard Range Maintenance Soldier exposed to soils at WBG. RGOs are calculated and presented in Section 2.1.4.3 for these seven COCs. All COCs have risks < 10^{-4} (EPA's unacceptable level) and HIs <1 (the level of concern for potential adverse noncarcinogenic health effects) (see Section 2.1.4.1).

2.1.4.3 Remedial goal options

The remedial action objective (RAO) is soil removal to achieve protection of the National Guard Range Maintenance Soldier. The numeric criteria developed to meet this RAO are risk-based RGOs. RGOs are developed for each chemical identified as a COC in this HHRA at WBG. RGOs are calculated for the National Guard Range Maintenance Soldier using the methodology presented in RAGS Part B (EPA 1991) while incorporating site-specific exposure parameters applicable to WBG. These RGOs are RBCs that will be used to define the extent of contamination that must be remediated and will be used to help develop costs for various alternatives. These soil RGOs are chemical-specific concentrations and are calculated for all seven COCs identified in this HHRA.

The process for calculating RGOs for this HHRA is a rearrangement of the cancer risk or non-cancer hazard equation, with the goal of obtaining the concentration that will produce a specific risk or hazard level. For example, the RGO for RDX at the cancer risk level of 10^{-5} for the National Guard Range Maintenance Soldier receptor is the concentration of RDX that produces a risk of 10^{-5} when using the exposure parameters specific to this receptor.

As discussed in Section 2.1.4.1, the cancer risk and non-cancer hazard are calculated as:

$$\text{Risk} = \text{Intake} \times \text{CSF} \qquad \textbf{(2-10)}$$

$$\text{Hazard} = \text{Intake} / \text{RfD} \qquad \textbf{(2-11)}$$

The pathway-specific (e.g., soil ingestion) equations for the intake variable in the above equations are provided in Section 2.1.2.3. Note that all of the intake equations shown in Section 2.1.2.3 include a concentration term multiplied by several other exposure parameters.

To obtain the RGO for a specific risk level (e.g., 10^{-5}), the risk equation is rearranged so that the equation is solved for C, the concentration term. Similarly, to obtain the RGO for a specific hazard level (e.g., 1.0), the hazard equation is rearranged so that the equation is solved for the concentration term.

To demonstrate for the soil ingestion pathway, note that by using the soil ingestion intake equation from Section 2.1.2.3 (Equation 2-1) and the general risk equation from Section 2.1.4.1, the risk from ingestion of soil is calculated as

$$\text{Risk}_{ing(soil)} = (C \times IR_s \times EF \times ED \times FI \times ET \times CF \times CSF) / (BW \times AT). \qquad \textbf{(2-12)}$$

To obtain the RGO at the 10^{-5} risk level for the ingestion of soil, a value of 10^{-5} is substituted in the equation above for $\text{Risk}_{ing(soil)}$, and the equation is rearranged to solve for C. Thus, the general RGO equation at the 10^{-5} risk level for the ingestion of soil is calculated as

$$\text{RGO}_{ing(soil)} \text{ at } 10^{-5} = (10^{-5} \times BW \times AT) / (IR_s \times EF \times ED \times FI \times ET \times CF \times CSF). \qquad \textbf{(2-13)}$$

A similar rearrangement of the ingestion of soil hazard equation is made, producing the general RGO equation at the 1.0 hazard level for this pathway/medium:

$$\text{RGO}_{ing(soil)} \text{ at } 1.0 = (1.0 \times BW \times AT \times RfD) / (IR_s \times EF \times ED \times FI \times ET \times CF). \qquad \textbf{(2-14)}$$

Thus, to obtain the ingestion of soil RGO at the 10^{-5} risk level for the National Guard Range Maintenance Soldier exposed to RDX, the parameter values for this receptor (from Table 2-4) and the chemical-specific parameter (oral CSF, from Table 2-7) for RDX are used:

$$\begin{aligned}\text{RGO}_{ing(soil)} \text{ at } 10^{-5} \text{ for RDX } &= [(10^{-5})(70)(25550)] / (0.0001)(85)(25)(1)(6)(0.042)(0.11)] \\ &= 3{,}060 \text{ mg/kg.}\end{aligned}$$

In this example, the RGO calculated is 3,060 mg/kg, which will produce a soil ingestion risk of 10^{-5} for the National Guard Range Maintenance Soldier. This example is based on soil ingestion; however, RGOs calculated for WBG include exposure by ingestion, dermal contact, and inhalation.

Note that if a calculated RGO is not physically possible (e.g., more than the pure chemical), then the RGO is adjusted accordingly. For example, if the calculated RGO is 5.5E+06 mg/kg, then the RGO is adjusted downward to 1.0E+06 mg/kg.

The FWHHRAM (USACE 2004b) identifies a 10^{-5} target incremental lifetime cancer risk (TR) for carcinogens and an acceptable Target Hazard Index (THI) of 1 for noncarcinogens, with the caveat that exposure to multiple COCs may require downward adjustment of these targets. The TR and THI are dependent on several factors, including the number of carcinogenic and noncarcinogenic COCs and the target organs and toxic endpoints of these COCs.

For example, if numerous (i.e., approaching or greater than 10) noncarcinogenic COCs with similar toxic endpoints are present, it may be appropriate to calculate chemical-specific RGOs with a THI of 0.1 to account for exposure to multiple contaminants. A TR of 10^{-5} and THI of 1.0 are identified as appropriate for calculating RGOs for WBG based on the small number of COCs identified for surface soil as described below for the National Guard Range Maintenance Soldier and the type of COCs (carcinogenic or noncarcinogenic).

A total of seven COCs were identified for the National Guard Range Maintenance Soldier, all carcinogens. Of the seven carcinogens, one (arsenic) is a Class A carcinogen with the respiratory system as the target organ; five are Class B2 carcinogens with different target organs [the stomach is the target organ for benz(*a,h*)anthracene and benzo(*a*)pyrene; benzo(*b*)fluoranthene and indeno(1,2,3-*cd*)pyrene are potentially associated with general tumors; and dibenz(*a,h*)anthracene potentially associated with immunodepressive effects]; and one (RDX) is a Class C carcinogen potentially associated with liver cancer (see type of cancers for each COPC in Table 2-7).

For this HHRA, RGOs are calculated for each exposure route (e.g., ingestion), as well as for the total chemical risk or hazard across all appropriate exposure routes. Based on the small number of COCs and the variation in the target organs and toxic endpoints of these COCs, carcinogenic RGOs are calculated and presented in this HHRA for a risk level of 10^{-5} and noncarcinogenic RGOs are calculated and presented in this HHRA for a hazard level of 1.0.

Some COCs (arsenic and RDX) have both cancer and non-cancer endpoints. For these COCs, RGOs are calculated for both a TR of 10^{-5} and a THI of 1.0. and the final RGO is the smaller of the two results.

The resulting RGOs are presented in Table 2-12 and are provided here to assist in defining the extent of contamination and help cost various alternatives in the FFS.

Results of a comparison of the WBG soils data (on a sample by sample basis) against the most conservative (smallest) RGO across all direct exposure pathways is shown in Table 2-13. This analysis reveals that

- soil concentrations exceeded RGOs for the five PAHs that are COCs [benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and indeno(1,2,3-*cd*)pyrene] at one sampling location (station WBG-217, at 2 to 4 ft bgs);

- four RDX soil concentrations exceeded its RGO; three of these were at Burn Pads 66 and 67 (0 to 1 ft bgs) and the other one at station WBGss-070 (0 to 2 ft bgs); and

- all individual arsenic soil concentrations were below the RGO.

As seen from Tables 2-12 and 2-13, the EPCs (i.e., the UCL_{95} concentration at WBG) are below the RGO for arsenic (EPC of 13 mg/kg and RGO of 102 mg/kg) and RDX (EPC of 190 mg/kg and RGO of 617 mg/kg). The EPCs for the five PAHs that are COCs exceed their respective RGOs (75 mg/kg for benz(*a*)anthracene, benzo(*b*)fluoranthene, and indeno(1,2,3-*cd*)pyrene and 7.5 mg/kg for benzo(*a*)pyrene and dibenz(*a,h*)anthracene]. Replacing the concentrations of these PAHs at the one location identified as exceeding the RGOs (Station WBG-217; see Table 2-13) with clean soil (i.e., a concentration of 0 mg/kg) would result in the EPCs decreasing into the range of 0.34 to 0.68 mg/kg for these five PAHs, well below their respective RGOs. Thus, a removal of soil from one location, accompanied by replacement with clean soil, would result in all EPCs being below their RGOs.

Table 2-12. Human Health Risk-based RGOs for National Guard Range Maintenance Soldier Exposed to Surface Soil (units = mg/kg)

COC	Target Hazard = 1.0				Target Risk = 10^{-5}			
	Ingestion	Dermal	Inhalation	Total	Ingestion	Dermal	Inhalation	Total
Metals								
Arsenic	3.61E+03	3.04E+03	NA	1.65E+03	2.24E+02	1.89E+02	7.49E+04	1.02E+02
Explosives								
RDX	3.61E+04	9.11E+03	NA	7.27E+03	3.06E+03	7.73E+02	NA	6.17E+02
Semivolatile Organic Compounds								
Benz(*a*)anthracene	NA	NA	NA	NA	4.61E+02	8.96E+01	1.00E+06	7.50E+01
Benzo(*a*)pyrene	NA	NA	NA	NA	4.61E+01	8.96E+00	3.63E+05	7.50E+00
Benzo(*b*)fluoranthene	NA	NA	NA	NA	4.61E+02	8.96E+01	1.00E+06	7.50E+01
Dibenz(*a,h*)anthracene	NA	NA	NA	NA	4.61E+01	8.96E+00	3.63E+05	7.50E+00
Indeno(1,2,3-*cd*)pyrene	NA	NA	NA	NA	4.61E+02	8.96E+01	1.00E+06	7.50E+01

COC = Chemical of concern.
NA = Not available due to lack of toxicity value.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RGO = Remedial goal option.

Table 2-13. Individual Soil Samples Results Exceeding Risk-based RGOs

COC	Station	Sample ID	Starting Sample Depth (ft)	Ending Sample Depth (ft)	Date Sample Collected	Result (mg/kg)	Data Qualifier	RGO (mg/kg)
Arsenic	None	None	None	None	None	None	None	None
RDX	WBGss-070	WBGSS-070-0534-SO	0	2	08/09/96	9,500	=	617
RDX	Burn Pad 66,67	WB2012	0	1	08/08/00	1,700	=	617
RDX	Burn Pad 66,67	WB2013	0	1	08/08/00	940	=	617
RDX	Burn Pad 66,67	WB2018	0	1	08/08/00	2,400	=	617
Benz(*a*)anthracene	WBG-217	WBG4065	2	4	10/22/00	570	=	75
Benzo(*a*)pyrene	WBG-217	WBG4065	2	4	10/22/00	510	=	7.5
Benzo(*b*)fluoranthene	WBG-217	WBG4065	2	4	10/22/00	620	=	75
Dibenz(*a,h*)anthracene	WBG-217	WBG4065	2	4	10/22/00	59	J	7.5
Indeno(1,2,3-*cd*)pyrene	WBG-217	WBG4065	2	4	10/22/00	320	=	75

COC = Chemical of concern.
RGO = Remedial goal option.
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.

Although groundwater is not evaluated as an exposure media under the Range Maintenance Soldier scenario, the RGOs for soil were qualitatively evaluated with respect to the potential for leaching to groundwater because soil source contaminants have been previously detected in monitoring wells within the AOC. A qualitative screening of the calculated RGOs in Table 2-12 against the generic soil screening levels (GSSLs) calculated in the Phase III RI report for WBG (e.g., assumed dilution attenuation factor of 20) was performed. The comparison indicates that all of the RGO values listed in Table 2-12 exceed the calculated GSSL screening values, except benzo(*a*)pyrene (GSSL screening value of 8 mg/kg versus an RGO of 7.5 mg/kg). As such, the potential exists that leaching of COCs to the water table at concentrations exceeding MCLs or Region 9 residential PRGs could occur. Further quantitative evaluation of leaching potential, if required, would fall under the purvue of the facility-wide groundwater investigation and would require the application of numerical models.

Note that potential leaching of any residual soil contaminants present at or below RGOs does not imply that they would reach the nearest receptor stream at concentrations exceeding applicable criteria. Soil leaching modeling conducted in the Phase III RI Report (USACE 2004a) indicated that timeframes to attain peak leaching concentrations for explosives ranged from 2 to 12 years, indicating that peak concentrations may have already occurred and groundwater quality conditions will improve as soil explosives are removed and/or attenuate. Conservative groundwater transport modeling from soil sources to Sand Creek indicated that only RDX would be expected to migrate to the receptor at concentrations greater than human health-based residential standards. Again, the estimated timeframe to attain peak concentrations at the receptor ranged from 6 to 11 years. This indicates that peak values may already have occurred because 25 years have passed since cessation of open burning operations (outside of the Pad 37 RCRA trays). The potential for soil contaminants to migrate to groundwater will be further evaluated in the Facility-Wide Groundwater Investigation.

2.1.5 Uncertainty Analysis

In estimating exposure and risks to receptors from contact with contaminated media, assumptions are made that incorporate uncertainties inherent in the process. This section identifies the uncertainties associated with each step of the risk assessment process and, where possible, quantifies those uncertainties. Uncertainties are not mutually exclusive.

2.1.5.1 Uncertainties associated with the data evaluation

Although the data evaluation process used to select COPCs adheres to established procedures and guidance, it also requires making decisions and developing assumptions on the basis of historical information, disposal records, process knowledge, and best professional judgment about the data. Uncertainties are associated with all such assumptions. The background concentrations and PRGs used to screen analytes are also subject to uncertainty. The following items discuss areas of uncertainty related to data evaluation.

- The determination of the chemical species for certain analytes is subject to various assumptions. For example, it is assumed that all metallic thallium is present as the most toxic form (thallium carbonate).

- Another area of uncertainty involves the qualitative evaluation (and elimination from further consideration) of essential nutrients, many of which have no available toxicity values. In addition, the toxicity values used in the derivation of PRGs are subject to change as additional information becomes available from scientific research. These periodic changes in toxicity values may cause the PRG values to change as well.

- Representative exposure concentrations are calculated in this HHRA based on the assumption that sample collection across WBG is random. Some sample locations were biased to identify areas of highest contaminant concentrations; some of the most contaminated areas were more heavily sampled than other areas. For example, there were 20 samples taken in the vicinity of Pad 67 (one of the more contaminated pads), this is contrasted with Pad 1 (a much cleaner pad), which had one sample taken.

- Environmental concentrations are assumed to be constant (i.e., concentrations are not reduced by loss due to natural removal processes such as volatilization, leaching, and/or biodegradation). Since the source of contamination (i.e., thermal destruction of munitions) no longer exists at WBG, this assumption is a source of uncertainty.

- Some unavoidable uncertainty is associated with the contaminant concentrations detected and reported by the analytical laboratory. The quality of the analytical data used in the risk assessment depends on the adequacy of the set of procedures that specify how samples are selected and handled and how strictly these procedures are followed. Quality assurance/QC procedures within the laboratories are used to minimize uncertainties; however, sampling errors, laboratory analysis errors, and data analysis errors can occur. Some current analytical methods are limited in their ability to achieve detection limits at or below risk-based screening levels (i.e., PRG concentrations). Under these circumstances, it is uncertain whether the true concentration is above or below the PRGs, which are protective of human health. When analytes are on the COPC list and have a mixture of detected and non-detected concentrations, risk calculations may be affected by these detection limits. Risks may be overestimated as a result of some sample concentrations being reported as non-detected at the method detection limit (MDL), which may be greater than the PRG concentration (when the actual concentration may be much smaller than the MDL). Risks may also be underestimated because some analytes that are not detected in any sample are removed from the COPC list. If the concentrations of these analytes are below the MDL but are above the PRG, the risk from these analytes would not be included in the risk assessment results.

- Common laboratory contaminants [e.g., bis(2-ethylhexyl)phthalate] appear on the COPC list for groundwater. In the data assessment process, elevated levels of these common laboratory contaminants can be evaluated to see if the detected concentrations are likely to be "false positives" (i.e., at high concentrations due to laboratory interference). This process involves a check against the concentrations detected in the associated laboratory method blank.

2.1.5.2 Uncertainties associated with the exposure assessment

At best, quantification of exposure provides an estimate of the chemical intake for various exposure pathways identified at the site. Several uncertainties associated with the various components of the exposure assessment include uncertainties about the exposure pathway equations, exposure parameters, representative exposure concentrations, and sampling and analysis of the media as follows.

- For each primary exposure pathway chosen for analysis in this HHRA, assumptions are made concerning the exposure parameters (e.g., amount of contaminated media a receptor can be exposed to and intake rates for different routes of exposure) and the routes of exposure. In the absence of site-specific data, the assumptions used are consistent with EPA-approved default values, which are assumed to be representative of potentially exposed populations (EPA 1989, 1991). All contaminant exposures are assumed to be from site-related exposure media (i.e., no other sources contribute to the receptor's health risk).

- Moderate uncertainty can be introduced in the data aggregation process for estimating a representative exposure concentration in the exposure media. A statistical test (the Shapiro-Wilk test) is performed to determine whether the concentration data are best described by a normal or lognormal distribution. Each COPC's mean and UCL_{95} on the mean concentrations are calculated using both detected values and one-half of the reported detection limit for samples less than the reporting limit. The EPC is the smaller of the MDC or the calculated UCL_{95} on the mean. This method may moderately overestimate the exposure concentration. In addition, when the resulting individual contaminant risks are summed to provide a total ILCR or HI, the compounding conservatism of this method for estimating EPCs will likely result in an overestimate of the total risk.

- Note that for the dermal contact with soil pathway, no exposure time is included in the equation. This is based on the assumption that the receptor may not bathe (i.e., remove the soil in contact with the skin surface) for 24 hrs following the initial exposure; therefore, the receptor is actually exposed to soil contaminants for 24 hrs/day. This may overestimate the risk associated with dermal contact with soil. This fact is especially important when the dermal pathway is the major contributor to the risks and/or hazards.

- Most exposure parameters have been selected so that errors occur on the side of conservatism. When several of these upper-bound values are combined in estimating exposure for any one pathway, the resulting risks can be in excess of the 99th percentile, and, therefore, outside of the range that may be reasonably expected. Therefore, the consistent conservatism employed in the estimation of these parameters generally leads to overestimation of the potential risks.

2.1.5.3 Uncertainties associated with the toxicity assessment

The methodology used to develop a noncarcinogenic toxicity value (RfD or RfC) involves identifying a threshold level below which adverse health effects are not expected to occur. The RfD and RfC values are generally based on studies of the most sensitive animal species tested (unless adequate human data are available) and the most sensitive endpoint measured. Uncertainties exist in the experimental dataset for such animal studies. These studies are used to derive the experimental exposure representing the highest dose level tested at which no adverse effects are demonstrated [i.e., the no-observed-adverse-effect level (NOAEL)]; in some cases, however, only a lowest-observed-adverse-effect level (LOAEL) is available. The RfD and/or RfC is derived from the NOAEL (or LOAEL) for the critical toxic effect by dividing the NOAEL (or LOAEL) by uncertainty factors. These factors usually are in multipliers of 10, with each factor representing a specific area of uncertainty in the extrapolation of the data. For example, an uncertainty factor of 100 is typically used when extrapolating animal studies to humans. Additional uncertainty factors are sometimes necessary when other experimental data limitations are found. Because of the large uncertainties (10 to 10,000) associated with some RfD or RfC toxicity values, exact safe levels of exposure for humans are not known. For noncarcinogenic effects, the amount of human variability in physical characteristics is important in determining the risks that can be expected at low exposures and in determining the NOAEL (EPA 1989).

The carcinogenic potential of a chemical can be increased through a two-part evaluation involving (1) a WOE assessment to determine the likelihood that a chemical is a human carcinogen, and (2) a slope factor assessment to determine the quantitative dose-response relationship. Uncertainties occur with both assessments. Chemicals fall into one of five groups on the basis of WOE studies of humans and laboratory animals (EPA 2004): (1) Group A – known human carcinogen; (2) Group B – probable human carcinogen based on limited human data or sufficient evidence in animals, but inadequate or no evidence in humans; (3) Group C – possible human carcinogens; (4) Group D – not classified as to human carcinogenicity; and (5) Group E – evidence of no carcinogenic effects in humans.

The CSF for a chemical is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. It is used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. The slope factor is derived by applying a mathematical model to extrapolate from a relatively high-administered dose to animals to the lower exposure levels expected for humans. The slope factor represents the UCL_{95} on the linear component of the slope (generally the low-dose region) of the tumorigenic dose-response curve. A number of low-dose extrapolation models have been developed, and Ohio EPA generally uses the linearized multistage model in the absence of adequate information to support other models; the linear equation is valid only at risk levels below 1E-02. For sites with very high chemical concentrations and risks above 1.0E-02, an alternative calculation is performed using the “one-hit” equation (EPA 1989):

$$ILCR = 1 - \exp(-Intake \times CSF) \qquad \textbf{(2-15)}$$

Additional uncertainty factors for toxicity information include the following.

- For several analytes, no toxicity information for either the noncarcinogenic or carcinogenic health effects to humans is available in EPA’s IRIS (EPA 2004) or HEAST (EPA 1997b). The carcinogenic potential has not been evaluated for some chemicals lacking EPA-approved toxicity values. Until and unless additional toxicity information allows the derivation of toxicity factors, potential risk from certain analytes cannot be quantified.

- The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. The toxicological data (CSFs and RfDs) for dose-response relationships of chemicals are frequently updated and revised, which can lead to overestimation or underestimation of risks. These values are often extrapolations from animals to humans, and this can also cause uncertainties in toxicity values because differences can exist in chemical absorption, metabolism, excretion, and toxic response between animals and humans.

- EPA considers differences in body weight, surface area, and pharmacokinetic relationships between animals and humans to minimize the potential to underestimate the dose-response relationship; as a result, more conservatism is usually incorporated into these steps. In particular, toxicity factors that have high uncertainties may change as new information is evaluated. Therefore, a number of the COCs—particularly those with high uncertainties—may be subject to change. Finally, the toxicity of a contaminant may vary significantly with the chemical form present in the exposure medium. For example, risks from metals may be overestimated because they are conservatively assumed to be in their most toxic forms.

- Uncertainties are associated with the GAF values used to modify the oral toxicity values to evaluate dermal toxicity. Similar uncertainties are associated with the TEF values used to estimate risks from exposure to PAHs. Many potential uncertainties are associated with the toxicity data used in this HHRA and can affect the risk, hazard, and COC determinations.

In the absence of EPA-approved toxicity values for benzo(*a*)pyrene, provisional values have been used in the risk characterization for these COPCs. The toxicity values for this chemical have larger uncertainties than other approved values. Because this COPC is identified as a COC in this HHRA, caution should be used, and a closer look at the withdrawn/provisional value(s) is appropriate when making remediation decisions for this COC.

2.1.5.4 Uncertainties associated with the risk characterization

Risk assessment as a scientific activity is subject to uncertainty. This is true even though the methodology used in this HHRA follows EPA guidelines. As noted previously, the risk evaluation in this report is subject to uncertainty pertaining to sampling and analysis, selection of COPCs, exposure estimates, and availability and quality of toxicity data. The principal uncertainties and limitations in the risk characterization include the following.

- Uncertainties related to the summation of HQs and ILCRs across chemicals and pathways are a primary uncertainty in the risk characterization. In the absence of information on the toxicity of specific chemical mixtures, it is assumed that ILCRs and HQs are additive (i.e., cumulative) (EPA 1989). The limitations of this approach for noncarcinogens are (1) the effects of a mixture of chemicals are generally unknown; it is possible that the interactions could be synergistic, antagonistic, or additive; (2) the RfDs have different accuracy and precision and are not based on the same severity or effect; and (3) HQ or intake summation is most properly applied to compounds that induce the same effects by the same mechanism. Therefore, the potential for occurrence of noncarcinogenic effects can be overestimated for chemicals that act by different mechanisms and on different target organs.

- Limitations of the additive risk approach for multiple carcinogens are (1) the chemical-specific slope factors represent the upper 95th percentile estimate of potency; therefore, summing individual risks can result in an excessively conservative estimate of total lifetime cancer risk; and (2) the target organs of multiple carcinogens may be different so the risks would not be additive. In the absence of data, additivity for ILCRs and HQs is assumed for this HHRA. However, because total risks and HIs are usually driven by a few chemicals, segregation of risks and HIs by target organ would most likely not have resulted in significantly different outcomes.

- Additional uncertainty can be associated with the method of selection of COCs. For this HHRA, COCs are selected for a given medium/land use scenario as chemicals with individual ILCRs ≥ 1.0E-06 and/or individual HQs ≥ 1.0 for any medium/land use scenario.

- Uncertainty is associated with the potential contribution of naturally occurring (i.e., background) metals to total risks at the site. One metal identified as a COC (arsenic) also has background risk in excess of 1.0E-06.

- Potential risks and hazards are not determined for the five soil COPCs (2-amino-4,6-DNT; 4-amino-2,6-DNT; benzo(*g,h,i*)perylene, nitrocellulose, and phenanthrene) that could not be evaluated quantitatively due to the lack of toxicity information and/or values. This results in uncertainty that could underestimate the total risk/hazard to human health.

2.1.6 Summary and Conclusions

This HHRA was conducted to evaluate risks and hazards to a National Guard Range Maintenance Soldier exposed to surface soil (0 to 3 ft bgs) at WBG to support the FFS. The following process was used to generate conclusions regarding human health risks and hazards associated with contaminated media at WBG:

1 identification of COPCs via frequency of detection and WOE screening, risk-based (PRG) screening, and background comparisons;

2 determination of a conservative receptor scenario associated with the Mark 19 Range land use;

3 determination of toxicity values for COPCs;

4 quantification of risks and hazards; and

5 identification of COCs.

Results are summarized in Table 2-11 and below.

- The HI across all pathways and COPCs was < 1; thus, there were no noncarcinogenic COCs.

- The total carcinogenic risk across all pathways and COPCs was 5×10^{-5}. Seven chemicals with risks $> 1 \times 10^{-6}$ were identified as soil COCs: arsenic, RDX, benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and indeno(1,2,3-*cd*)pyrene.

- Although arsenic was identified as a COC in soils, the risk associated with the background concentration (1.5×10^{-6}) is higher than the risk quantified for exposure to arsenic in WBG soils (1.3×10^{-6}).

- Lead was identified as a COPC at WBG. The EPA ALM indicated that the probability of exceeding acceptable fetal blood levels was estimated to be less than 1% for the National Guard Range Maintenance Soldier exposed to lead in the soils at WBG. Based on these results, lead is not a COC at WBG.

- Risk-based RGOs were estimated for all seven soil COCs and compared against the soils data at WBG. An analysis of individual sample results indicated that (1) there was no exceedance of the arsenic RGO; (2) four sample locations have RDX concentrations that exceed its RGO; however, the EPC for RDX across WBG is below the RGO; and (3) a single sample location has soil concentrations that exceed the RGOs for the five PAHs. Removal of the contaminated soil in the area of this one sample location where PAHs exceed their RGOs, accompanied by replacement with clean fill material, would result in EPCs less than RGOs for all COCs.

2.2 REMEDIAL GOAL OPTIONS AND ECOLOGICAL RISK ASSESSMENT

This section provides a rationale for why quantitative RGOs for soil are not needed for ecological receptors at WBG. This rationale has the following five elements.

- Ecological risks exist, but they are relatively small for vegetation and small mammals as evidenced by HQs and field biological measurements.

- Habitat alteration will be intensive and extensive to meet the military land use mission (Mark 19 Range), and the military mission overrides the results of the HQ and field-truthing study.

- No unique ecological resources are found at WBG, and nearby habitat offers home ranges for wildlife to escape from Mark 19 Range activities.

- No off-site contaminant migration has occurred.

- Mitigations are of two types that will lower the already relatively small exposure and ecological risk, and physical alteration such as vegetation removal is a trade-off.

2.2.1 Overview of Ecological Risk Assessment and Biological Ground-Truthing Findings

This section summarizes the HQs (Section 2.2.4.1), as well as field-truthing of vegetation and small mammals (Section 2.2.4.2), that were performed to evaluate ecological risk from soil contaminants at WBG. A summary of the joint interpretation of the HQ risks and the field-truthing risks is presented in Section 2.2.4.3.

2.2.1.1 Re-screened HQs at WBG

After completion of the WBG screening-level ERA, which included calculation of the conservative, screening HQs in the Phase II RI (USACE 2001a), re-screened HQs (SAIC 2003) were calculated for three Burn Pad pairs (37/38, 58/59, and 66/67) in which arithmetic mean concentrations of contaminants (instead of maximum detects) were compared against representative screening values. These 6 pads were selected from among the 70 total pads at WBG because they represented the ones with the highest contaminant concentrations and HQs. A summary of the HQs and their associated ecological receptors by pad is presented in Table 2-14.

The conclusion is that the prevalence of HQs < 1 and minimally > 1 (in the range of 1 to 10) for plants, earthworms, and wildlife indicates that adverse effects to these receptors could occur but are unlikely. The notable exception to the small HQs is the relatively large HQ for mercury for woodcocks, which suggests that this receptor might be at risk of adverse impacts from this contaminant at all three pad pairs. Site-specific verification for plants and animals of the expression of risk as actual adverse effects is presented in the discussion of biological field-truthing community risks below.

Table 2-14. Summary of Re-Screen Highest HQs Based on Arithmetic Means and General Screening Values[a] for WBG Pad Pairs 37/38, 58/59, and 66/67

Analyte	HQs and Their Associated Receptors (in parenthesis)		
	Pad pair 37/38	Pad pair 58/59	Pad pair 66/67
Inorganics			
Aluminum	**328 (plant)**	**255 (plant)**	**254 (plant)**
Antimony	< 1 (plant)	**2.3 (plant)**	**1.1 (plant)**
Arsenic	**1.2 (shrew/plant)**	**1.3 (shrew/plant)**	**1.3 (shrew/plant)**
Barium	< 1 (woodcock)	< 1 (woodcock)	**4.6 (woodcock)**
Beryllium	< 1 (plant)	< 1 (plant)	< 1 (plant)
Cadmium	**8.6 (plant)**	< 1 (plant)	< 1 (plant)
Chromium	**49 (earthworm)**	**72 (earthworm)**	**57 (earthworm)**
Cobalt	< 1 (plant)	< 1 (plant)	< 1 (plant)
Copper	< 1 (earthworm)	**2.0 (earthworm)**	**3.3 (earthworm)**
Lead	**3.4 (woodcock)**	**6.8 (woodcock)**	**2.6 (woodcock)**
Mercury	**118 (woodcock)**	**373 (woodcock)**	**235 (woodcock)**
Nickel	< 1 (plant)	< 1 (plant)	< 1 (plant)
Selenium	**5.5 (mouse)**	**4.6 (mouse)**	**4.2 (mouse)**
Silver	< 1 (plant)	**1.1 (plant)**	< 1 (plant)
Thallium	< 1 (plant)	< 1 (plant)	< 1 (plant)
Vanadium	**11 (plant)**	**11 (plant)**	**12 (plant)**
Zinc	**18 (woodcock)**	**55 (woodcock)**	**35 (woodcock)**
Explosives[b]			
1,3-Dinitrobenzene	< 1 (masked shrew)	< 1 (masked shrew)	**4.7 (ESL-shrew)**
2,4-Dinitrotoluene	< 1 (masked shrew)	< 1 (masked shrew)	< 1 (masked shrew)
2,6-Dinitrotoluene	**3.9 (masked shrew)**	< 1 (masked shrew)	**205 (masked shrew)**
Nitrobenzene	< 1 (masked shrew)	< 1 (masked shrew)	**2.1 (masked shrew)**
RDX	< 1 (masked shrew)	< 1 (masked shrew)	**151 (masked shrew)**
1,3,5-Trinitrobenzene	< 1 (masked shrew)	< 1 (masked shrew)	**49 (masked shrew)**
2,4,6-Trinitrotoluene	< 1 (masked shrew)	< 1 (masked shrew)	**5.2 (masked shrew)**

[a]Unless stated otherwise, general screening values are preliminary remediation goals in Efroymson et al. (1997); all others are EPA Region 5 ecological screening Levels (ESLs) based on exposures to masked shrews.
[b]All the HQs for the explosives were based on EPA Region 5 ESLs for masked shrews.
HQs > 1 and their receptors are in **bold font**.
HQ = Hazard quotient.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
WBG = Winklepeck Burning Grounds.

2.2.1.2 Biological field-truthing at WBG

Biological field-truthing was conducted for vegetation and for small mammals at WBG to support and add information to the ERA. Field measures were used to determine whether or not soil contaminants have affected those receptors at WBG. The field-truthing of vegetation and small mammals was intended to corroborate or refute the calculated HQs, which were predictions of risk for those two groups of receptors. The field-truthing did not include surveys for birds, so it does not address the HQ results for woodcocks.

Regarding vegetation, the conclusion is that site-specific verification of the expression of risk as actual adverse affects indicates that risks to plants at all the contaminated pads is negligible because all three abundance measures and two of the three plant community composition measures indicate no statistically significant difference between any of the pads and their reference sites. Although the percent exotic species is statistically significantly higher at four of the six contaminated pads compared to their reference sites, contamination is not necessarily the cause.

Regarding small mammals, the conclusion is that site-specific verification of the expression of actual adverse affects indicates that risks to these receptors at all the contaminated pads is negligible to low. All three reproductive measures (i.e., sperm count, sperm mobility, and sperm morphology), as well as liver-to-body weight ratio, body weight, and small mammal community composition/structure indicate minimal difference between the pads and their reference sites and none of the reproductive measures were sufficiently reduced to adversely affect reproduction, based on published thresholds for effect. Although the number of individuals and number of species that were collected at the contaminated sites were only about one-half as many as from the reference sites, the small mammal communities were nevertheless diverse, surviving, and reproducing. Thus, the field-truthing provides supporting evidence that the small mammal communities at the pads are at low to negligible risk.

2.2.1.3 Joint interpretation of relatively low HQs and relatively low-effects field-truthing

In summary, there are several HQs > 1 at all three pad pairs. An HQ > 1 means that risk may be present. Ground-truthing studies of vegetation indicate negligible adverse effects at pad pairs, and ground-truthing studies of mammals lean in that direction. The WBG ecosystem appears to be functioning properly in terms of nutrient cycling and energy flow with all trophic levels present. Thus, combined relatively small HQs and a lack of obvious field-observed effects support the lack of a need for ecological RGOs. This realization is also supported by the other WOE topics in this section.

2.2.2 Intensive and Extensive Habitat Alteration

Habitat alteration, as a result of constructing the Mark 19 Range, is expected to be relatively intense at any one acre. For example, areas within WBG will be cleared of brush to permit the completion of the land survey and MEC density survey. The firing point area and target arrays that fall within the boundaries of the WBG will be surface-cleared. Where the target arrays cross burn pads, with the exception of Pads 45, 58, 60, 61, and 67, soil will be screened and cleared of MEC to a depth of 1 ft. Where the target arrays cross Pads 45, 58, 60, 61, and 67, the soil will be excavated to a depth of 4 ft and screened for MEC. There is more description of this in Section 1.3.1 on land use construction activities.

The area of habitat to be altered is small compared to the total facility acreage. WBG consists of about 200 acres of altered habitat, but the training range is part of a facility that is 21,419 acres in size. Thus, this represents 200 acres/21,419 acres = 0.9% of the total area.

2.2.3 Nearby Habitat Offers Home Ranges to Wildlife

Vegetation and animals are found at WBG. A description of them is found in the WBG RI (SAIC 2001). Briefly, vegetation consists of many old-field communities with corridors and patches of forest vegetation. Animals consist of soil invertebrates, many species of insects, mammals, and birds. However, no known threatened and endangered species or unique natural resources are present at WBG. Thus, the Mark 19 Range would be constructed in an environment where impact would be limited to “normal” ecological resources.

Nearby habitat is available to receive wildlife that leaves the military area. Vegetation, especially trees and bushes, is expected to be removed. Old-field vegetation may be mowed or cleared in another way. Wildlife is expected to be disturbed by the movement and noise of construction equipment as well as operations. Wildlife can leave and enter adjacent old fields and forest patches and vegetative corridors. As inferred earlier, WBG has thousands of acres of habitat and wildlife can find new home ranges there. Thus, any lack of protection from no RGOs would be minimal because wildlife species can move away.

2.2.4 No Off-site Contaminant Migration

A facility-wide surface water investigation was performed by USACE with cooperation of Ohio EPA. In the investigation, water and sediment samples were taken from locations along the major stream and tributaries, ponds, and wetlands throughout RVAAP at locations that could have been impacted by former facility activities and sites where the streams entered RVAAP. Fish were caught, identified, and released in the water and sediment sample locations. Invertebrate biota was collected by Hester-Dendy samplers set in the same locations and by qualitative sampling of organic debris and rocks in the stream reach. Additionally, funnel traps were placed in ponds and wetlands for further invertebrate sampling. The details of the study, locations, techniques, and results from this study are published in the Ravenna facility-wide surface water study: streams (USACE 2004c) and Ravenna facility-wide surface water study: ponds and wetlands (USACE 2004d).

Sand Creek, which receives surface water runoff from WBG, was investigated in several locations where site activities could have impacted the habitat or biotic quality. Specific for WBG, a sample was taken at the site where drainage from WBG could have entered the creek in a 150-m reach with an upstream limit at the overpass of George Road. The results are fully described in the facility-wide surface water reports.

The facility-wide surface water sampling and assessment effort revealed that, in general, surface water quality in the streams was good to excellent with few exceedances of Ohio Water Quality Standards criteria. Intact riparian buffers around the streams contributed to good habitat and absence of substantial silt deposits. Evidence suggests that an additional remedial investigation effort, on an installation-wide basis, of the streams included in the report is not warranted. However, this does not preclude investigating surface water and sediment on an individual basis as required by Ohio EPA. Contamination is not currently present in the sediments in the sampled reaches, and the surface water appears to be similarly free of contaminants.

2.2.5 Mitigation of Ecological Risk with Context of Physical and Chemical Sources of Risk

Actions that will result in a decrease in ecological risk include planned remedial actions at Burn Pads 66 and 67 to reduce soil concentrations of COCs below RGOs for human health (Section 2.1.4.3). These removals will decrease the concentrations of COCs and reduce the number of COCs in soil to which ecological receptors are exposed, thereby reducing ecological risk. The application of human health-based RGOs at those locations will protect human health and will at the same time reduce exposure and ecological risk enough that ecologically based RGOs would not be needed. For example, the EPA Region 5 ESL for indeno(1,2,3-*cd*)pyrene in soil is 109 mg/kg, whereas the human health RGO is 75 mg/kg (Section 2.1.4.3, Table 2-13). Any soil that is replaced because the concentration of indeno(1,2,3-*cd*)pyrene was above 75 mg/kg will no longer have elevated concentrations of any PAHs, reducing risk to ecological receptors from all PAHs. Section 2.1.4.3 states that the planned soil removals will reduce the EPCs for PAHs to a range of 0.34 to 0.68 mg/kg, whereas the ESLs for the same PAHs range from 15 to 148 mg/kg, well above the residual concentrations after remediation. In addition, some soil will be remediated to remove UXO. These removals will also reduce the concentrations of soil contaminants. The soil removals triggered by human health RGOs and by the presence of UXO will directly reduce the contaminant concentrations to which ecological receptors are exposed regardless of any potential ecological RGOs.

Ecological risk will also be reduced indirectly through remediation by removing exposure pathways. In addition to ingestion of soil, ecological receptors are exposed to soil contaminants by ingestion of plants and animals that have taken up the contaminants from soil. Removal of contaminated soil to mitigate human health risk will alter habitat. Plants that serve as food to herbivores and omnivores will be removed, so the exposure pathway from soil to plants to plant-eating animals will be broken. Similarly, removal of soil invertebrates will break the exposure pathway from soil to soil invertebrates to invertivores and omnivores. Shelter for mammals and birds will be reduced, so the mammals and birds will leave the area to find shelter elsewhere. As a result, the exposure pathway from soil to carnivores will also be made incomplete because fewer or no carnivores would forage at the site. Thus, the opportunity for exposure of all ecological receptors to soil at the site will be reduced for a period of time and stay reduced during the operation and only change if the site were to be partially revegetated and redevelop a food web. Repopulation will likely be faster for soil invertebrates than for plants because the clean soil that will replace the soil that will be removed will likely contain a population of soil invertebrates that will help to re-establish the food web.

There is a trade-off of two kinds of risk: physical alterations and residual contamination. That is, the localized ecosystem either can have clean soil because of removal and replacement but have a highly disturbed habitat as a result, or it can have exposure to contaminants in the soil in a habitat that is minimally disturbed. In some cases, it can be appropriate to allow plants and animals low in the food chain to be exposed to somewhat toxic concentrations, sparing important habitat, if animals higher in the food chain (especially threatened and endangered species) are not receiving toxic exposures. In other cases, especially when human health is threatened, it is necessary to alter or destroy habitat to prevent exposure to soil contaminants (Suter et al. 1995). In the case of Mark 19 Range activities, the military mission requires activities that will greatly alter, even destroy, habitat and create high noise levels, thereby reducing both the presence and the exposure of ecological receptors.

In conclusion, there will be soil removals at several of the most contaminated pads. UXO removal is one of the reasons, and the other motive is to apply human health RGOs to protect the Range Maintenance Soldier. These removals will consequently reduce exposure and risk to any remaining organisms on the Mark 19 Range.

2.2.6 Recommendation

It is recommended that no quantitative RGOs for soil to protect ecological receptors be developed at WBG. Stewardship of the environment will be a major consideration in all phases of planning, design, and construction of the Mark 19 Range. Presently, ecological risk is probable albeit the re-calculated HQs are mostly under 1 and, if not, mostly under 30 for conservative scenarios. Biological measurements at WBG corroborate the generally low HQs, i.e., low ecological risk. Habitat alteration is expected to be intensive and extensive and result in vegetation removal (simpler or missing habitat), shorter food chains (simpler ecosystem), and lower exposure (fewer organisms). Finally, there is planned removal of soil at 6 pads to achieve human health RGOs; these pads are among the most contaminated of the 70 pads. This removal will reduce the overall concentration of many contaminants and would have the effect of lowering the already low exposure and low risk.

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3.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

3.1 INTRODUCTION

CERCLA Section 121 specifies that remedial actions must comply with requirements or standards under federal or more stringent state environmental laws that are “applicable or relevant and appropriate to the hazardous substances or particular circumstances at the site.” Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured. This chapter summarizes potential federal and state chemical-, location-, and action-specific ARARs for the potential remedial actions at WBG conducted under the IRP to address HTRW contamination. As noted in Section 1.3.1, RVAAP is in the process of transferring the site to OHARNG for use as a Mark 19 Range. This transfer will be completed prior to range construction and will be implemented under a DDESB ESS. As part of, and prior to, the transfer of the site, a separate MEC removal action will be conducted that is concurrent with the HTRW remedial action. This separate, but concurrent MEC removal action will be governed under the terms and ARARs dictated by the ESS rather than CERCLA. It is noted that common ARARs (e.g., promulgated regulations, such as storm water controls, wetlands protection, etc.) may apply to both the HTRW and MEC actions; however, this FFS addresses only those ARARs specific to the HTRW action. Any additional ARARs that are uniquely relevant to the MEC removal action are addressed under the ESS and attendant documentation. The concurrent MEC action at WBG is addressed under a separate Army protocol in accordance with its applicable requirements governing MEC removal (e.g., UXO ESSs, etc.).

ARARs include those federal and state regulations that are designed to protect the environment. Applicable requirements are “those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site” [40 *Code of Federal Regulations (CFR)* 300.5]. EPA has stated in the NCP that applicable requirements are those requirements that would apply if the response action were not taken under CERCLA.

Relevant and appropriate requirements are “those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site” (40 *CFR* 300.5).

In the absence of federal or state-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs but are to-be-considered guidance [40 *CFR* 300.400(g)(13)].

CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation [CERCLA Section 121(e)]. EPA reaffirmed this position in the final NCP [55 *Federal Register (FR)* 8756, March 8, 1990]. Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation. EPA recognizes that certain administrative requirements (i.e., consultation with state agencies, reporting, etc.) are accomplished through state involvement and public participation. These administrative requirements should also be observed if they are useful in determining cleanup standards at the site (55 *FR* 8757).

Although on-site remedial actions at National Priorities List (NPL) sites must comply only with the substantive requirements of federal or state environmental regulations, the Ohio Revised Code (ORC) does not provide a similar permit waiver for actions conducted under the Ohio EPA Remedial Response Program. Policy. The Ohio EPA's Division of Emergency and Remedial Response (DEER) Policy DERR-00-RR-034 states that, "it has been DERR's policy to require responsible parties to acquire and comply with all necessary permits, including the substantive and administrative requirements."

CERCLA Section 120(a)(4) requires federal facilities not on NPL, such as RVAAP,, to comply with all state laws concerning removal and remedial action, which are equitably enforced at federal and non-federal facilities [42 *United States Code (U.S.C.)* §9620(a)(4)]. CERCLA contains a narrow waiver of sovereign immunity for compliance with state laws regarding removal and remedial actions [42 *U.S.C.* §9620(a)(4)]. The section provides that, "State laws concerning removal and remedial action, including State laws regarding enforcement, shall apply to removal and remedial action at facilities owned or operated by a department, agency, or instrumentality of the United States ... when such facilities are not included on the [NPL] ..." This CERCLA statutory mandate differs from the compliance with ARARs mandate under CERCLA Section 120(d)(2)(A) in that the applicable state laws concerning removal or remedial action must be met regardless of the level of risk present at the site. The compliance with ARARs mandate only arises under CERCLA 121(d)(2)(A) when an on-site remedial action is required due to unacceptable risk. Therefore, regardless of the risk present at the site, the Army will be required to meet the substantive requirements of any state laws and implementing regulations that require corrective action. Remedial activities at WBG are being conducted in accordance with the orders and findings signed on June 10, 2004.

3.2 CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Chemical-specific ARARs are normally health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment (EPA/540/G-89/006, August 1988). The chemical specific ARARs and requirements for WBG are provided in Table A-1.

3.2.1 Groundwater

Where the beneficial use of the groundwater is as a current or potential source of drinking water, EPA states a preference for Safe Drinking Water Act of 1974 non-zero MCL goals (MCLGs) and MCLs where they are relevant and appropriate [CERCLA 121(d)(2)(A), as amended, and 40 *CFR* 300.430(e)(2)(i)(B) and (C)]. Groundwater is not being addressed under the considered alternatives and, therefore, chemical-specific ARARs are not identified for groundwater in this FS.

3.2.2 Surface Water

Section 121(d)(2) of CERCLA states that every remedial action shall require a level of control which at least attains water quality criteria established under Sections 304 or 303 or the Clean Water Act (CWA). Therefore, surface water quality criteria are ARARs for surface water clean-up. The considered alternatives do not address surface water. Waters of the state (drainage ways to Sand Creek), per ORC 6111 – Waters of the State, are located 50 to 100 ft south of the excavation zones at Burn Pads 66 and 67. Measures will be implemented during construction to prevent settled solids or toxic substances from entering these waters These measures will assure that the water quality criteria of OAC 3745-1-04 and anti-degradation provisions of OAC 3745-1-05 are met. These requirements have been included in Table A-1 to indicate that the HTRW actions will be protective of these waters of the state.

3.2.3 Soil

The generic direct contact soil standards (GDCS) of OAC 3745-300-08 are not applicable to WBG because remediation is not conducted under Ohio's Voluntary Action Program. These standards are not relevant and appropriate because the circumstances specified in OAC 3745-300-08 (B)(1) exist at WBG. Property-specific risk-based standards must be determined in place of or in addition to the GDCS if (1) the exposure pathways or exposure factors for the intended land use are not included in the development of the GDCS for residential, commercial, or industrial scenarios; (2) the COCs at the property are not included in the GDCS; (3) radioactive materials are identified on the property; (4) PCBs subject to TSCA are identified on the property; or (5) important ecological resources are identified on the property. Property-specific risk-based clean-up standards are applicable to WBG because the exposure scenarios for the intended land use are not considered in the development of the GDCS and certain COCs are not included in OAC 3745-300-08 (B)(3).

3.3 POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section summarizes the potential action-specific ARARs that may be pertinent to management of the soils resulting from excavation as described in this FFS. Potential action-specific ARARs are identified in Table A-2.

Remedial actions that involve excavation of soils or capping will require site preparation activities such as clearing of trees, grubbing, and grading of the site. During these activities, measures will need to be implemented to control fugitive dust emissions so that requirements of OAC 3745-17-08 will be met. Control measures typically include the application of water or other dust suppressants during clearing, grubbing, and grading. Site-related vegetation from these activities may be burned at WBG provided the fire is set when atmospheric conditions will readily dissipate the emissions, the fire is at least 1,000 ft from any inhabited structure, and an air curtain destructor is used.

Under 40 *CFR* 63, Subpart GGGGG air emissions standards have been proposed for site remediation activities at facilities that are major sources of hazardous air pollutants (HAPs) where the facility has implemented maximum achievable control technology for one of the major sources listed under Section 112 of the Clean Air Act of 1970 (CAA). Major sources are facilities that emit more than 10 tons/year for an individual HAP or greater than 25 tons/year of a combination of HAPs. Under the proposed rule, emissions limits are set for process vents, remedial materials management units, and work practices. The proposed rule exempts sites being addressed under CERCLA authority and corrective actions initiated under permits and orders. These National Emission Standards for Hazardous Air Pollutants provisions will apply to WBG only if RVAAP is a major source.

Site clearing and grading activities will disturb more than 1 acre of land. As of March 10, 2003, construction activities disturbing more than 1 acre of land are subject to the stormwater National Pollutant Discharge Elimination System permit requirements of 40 *CFR* 122.26. General permits are issued by authorized states and incorporate the requirements of the EPA's "Core" General Permit for Industrial Activity or the "Core" General Permit for Construction Activities issued by EPA in 1992. The core or baseline permits establish the same terms and conditions for all covered dischargers. State-issued core or baseline permits may also contain requirements in addition to those specified by the federal baseline general permits. Stormwater discharges from construction activities are covered under Ohio EPA's General Permit OHC000002. Coverage under the general permit is obtained by submission of a Notice of Intent to the control authority. Dischargers covered under a general permit are also required to develop and implement a Storm Water Pollution Prevention Plan (SWP3). At a minimum, the SWP3 for construction activities must address the following:

- interim and permanent stabilization practices such as the use of temporary seeding, mulching, geotextiles, vegetative buffer strips, and preservation of existing vegetation;
- a plan for sequencing of disturbances and stabilization activities;
- implementation of storm water diversion structures to divert run-on away from disturbed areas;
- the use of sediment basins, sediment traps, and silt fences;
- the use of stormwater detention structures, retention basins, run-off flow controls, and velocity dissipation devices;
- good housekeeping practices; and
- procedures to minimize off-site tracking of sediments by vehicles.

As indicated previously, the DERR requires responsible parties to obtain all permits that are relevant to the considered action.

Under 40 *CFR* 262.11 (OAC 3745-52-11), any person who generates a solid waste must determine if that waste is hazardous by evaluation of whether the waste is excluded from Subtitle C regulation, listed under 40 *CFR* 261; Subpart D; or exhibits one of the hazardous waste characteristics under 40 *CFR* 261, Subpart C. Based on the nature of the processes conducted at RVAAP and the information submitted in the RCRA Part B permit application that was withdrawn, RVAAP historically generated K044, K046, and K047 listed wastes. The Phase II RI Report states that wastewater filter media were treated at WBG. Soil samples from the vicinity of Burn Pads 37, 45, 61, 66, and 67 have total concentrations of barium, cadmium, chromium, and lead that are greater than 20 times the toxicity characteristic leaching procedure (TCLP) regulatory thresholds. Total concentrations of lead are 20 times greater than a derived toxicity characteristic (TC) limit (20 times the TC threshold). Although the soils have not been extracted by TCLP, the available data indicate the potential for the soils to exhibit the TC for metals.

On May 26, 1998, EPA promulgated a Phase IV land disposal restriction (LDR) rule that established treatment standards for hazardous contaminated soil. Hazardous contaminated soil is defined as soil that contains a listed waste or exhibits a characteristic of a hazardous waste. As indicated above, a portion of the soils may be hazardous contaminated soil. As such, RCRA Subtitle C regulations, such as the LDRs, will be applicable to the extent that the action generates and, subsequently, actively manages (treats, stores, or disposes) these soils.

If the excavated soils exhibit the TC or contain listed wastes, RCRA Subtitle C standards will be potentially applicable for the screening unit. The process reduces the concentrations of the COC, which may be viewed as treatment by Ohio EPA. If screening is considered treatment by Ohio EPA, the unit would be subject to permitting standards for physical, chemical, and biological treatment (40 *CFR* 265 Subpart Q). Alternately, screening of excavated soils could be performed without meeting certain of the above standards if the wastes were managed in a temporary unit (TU). TUs may be used to store or conduct non-thermal treatment on remediation wastes for a period of up to 12 months. Additionally, under 40 *CFR* 268.3 (OAC 3745-270-03), the process must not dilute the waste as means of achieving compliance with the LDR treatment standards. A determination of the applicability of the LDR treatment standards must be made at the point of generation (upon excavation).

It is assumed that any debris separated from the soils would be accumulated on-site in containers for less than 90 days. Containers must be kept closed, constructed of materials that are compatible with the stored waste, and maintained in good condition.

One option for staging of excavated soils is a waste pile. Waste piles that hold hazardous wastes, hazardous debris, or hazardous contaminated soils must have a double-liner system. The bottom liner must be a composite liner with a thickness of at least 3 ft and a hydraulic conductivity of $\leq 10^{-7}$ m/sec. Waste piles used to store RCRA Subtitle C wastes must also have a leachate collection between the top and bottom liners that is sloped at 1%. The leachate collection system must have a minimum thickness of $\geq$ 12 in. and a hydraulic conductivity of 10^{-2} cm/sec. Both the liners and leachate collection system must be constructed from materials that are compatible with the stored waste. The leachate collection system must be designed with sumps or similar collection systems that keep the leachate head at < 12 in. Waste piles must be protected from precipitation, surface water run-on, and wind dispersal. Under DERR policy, this waste pile would require RCRA permitting to receive the excavated soils. Accordingly, Table A-2 summarizes the RCRA-permitting standards of 40 *CFR* 264 Subparts B-G and 40 *CFR* 270 (and their corollary OAC provisions).

As indicated, a portion of the soils within the hot spots may contain listed wastes or exhibit the TC for barium, cadmium, chromium, or lead. Accordingly, the LDRs of 40 *CFR* 268 (OAC 3745-270-40) are potentially applicable to these soils. The LDR program requires hazardous wastes to be treated to meet certain standards prior to land disposal. Under 40 *CFR* 268.2, the term “land disposal” means placement in or on the land and includes “… placement in a landfill, surface impoundment, waste pile, land treatment facility… or concrete vault or bunker intended for disposal purposes.” Treatment standards under the LDR program may be either concentration limits for certain constituents in the waste or specified treatment technologies.

A Phase IV LDR rule, promulgated May 26, 1998, revised treatment standards for metal-bearing wastes and established treatment standards for hazardous contaminated soils. Consistent with CERCLA policy, this Phase IV rule indicated that, “LDRs only attach to hazardous waste or hazardous contaminated soil when it is generated and placed into a land disposal unit. Therefore, if contaminated soil is not removed from the land, LDRs can not apply” (63 *FR* 28617). Conversely, if any volume of soil contains a listed waste or exhibits a characteristic at its point of generation (excavation), the LDRs must be met prior to placement of such soil in a land disposal unit. The treatment standards specific to hazardous contaminated soils are codified in 40 *CFR* 268.49 (OAC 3745-270-49) and require the concentrations of all underlying hazardous constituents (UHCs) to be reduced by 90% and capped at 10 times the universal treatment standards (UTSs) of 40 *CFR* 268.48. Therefore, if soils that exhibit the TC or contain listed wastes are excavated, these volumes of soils must meet hazardous contaminated soil treatment standards prior to being placed in a waste pile or prior to being disposed of in a landfill after management in another unit.

Under the recently promulgated Hazardous Waste Identification Rule – Media, EPA created a new unit for the temporary management of remediation wastes, known as the staging pile. The staging pile is an accumulation of solid, non-flowing remediation wastes that may be used for storage of those wastes for 2 years. Placement of remediation wastes into a staging pile does not trigger LDRs because such units are not considered land disposal units. The potential action-specific ARARs for staging piles are the performance criteria of 40 *CFR* 264.552. These standards require that

- the staging pile must be designed to prevent, or minimize, releases of hazardous waste or hazardous constituents to the environment;

- the staging pile must be designed to minimize cross-media transfer, as necessary, to protect human health and the environment;

- the staging pile cannot be used for treatment; and

- the 2-year time limitation indicated above.

Specific designation of the unit as a staging pile, and the design and operating specifications to meet these performance standards, are prescribed by the EPA Regional Director, or authorized state, within an RCRA permit. Potential use of a staging pile is a preferable option to use of a waste pile in management of excavated soil. However, Ohio EPA has proposed adoption of these rules but has not finalized the rulemaking process at this time. Therefore, the provisions for a staging pile are not currently available to WBG.

As previously stated, the LDRs would apply to any volume of hazardous contaminated soil that was excavated and either treated or stored in another unit prior to being land disposed. These provisions would require any ex situ treatment technology to meet the soil LDRs (90% reduction in the concentrations of all UHCs capped at 10 times the UTSs) prior to placement of the solid in a waste pile if the soil would be re-placed in the excavation zones. However, the requirement to meet the soil LDRs for all UHCs would not apply if WBG was designated as corrective action management units (CAMUs). A CAMU is an area within a facility that has been designated for the purpose of implementing corrective action under RCRA. A CAMU may also be utilized when conducting CERCLA remedial actions. CAMUs may be used only within the contiguous property under the control of the owner/operator and may be used only for the management of remediation wastes. Placement of CAMU-eligible wastes (solid and hazardous wastes, debris, and media from remediation) into a CAMU does not constitute land disposal (would not trigger LDRs) and does not result in the unit being subject to the HSWA minimum technological requirements (MTRs) concerning liners and leachate collection systems. In general, CAMUs cannot receive liquid wastes or hazardous wastes containing free liquids.

The criteria that must be evaluated in the CAMU designation are specified at 40 *CFR* 264.552 and include

- whether the CAMU facilitates implementation of a reliable protective and cost-effective remedy;

- waste management activities associated with the CAMU shall not create unacceptable risks to human health or the environment;

- the CAMU shall not include uncontaminated lands, except in certain circumstances;

- areas within the CAMU where wastes remain in place after closure shall minimize future releases;

- the CAMU shall expedite the timing of the remedial action;

- the CAMU shall incorporate treatment technologies that enhance long-term effectiveness by reducing the volume, toxicity, or mobility of wastes that remain in place; and

- the CAMU shall minimize the land area within which wastes will remain in place.

Criteria that must be specified within the CAMU designation include

- the areal configuration of the CAMU,
- design and operating specifications for those areas of the CAMU used for treatment or storage of remediation wastes,
- groundwater monitoring to be conducted for the CAMU, and
- closure and post-closure care requirements.

If WBG were designated as CAMU, hazardous contaminated soil could be excavated, placed within a pile, and replaced within its boundaries without invoking LDRs or MTRs.

Under recently revised Federal rules, CAMUs must be designed with a composite liner and leachate collection systems. The composite liner shall consist of a minimum of 2 ft of compacted clay with a hydraulic conductivity of 10^{-7} cm/sec overlain by a 30-mL-thick flexible membrane liner. The composite liner system must be overlain by a leachate collection system designed to maintain the leachate depth at less than 12 in. The liner, leachate collection, and groundwater monitoring provisions do not apply if the soils being placed in the CAMU meet the remediation levels. Wastes remaining in a CAMU at closure must meet the treatment standards specified in 40 *CFR* 264.552 (35 OAC 274.652). These standards require that the principal hazardous contaminants, identified by the Regional Administrator, be treated to a 90% reduction in total concentration of non-metal constituents capped at 10 times the UTS. A 90% reduction of metal constituents capped at 10 times the UTS must be achieved, as measured in leachate, through use of the TCLP extraction method. The treatment requirement applies to the soil being placed in the CAMU regardless of whether the soils meet the remediation levels. The rules also provide for the potential of development of alternate treatment standards. However, if wastes were left within the CAMU, at closure, the minimum treatment standards would have to be achieved unless alternate standards were approved. The CAMU designation would also incorporate the criteria indicated above for the unit. It should be noted that Ohio EPA has proposed adoption of these changes to the CAMU rule but has not finalized the rulemaking process.

Soils exceeding the RGOs will be transported off-site for disposal. Soils that exceed the alternative treatment standards of 40 *CFR* 268.49 must be treated to meet these alternative LDR standards for soils prior to off-site disposal in a Subtitle C Landfill. Excavation may also result in the generation of limited quantities of hazardous debris (i.e., lead castings). These wastes must be treated to meet the hazardous debris treatment standards of 40 *CFR* 268.45 prior to off-site land disposal.

Wastewater from the decontamination of equipment must be characterized to determine if these wastewaters exhibit the TC. If the wastewater contains a listed waste or exhibits the TC, RCRA Subtitle C requirements for storage wastewater in tanks would be applicable unless the tank was a wastewater treatment unit (WWTU) that discharged to surface water or a Publicly Owned Treatment Works (POTW). Under 40 *CFR* 264.192, tank systems must be designed and constructed to ensure the structured integrity of the walls, any weld seams, base or bottom, roof, and ancillary equipment. Ancillary equipment (pumps and piping) must be supported and protected against physical damage and stress such as vibration or thermal expansion and contraction. Tank systems must be constructed of materials that are compatible with the wastes and reagents that will be introduced during the process. Tank systems should be inspected for integrity and tightness-tested before being placed into use. Under 40 *CFR* 264.193, tank systems must be provided with secondary containment that is structurally sound; free of cracks, gaps, holes, or other penetrations; and that covers all surrounding areas that might be contacted in the event of failure. Secondary containment systems must have a capacity equal to 100% of the volume of the largest tank within its boundaries and the volume of rainfall from a 24-hr, 25-year storm event. The containment system must also be provided with monitoring that allows detection of any release within 24 hrs. Additionally, 40 *CFR* 264.194 requires the tank system to be fitted with spill and overflow controls such as level alarms, feed cut-off interlock switches, pressure and temperature instrumentation and controls, and pressure-relief values.

Based on analytical results for wastewater generated in the RI, it is unlikely that this wastewater would exhibit the TC. If the tank system is used to store the wastewater prior to its conveyance to a WWTU or is part of on-site WWTU, the relevant and appropriate requirements are CWA standards. Under 40 *CFR* 264.1, WWTUs are exempt from the 40 *CFR* 264 and 270 standards. If the wastewater is indirect discharged to the POTW, it must meet the general and specific prohibitions of the federal pretreatment program and requirements that prohibit slug discharges or discharges resulting in unnatural coloring.

Discharge of the wastewater to the POTW and off-site disposal of the soils will also require a determination of acceptability for the receiving facility under the CERCLA Off-Site Rule. The determination of acceptability by EPA Region 5 requires the receiving facility to be in compliance with its permits and the relevant state environmental regulations under the CWA, CAA, and RCRA. Additionally, the receiving unit must not have any releases of hazardous constituents to the environment.

3.4 LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The potential location-specific ARARs for WBG derive from Section 404 of the CWA and the Endangered Species Act of 1973 (ESA). These potential ARARs are summarized in Table A-3.

Under Appendix A of 40 *CFR* 6.302 and 40 C*FR* 6, federal agencies are required to evaluate the potential effects of actions that may be taken in a floodplain/wetland to avoid adverse impacts, whenever possible, and to provide for restoration and preservation of such land areas. These regulations, implementing Executive Order 11988, apply to federally financed or assisted construction and improvement of facilities or management of lands and property. Prior to taking such action, the federal agency is required to perform a floodplain or wetlands determination and conduct a floodplains/wetlands assessment for any action considered within such locales. If there is not a practical alternative to locating within the floodplain or wetland, actions must be taken to minimize the impacts, restore the natural and beneficial values of the locale, and conform with the requirements of the National Flood Insurance Program. These requirements are relevant because of their intent and the location of the unit.

Under CWA Section 404, the discharge of dredged or fill materials to waters of the United States is subject to the permit program administered by USACE in accordance with 33 *CFR* 320-330. Guidelines for CWA Section 404 permits are codified in 40 *CFR* 230 et seq. Provisions of the program are applicable for those actions that involve placement or discharge of excavated materials into waters of the United States. Such waters include rivers, lakes, streams, impoundments, etc., that are suitable for commerce; their tributaries; the associated floodplain to the ordinary high-water-mark elevation; and wetlands. The discharge of dredged materials occurs whenever such materials

- are placed in a specified discharge location in a regulated body of water,

- enter a regulated body of water by run-off or overland flow from a contained land or water disposal area, and

- are added to a regulated body of water in conjunction with any ditching, channelization, mechanized land clearing, or excavation activity.

CWA Section 404 authorization is not required for the incidental addition of dredged materials that do not degrade the receiving stream. Otherwise, a pre-construction assessment demonstrating that degradation will not occur must be performed. Therefore, any remedial activities that involve the removal of contaminated soils or sediments from wetland areas at WBG or that involve placement of the excavated material into wetland areas need to consider CWA Section 404 requirements as ARARs.

Under the Section 404 guidelines, the discharge of dredged or fill materials is prohibited

- if there is a practical alternative to the considered action that has less adverse effects on the aquatic ecosystem,

- if the discharge causes or contributes to violation of the ambient water quality criteria in the receiving stream,

- if the discharge jeopardizes the existence of an endangered or threatened species or results in modification of a critical habitat,

- if the discharge causes or contributes to degradation of the receiving stream, and

- if the considered alternative does not include steps to minimize adverse impacts to the aquatic ecosystem.

Therefore, planning for remedial activities at WBG should include an evaluation of design alternatives that avoid placement or redeposition of excavated materials or fill materials to any wetlands.

If placement, redeposition, or incidental addition of excavated materials in the floodplain cannot be avoided, the remedial design should include controls and specifications that minimize adverse impacts, such as

- confining the discharge or relocating the discharge points,

- using discharge methods that dissipate energy and reduce erosion,

- using lined containment areas,

- containing the discharged material,

- implementing run-off controls such as sediment traps and screens,

- implementing controls that limit the rate of discharge,

- timing activities to avoid periods of storm events and increased stream flows,

- implementing treatment methods to reduce total suspended solids and pollutant loads,

- avoiding changes in water circulation and stream flow conditions,

- avoiding alteration of the aquatic environment (including the floodplain) in a manner that supports species with a competitive edge over indigenous species, and

- using construction techniques and planning for restoration to produce a new environment of higher ecological value.

The requirements for a CWA Section 401 Certification may apply when dredged or fill material will be discharged to waters of the state. The discharge of dredged or fill material into wetlands is prohibited if there is a practical alternative that would have less adverse impact. The wetland designated use shall be maintained and protected such that degradation through direct, indirect, or cumulative impacts does not result in the loss of wetland acreage or functions. Each wetland shall be assigned a category by Ohio EPA. Wetland use shall be maintained unless there is no practical alternative that would have less adverse impact. Mitigation shall be provided in accordance with the ratios indicated in OAC 3745-1-54 (F). Temporary or permanent impacts to Category 1 and 2 wetlands are limited to 0.5 acre. Mitigative measures, including wetlands delineation, as required by OAC 3745-1-50 through 54 must be implemented. The filling or discharge of dredged material into less than 0.5 acre of Category 1 or 2 isolated wetlands must comply with the General Permit conditions. Wetlands delineation shall be performed. Only non-contaminated dredge or fill material may be placed in the subject wetland. Mitigation shall be provided at a ratio of 2:1 for non-forested wetlands and 2.5:1 for forested wetlands.

The ESA, 16 *U.S.C.* Section 1531 et seq., provides a means for conserving various species of fish, wildlife, and plants that are threatened with extinction. The ESA defines an endangered species as “any species, which is in danger of extinction throughout all or a significant portion of its range…” In addition, the ESA defines a threatened species as “any species, which is likely to become an endangered species within the foreseeable future…” Further, the ESA provides for the designation of critical habitats that are “specific areas within the geographic area occupied by the (endangered or threatened) species… on which are found those physical or biological features essential to the conservation of the species…”

Section 7(a) of the ESA requires federal agencies, in consultation with the U.S. Department of the Interior, to ensure that the actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of endangered or threatened species, or to adversely modify or destroy their critical habitats.

Substantive compliance with the ESA means that the lead agency must identify whether a threatened or endangered species, or its critical habitat, will be affected by a proposed response action. If so, the agency must avoid the action or take appropriate mitigation measures.

Section 7 of the ESA requires consultation to determine whether the project is likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of a critical habitat. A determination, during informal consultation, that an endangered or threatened species or critical habitat is present and may be impacted by site activities will necessitate preparation of a biological assessment (BA) by the lead agency. The intent of the BA is to examine any possible impacts of a proposed action upon the affected species or critical habitats in the project area.

If the lead agency determines that the project will not affect any listed or proposed species, the lead agency will supply the appropriate area manager or regional director of the U.S. Fish and Wildlife Service (FWS) with that determination and the completed BA. Unless the FWS or the National Marine Fisheries Service (NMFS) disagrees with the determination of no effect, the lead agency’s endangered species responsibilities have been met. If the lead agency anticipates that the project will affect a listed or proposed species, the lead agency must initiate the formal consultation process with the appropriate regional office(s) of FWS or NMFS. No action can be approved until the formal consultation process is completed.

In addition to the ESA, the prohibitions of OAC 1501-18-1 and 1501-31-23 on the taking of any state-listed threatened or endangered species will also be relevant and appropriate for remedial actions at WBG. Therefore, planning for actions at WBG must ensure that adverse impact will not result from the implementation of the remedial actions.

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4.0 IDENTIFICATION OF PROPOSED REMEDIAL ACTIONS

4.1 SELECTION OF REMEDIAL ACTIONS

This section presents a range of general response actions incorporating readily available technologies and options applicable to the RAOs for soil at WBG for RVAAP. The categories of general response actions evaluated are as follows: no action, institutional actions, excavation actions, beneficial re-use actions, and disposal actions. Feasibility of technologies in each response action category to meet the RAOs is discussed briefly. Response actions and technologies most suitable for remediating soil contamination at the WBG site are grouped into a limited number of proposed remedial action alternatives. These alternatives will be evaluated further against the CERCLA detailed analysis criteria in Chapter 5.0.

4.2 ESTIMATION OF SOIL CONTAMINATION

The COCs in soil at WBG above the Range Maintenance Soldier land use scenario are benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, indeno(1,2,3-*cd*)pyrene, and RDX. The detected concentrations of benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and indeno(1,2,3-*cd*)pyrene (hereafter PAHs) were all found south of former Burn Pad 61 in the 2- to 4-ft interval of sample location WBG-217. The detected concentrations of RDX above RGOs were found in four sampling locations within and near former Burn Pads 66 and 67. One soil sample (WBG-018) was located immediately to the north of the former Burn Pad 66 in the 0 to 1-ft interval. Two soil samples were located within the former Burn Pad 67 in the 0 to 1-ft interval (WBG-105 and WBGss-071) and one of the soil samples (WBG-070) was located to the west of former Burn Pads 67 in the 0 to 2-ft interval. The locations of the elevated PAHs and RDX soil samples are presented in Figure 4-1.

Since the PAHs were found in the 2- to 4-ft sampling interval (WBG-217), a depth of 1.2 m (4 ft) will be assumed as the depth of contamination. All RDX contamination was found in surface samples; therefore, a depth of 0.3 m (1 ft) will be assumed as the depth of contamination. Additionally, the future land use will not require disturbance of soils below 0.91 m (3 ft); therefore, the maximum depth that would be excavated is 0.91 m (3 ft). The depth, surface area, and volume of each site are shown in Table 4-1. The areas of contamination are shown on Figure 4-1. The default assumption for area of contamination associated with a point is 9.6 m^2 (100 ft^2).

Table 4-1. Estimated Volume of Contaminated Soil Requiring Excavation

Site	Name	Media/ COC	Depth m (ft)	Surface Area m^2 (ft^2)	Excavated Volume m^3 (yd^3)
1	Sample Location WBG-217 (south of former Burn Pad 61)	Soil/ PAHs	1.2 (4)	9.3 (100)	11.2 (15)
2	Sample Location WBG-243 (north of former Burn Pad 66)	Soil/ RDX	0.3 (1)	9.3 (100)	2.8 (4)
3	Sample Location WBG-070 (west of former Burn Pad 67)	Soil/ RDX	0.3 (1)	9.3 (100)	2.8 (4)
4	Sample Locations WBG-105 and WBGss-071 (west side of former Burn Pad 67)	Soil/ RDX	0.3 (1)	16.7 (180)	4.4 (7)
			Totals	**53.9 (480)**	**21.2 (34)**

COC = Chemical of concern.
PAH = Polycyclic aromatic hydrocarbons.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

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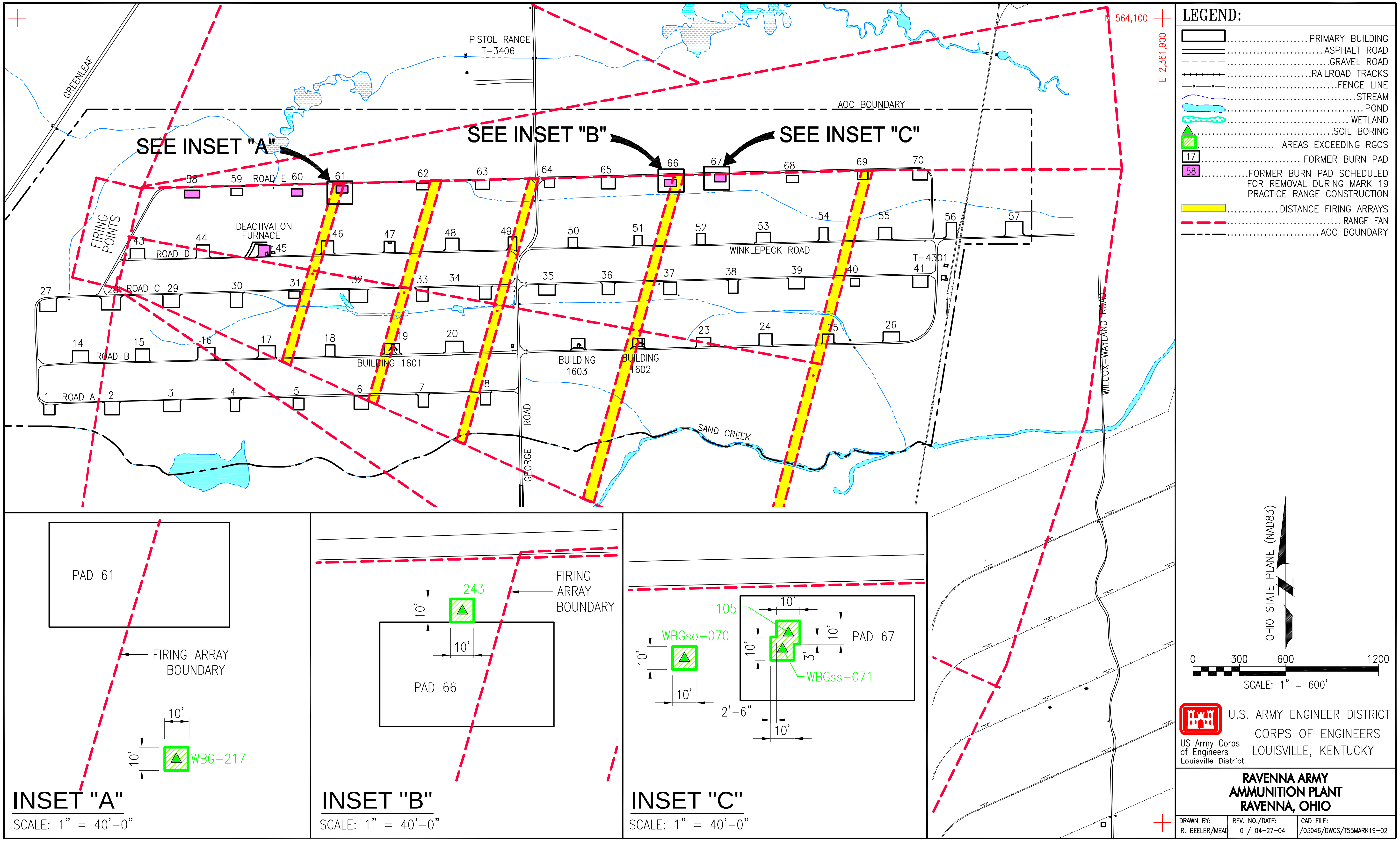

Figure 4-1. Mark 19 Range, Winklepeck Burning Grounds, Areas of Contamination Above Site RGOs

4.2.1 General Response Actions

Selection of a removal action for evaluation will focus on a few viable technologies/process options that are relevant to achieving the RAO. Only qualified technologies/process options that apply to the media (soils) and source of contamination (PAHs and RDX) were considered. General response actions were limited to those that allowed the greatest flexibility, had been used historically for the remediation of PAHs and RDX, and were appropriate for the future land use. This approach eliminated, for example, in situ treatment technologies, because such a technology could impact planned construction of the Mark 19 Range. Similarly, ex situ treatment was eliminated from further consideration because the resources and time that would be required to treat the small volume of soil greatly outweigh the benefits. Presumptive remedies were used to focus the selection of technologies/process options. Presumptive remedies are those remedial technologies that have been selected and were successful in the past at similar sites or for similar contaminants. This results in a limited number of alternatives selected for the detailed analysis (Chapter 5.0).

WBG was an operational facility where non-conforming munitions, explosives, or explosives-contaminated materials were burned. As part of the RVAAP process of transferring the site to OHARNG for use as a Mark 19 Range, a MEC removal action will be conducted under a DDESB ESS. The MEC removal action will be conducted by the JMC and is planned to be a separate, but concurrent, activity with respect to any HTRW remedial action conducted under the IRP and CERCLA. The MEC removal action will be governed under the auspices of the ESS; thus, it is not evaluated as component of the HTRW remedial alternatives in this FFS. However, because any soil area within WBG that exceeds RGOs, and consequently must be addressed under the HTRW remedial alternative, would also involve a MEC screening component, the HTRW alternatives presented and evaluated in this FFS are referenced to the logistically and financially beneficial concurrent MEC removal.

The following general response actions were considered:

- No action,
- Institutional controls,
- Excavation actions,
- Beneficial reuse actions, and
- Disposal actions.

The technologies/process options screened under each general response action were selected for their ability to remove or reduce PAH and RDX contaminants in soil. Site-specific considerations included PAHs at one location at a depth of up to 1.2 m (4 ft) and RDX at four locations near and within the former Burn Pads 61, 66, and 67 at shallow depth [0.3 m (1 ft)]. Because the site contains small volumes of contamination, the technologies/process options under the general response actions were evaluated for their applicability to removing or reducing contaminants in a small volume of soil in the shortest time frame. This allows a more equitable comparison of technologies/process options under each general response action, specifically when evaluating cost-effectiveness criteria in the detail analysis (Chapter 5.0). Another site-specific consideration is the proposed Mark 19 Range will require up to 10 acres of the site to be surveyed and cleared of MEC. The MEC action will not impact the technologies evaluated, but will impact the process used to implement the technologies. The applicable technologies/process options considered within each general response action are presented in Table 4-2 and discussed below.

Table 4-2. Summary of Screening of Technologies and Process Options Under General Response Actions

General Response Action Technology/Process Option	Evaluation Result	Justification
		No Action
No Action	Retained	Required under CERCLA regulations and provides a baseline for comparison with other alternatives
		Institutional Controls
Land Use Controls or Access Restrictions	Retained	Institutional controls, including access-use restrictions, are intended to prevent or reduce exposure to contamination. Institutional controls include such components as fencing, signage, and restrictions on future land use. It should be noted that institutional controls are generally used in conjunction with other actions. Institutional controls were retained as an incidental component of all remedial actions except no action. The OHARNG Mark 19 Range Standard Operating Procedure will contain administrative access restrictions. Physical institutional controls for the Mark 19 Range include fencing, restricted gate access points, and signage
Excavation Actions	Retained	Source of contaminants are easily removable using excavation technologies because total volume is limited and manageable. Long-term mitigation of threats to on-site workers is eliminated because sources are removed. Proven technology for the removal of contaminated soil
		Beneficial Re-use Actions
On-site beneficial reuse (soils)	Retained	Long-term mitigation of threats to on-site workers is eliminated because sources are removed and treated and characteristics confirmed prior to on-site disposal. Treated soil would be subject to meeting RGOS for the Range Maintenance Soldier receptor. Proven technically feasible method for the disposal of treated soil
On-site beneficial re-use (moisture-conditioning soils to reduce dust and allow optimum compaction) (aqueous[a] waste)	Retained	Long-term mitigation of threats to on-site workers is eliminated because soil is tested and confirmed to meet RGOs prior to on-site reuse. Proven technically feasible methods exist for the disposal of aqueous waste
		Disposal Actions
Off-site disposal to approved Subtitle D landfill (soils)	Retained	Long-term mitigation of threats to on-site workers is eliminated because sources are removed. Proven technically feasible method for the disposal of solid waste. Waste must meet acceptance criteria of approved Subtitle D Landfill
Off-site disposal to POTW (aqueous[a] waste)	Retained	Long-term mitigation of threats to on-site workers is eliminated because sources are removed. Proven technically feasible method for the disposal of aqueous waste. Aqueous waste must meet acceptance criteria of POTW

[a] Aqueous waste is wastewater from decontamination of equipment.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
POTW = Publicly Owned Treatment Works.

4.2.1.1 No action

In this response, no action would be taken to implement remedial technologies to reduce risks to potential human receptors or the environment at the WBG site. Including a no action response in this FFS is consistent with EPA guidance for removal actions under CERCLA (EPA 1993b). Environmental monitoring and periodic 5-year reviews associated with selection of a no action response would be deferred to the CERCLA final remedy for WBG under the IRP. The no action alternative provides a baseline for comparison with other alternatives.

4.2.1.2 Institutional controls

Institutional controls are used in CERCLA remedies to prevent or control exposures of potential receptors to contamination remaining in place at a site "…to assure continued effectiveness of the response action" [40 *CFR* 300.430 (e)(3)(ii)]. Institutional controls will not be considered as a stand-alone technology but as a general technology used in combination with other alternatives to enforce land use controls during the implementation of, and following, the chosen alternative. Public access to RVAAP in general, and WBG, is currently restricted by fencing and security surveillance.

Additional planned physical access controls under the Mark 19 Range land use include fencing around the range, restricted gate access points, and signage. Administrative access controls will be specified in the OHARNG range standard operating procedure (SOP). The range SOP will also address non-routine range operations (e.g., soil disturbance) and the administrative requirements for working such issues with Ohio EPA prior to implementation of non-routine operations.

4.2.1.3 Excavation actions

Excavation actions involve removal of soil using conventional earth-moving equipment such as excavators and loaders. Soil excavation would be used in conjunction with beneficial re-use or disposal actions. Excavation is suitable for the WBG site because of the proximity of the contaminants to the soil surface, and because the total volume of waste soils that would be generated would be limited and manageable. Excavated soils would be staged temporarily on-site until waste analysis is completed. Excavated areas would be brought back to grade with clean fill soil, and then revegetated. Removal of the contaminant source by excavation is a permanent remedy when used in conjunction with other actions, and is consistent with the release of the site for Range Maintenance Soldier land use scenario.

4.2.1.4 Beneficial re-use actions

Beneficial reuse actions for soil involve use of clean, sifted soil (e.g., after sifting for MEC and verifying as clean) as fill in excavated areas at the WBG site. Beneficial re-use of incidental wastewater (decontaminated or contact water) involves the use of clean (below MCLs) wastewater for moisture conditioning the soils to reduce dust and to allow for optimum soil compaction. Because the source of contamination would be below RGOs, beneficial re-use actions would be consistent with the RVAAP objective of releasing the WBG site for the Range Maintenance Soldier land use scenario.

4.2.1.5 Disposal actions

Disposal involves the permanent disposition of the contaminated soil and incidental wastewater in a manner that protects human health and the environment. Off-site disposal would involve the transportation of excavated soil to an approved and licensed disposal facility. All excavated materials will be sampled for waste profiling prior to any disposal activities. Wastewater accumulated during equipment decontamination at the sites could be disposed of off-site at a treatment, storage, and disposal facility or a POTW, depending on its characteristics. Because the source of contamination would be permanently removed, off-site disposal actions would be consistent with the objective of releasing the WBG site for the Range Maintenance Soldier land use scenario.

4.2.2 Summary of Proposed Remedial Actions

This section identifies response actions incorporating specific technologies to be retained for detailed analysis. The alternatives selected are based on a Range Maintenance Soldier land use scenario for the proposed Mark 19 Range. The retained technologies were grouped into three alternatives that represent a focused range of remedial actions. The alternatives to be evaluated are as follows.

- Alternative 1: No Action.
- Alternative 2: HTRW Contamination Removal Concurrent with the Mark 19 Range MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Soil Disposition Options, including Beneficial Re-use or Disposal.
- Alternative 3: HTRW Contamination Removal Independent of the Mark 19 Range MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Soil Disposition Options including Beneficial Re-use or Disposal.

Since the construction of the Mark 19 Range will require MEC surveys and clearance, the HTRW removal action was evaluated as a concurrent activity with the MEC action in the development of Alternative 2. Alternative 3 assumes the HTRW removal is independent of the Mark 19 Range.

4.2.2.1 Alternative 1: No Action

The No Action alternative is included for baseline comparison with the other alternatives. Under the no action alternative, contaminated soil would remain in place at the WBG site and no further action would be taken.

4.2.2.2 Alternative 2: HTRW Contamination Removal Concurrent with the Mark 19 Range MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Soil Disposition Options including Beneficial Re-use or Disposal

Alternative 2 incorporates the planned construction of the Mark 19 Range at WBG by OHARNG. This alternative includes coordination of the MEC removal actions necessary to construct the practice range with the HTRW cleanup of soils. Construction will involve surface disturbance across approximately 10 acres, as described below and shown on Figure 4-1. Planned MEC actions include the following.

1. MEC surveys and clearance (excavation and sifting) of the 1.5-acre firing points located on the western side of the WBG site to depth of 4 ft.
2. MEC clearances of six former burn pads (45, 58, 60, 61, 66, and 67). Where the pad or a portion of the pad is located within the firing arrays, the soil will be excavated to depth of 4 ft bgs and screened for MEC. Where the pad or a portion of the pad is located outside the firing arrays, the soil will be cleared to a depth of 1 ft bgs.
3. MEC clearance of the known distance firing arrays, out to 1,500 m (4,950 ft) from the western edge, running north to south across the site. These areas will be surface-cleared of MEC to a depth of 1 ft, except where the array crosses one of the six pads noted above.

The MEC clearing process would include geophysical surveys, excavation by layers, and sifting (screening) of the excavated soil for metal debris. No soils within the MEC action footprint were identified to be above RGOs. However, disposition of the sifted material would be determined by collecting composite samples and analyzing for the COCs identified in this FFS. The disposition of soils after the analytical testing is complete would be based on the following options.

1. The screened soils below RGO values would be beneficially used as backfill in the existing excavation.

2. The screened soils above RGO values would be disposed off-site at an approved disposal facility. Additionally, samples from MEC excavation will be collected to ensure that soil is less than the RGOs at the base/sides.

Those areas containing HTRW contaminants above RGOs, but outside the footprint of the planned MEC actions, will be excavated to the estimated depths outlined in Table 4-1 under this alternative. Thus, the MEC surveys and clearance footprint would simply be expanded to also encompass the points with known HTRW contaminants.

4.2.2.3 Alternative 3: HTRW Contamination Removal Independent of the Mark 19 Range MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Soil Disposition Options including Beneficial Re-use or Disposal

Alternative 3 is a separate HTRW contamination remediation independent of MEC removal action associated with the construction of the Mark 19 Range. This alternative includes the cleanup of soils exceeding RGOs (Table 4-1) present at the site without consideration of Mark 19 Range MEC removal actions. The alternative includes excavation of soil that exceeds the calculated RGO value for the Range Maintenance Soldier land use scenario. Because of past activities at WBG, all areas selected for excavation will have to be surveyed and cleared of potential MEC. This process would include geophysical surveys, excavation by layers, and sifting (screening) of the excavated soil for metal debris. Disposition of the sifted material would be determined by collecting composite samples and analyzing for the COCs. The disposition of soils after the analytical testing is complete would be based on the following options.

1. The screened soils below RGO values would be beneficially used as backfill in the existing excavation.
2. The screened soils above RGO values would be disposed off-site at an approved disposal facility.

4.2.3 Combination of Proposed Remedial Actions

The technologies retained under Alternatives 2 and 3 are the same. Alternative 2 includes HTRW contamination removal concurrent with the planned MEC removal for the Mark 19 Range. Alternative 3 includes HTRW contamination removal independent of the Mark 19 Range MEC removal. The screening of the analytical soil data against the RGOs revealed that only one sample contained PAHs above RGOs near former Burn Pad 61 and RDX above RGOs at four sample locations within and near former Burn Pads 66 and 67. Since all these samples are within or immediately adjacent to (< 30 ft) the Mark 19 Range MEC removal footprint and the technologies are the same, the logistical and cost considerations for an HTRW removal action independent of the MEC action are not warranted. Therefore, Alternative 3 will not be carried forward in the detailed description or analysis of alternatives. The alternatives to be retained for detailed description and analysis are (1) Alternative 1: No Action, and (2) Alternative 2: HTRW Contamination Removal Concurrent with the Mark 19 Range MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Soil Disposition Options including Beneficial Re-use or Disposal.

5.0 IDENTIFICATION AND ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

Technologies retained under the general response actions were combined into the following two alternatives for detailed analysis:

- Alternative 1: No Action.
- Alternative 2: HTRW Contamination Removal Concurrent with the Mark 19 Range MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Soil Disposition Options including Beneficial Re-use or Disposal.

5.1 DETAILED DESCRIPTIONS

Detailed descriptions of the two removal action alternatives are presented in the following sections.

5.1.1 Alternative 1: No Action

For this alternative, no action would be taken to reduce the hazards present at the site to potential human or ecological receptors. There would be no reduction in toxicity, mobility, or volume of the contaminated media. Accessibility to contaminants by workers and the public would not be prevented. Consideration of the no action alternative is required under EPA guidance for removal actions under CERCLA for baseline comparison with other alternatives.

5.1.2 Alternative 2: HTRW Contamination Removal Concurrent with the Mark 19 Range MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Beneficial Re-use or Disposal

Under this alternative, the munitions response areas (MRAs) designated for removal as part of the Mark 19 Range construction would be surveyed and cleared of MEC. Construction would involve surface disturbance across approximately 10 acres, as described below and shown on Figure 4-1. Planned MEC actions include the following.

- MEC surveys and clearance (excavation and sifting) of the 1.5-acre firing point area located on the western side of the WBG site to depth of 4 ft.
- MEC clearances of six former burn pads (45, 58, 60, 61, 66, and 67). Where the pad or a portion of the pad is located within the target array bands, the soil would be excavated to depth of 4 ft bgs and screened for MEC. Where the pad or a portion of the pad is located outside the target array bands, the soil would be cleared to a depth of 1 ft bgs.
- MEC clearance of the known distance target array bands, out to 1,500 m (4,950 ft) from the western edge, running north to south across the site. These areas would be surface-cleared of MEC to a depth of 1 ft, except where the target array bands crosses one of the six pads noted above.

Since all the soils exceeding RGOs are within or immediately adjacent to (< 30 ft) the MRAs, these soils would become part of the MEC Contractor's Scope of Work and be integrated with the construction activities. The contaminated soils exceeding the RGOs would be excavated to a depth of 0.3 to 1.2 m (1 to 4 ft) and screened for potential MEC. Due to past activities at WBG, all areas selected for excavation would have to be surveyed and cleared of potential MEC. This process would include clearing vegetation, geophysical surveys and visual inspections, excavation by layers, and sifting (screening) of the excavated soil for metal debris. No soils within the MEC action footprint were identified to be above RGOs. However, disposition of the sifted material would be determined by collecting composite samples for comparison against the RGO values. The disposition of soils after the MEC screening is complete would be based on the composite sampling results. The screened soils below RGO values would be used as backfill in the existing excavation. The screened soils above RGO values would be disposed off-site at an approved facility. Additionally, samples from MEC excavation will be collected to ensure that soil is less than the RGOs at the base/sides.

Those areas containing HTRW contaminants above RGOs, but outside the footprint of the planned MEC actions, will be excavated to the estimated depths outlined in Table 4-1 under this alternative. Thus, the MEC surveys and clearance footprint would simply be expanded to also encompass the points with known HTRW contaminants. Figure 5-1 presents a schematic of Alternative 2 as it would be implemented at a site.

Removal action work would begin with demarcation of the areas exceeding RGOs. The perimeter of the area to be excavated would be delineated with flagging and enclosed with temporary fencing or another barrier to limit access. A sign would be posted at the entrance to each site listing the hazards present at the site and a telephone number of someone to contact to gain access to the site.

Because of potential MEC concerns associated with the remediation of the sites, MEC-trained personnel would be present for all work. Below is a general discussion of MEC removal; however, specific removal details would be determined by the contractor and detailed in the ESS Plan approved by the Army Technical Center Explosive Safety. In accordance with the ESS Plan, qualified personnel would survey the areas to be excavated using magnetometers, prior to initiation of excavation activities. After the first 0.3 m (1 ft) of soil is excavated, the MEC team would survey the area again if additional soil is to be excavated. If surveys indicate the area is clear, the excavation would proceed in 0.3-m (1-ft) increments until the excavation is complete. The project health and safety plans would specifically address MEC concerns and actions to limit hazards associated with MEC. If MEC were identified, it would be managed in accordance with the approved ESS Plan.

Site preparation would include, as required based on the local site topography, constructing temporary diversion ditches to minimize surface run-on into the excavations, installing silt fence and staked hay bales to minimize transport of soil in run-off, constructing temporary pads for soils, equipment laydown areas, and establishing decontamination areas at the site.

A waste staging area would be designated for the site. Due to the location of contaminants, one staging pile should be maintained for the PAH contaminants and a separate staging pile for the RDX contaminants. If available, an existing graveled or paved area would be used. If an existing prepared area is not available, a waste staging location would be chosen where run-on and run-off are minimal. Staging piles would be covered with reinforced polyethylene covers.

A clean equipment laydown area would be identified for each site or group of sites. If available, existing paved or graveled areas would be used. If not, a grassy area may be used.

A backhoe, excavator, or other suitable equipment would excavate soil materials. There are no known utilities to be located within WBG. Excavated material would be placed directly into a “Grizzly” unit or stockpile for future soil sifting. After the excavated soils have been sifted, the temporary storage piles would be covered with reinforced polyethylene covers. Soil excavated from areas greater than the RGOs will be kept segregated from soil removed as part of the MEC action footprint.

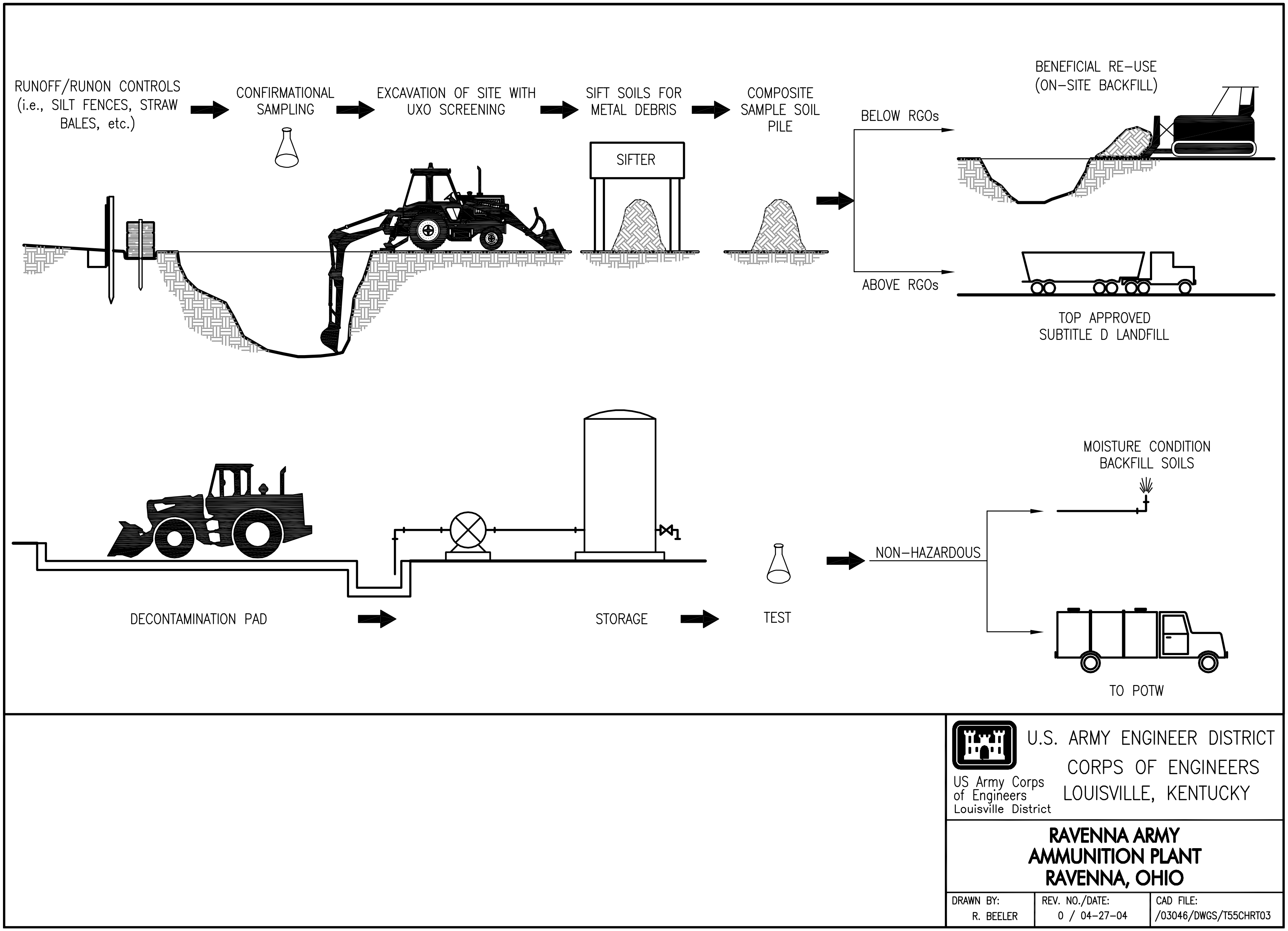

Figure 5-1. Alternative 2, Remedial Action Process Flow Chart

Measures would be taken to avoid erosion of contaminated soils or ponding of water in the open excavations. The use of diversion ditches, silt fences, and staked hay bales was mentioned previously. In addition, local weather forecasts would be evaluated prior to initiating excavation activities to limit work delays due to rain while the excavation is open.

All construction equipment and tools that come into contact with contaminated or potentially contaminated media would be decontaminated prior to being used for site restoration activities or being moved out of the controlled area. A temporary decontamination pad capable of collecting wash water including overspray would be assembled. Equipment and tools would be thoroughly cleaned with a steam cleaner to remove all visible soil and mud. No soap or detergent would be used. The decontamination water would be collected in portable polytanks. Soil residue would be placed in the temporary storage piles.

The wastewater stored in portable polytanks would be tested for contaminants, as listed in Table 5-1. Nonhazardous (below MCLs) wastewater would be used to moisture-condition the storage piles to reduce dust and allow for optimum compaction. If wastewater is determined to be above MCLs, the water would manifested and transported to an approved off-site treatment and disposal facility. It is not expected that any of the wastewater would be above MCLs; therefore, the polytanks would be stored at the waste staging areas without the need for secondary containment.

Confirmatory samples would be taken from the sidewalls and bottom of the completed excavations to verify that the contaminated soil above RGOs was removed. Samples would be analyzed for contaminants as listed in Table 5-1. Table 5-1 also gives the numbers of samples to be taken from each site. If analysis results indicate that contamination remains in the ground, additional soil would be excavated as directed by the RVAAP-authorized representative. Confirmatory samples would be taken from the extended excavation, and the process repeated as necessary until the soil to remain in place meets the RAOs.

The storage pile would be sampled for contaminants as listed in Table 5-1. The sample would be obtained by compositing four samples from each quarter of the storage pile. The disposition of soils after the analytical testing is complete would be based on the composite sampling results. The screened soils below RGOs would be used as backfill in the existing excavation. The screened soils above RGOs would be disposed off-site at an approved facility.

The soils meeting the established RGOs would be used as backfilled within the excavations. The fill would be placed in lifts and compacted to yield 15 cm (12 in.) maximum lift thicknesses. The top lift would be filled with soil capable of sustaining vegetation. The area would be seeded, mulched, and maintained and irrigated as necessary until a stand of grass is developed. Based on existing analytical data, it is highly probable that all of the soils would meet RGOs and be used as backfill.

If soils exceed the established RGOs, they would be transported to an off-site disposal facility appropriate for the type of waste. If the waste were determined to be nonhazardous, it would be disposed of at a Subtitle D Landfill permitted to accept special waste. The soils would be placed into lined intermodal containers and transported to an approved facility. No labeling or placarding is required for this material, and the transporter would not be required to be licensed for hazardous waste transportation.

No off-site borrow materials should be used on-site. The construction of the Mark 19 Range would generate additional backfill material if required.

The Mark 19 Range will be fenced appropriately, in accordance with current Department of Army regulations. Signage placed on the fence will clearly indicate that the Mark 19 Range is prohibited from unauthorized entry. The OHARNG's Mark 19 Range SOP will establish effective administrative controls

Table 5-1. Estimated Number of Confirmatory and Waste Samples and Analysis at Each Site

	Confirmatory Samples[a]					Waste Samples[b]			
Site	**Media**	**Bottom**	**Sidewalls**	**Total**	**Analytes**	**Media**	**Volume**	**Composite Samples**	**Analytes**
Sample Location WBG-217 (south of former Burn Pad 61)	Soil	1	4 (one from each sidewall)	5	Explosives	Storage pile after sifting	15 yd^3	1	SVOCs
						Soil requiring off-site disposal	15 yd^3	1	TCLP metals
Sample Location WGB-2018 (north of former Burn Pad 66)	Soil	1	4 (one from each sidewall)	5	Explosives	Storage pile after sifting	4 yd^3	1	Explosives
						Soil requiring off-site disposal	4 yd^3	1	TCLP metals
Sample Location WBGso-070 (west of former Burn Pad 67)	Soil	1	4 (one from each sidewall)	5	Explosives	Storage pile after sifting	4 yd^3	1	Explosives
						Soil requiring off-site disposal	4 yd^3	1	TCLP metals
Sample Locations WBG-2013 and -2013 (west side of former Burn Pad 67)	Soil	1	4 (one from each sidewall)	5	Explosives	Storage pile after sifting	7 yd^3	1	Explosives
						Soil requiring off-site disposal	7 yd^3	1	TCLP metals
All Sites						Decontamination water	55 gal	1	Explosives

[a]Does not include quality control samples.
[b]Does not include samples of collected rainwater.
SVOC = Semivolatile organic compound.
TCLP = Toxicity characteristic leaching procedure.
VOC = Volatile organic compound.

that properly control access to the Range. Land use controls would be addressed under the RVAAP Base Management Plan. Long-term monitoring of groundwater/surface water will be addressed by OHARNG and BRAC in a separate MOA, under direction of the NGB. Monitoring activities within the surface danger zone of the Mark 19 Range will be conducted only after coordination with RTLS Range Control. The Mark 19 Range SOP will address administrative access requirements for activities within the Range other than Mark 19 firing, (i.e., monitoring, sampling, construction, road and land repair, etc.). The SOP will also outline provisions for protection of the groundwater monitoring network, periodic well inspections, and well maintenance within the Range. Such activities include installing signs on monitoring wells, as appropriate, and maintaining high visibility paint, protective posts, protective pads, and well security devices. The details of the designated land use and any institutional or land use controls under CERCLA for WBG, and RVAAP as a whole, will be negotiated between the site owner and Ohio EPA and incorporated into the LUCIP for RVAAP. The LUCIP will specify land use for various portions of RVAAP as identified in various decision documents for AOCs within RVAAP and specifies the continued maintenance of the RVAAP perimeter fence and signage. Any long-term surface water and groundwater monitoring requirements specific to WBG will be incorporated into facility-wide decisions for those respective media. The LUCIP will also address long-term monitoring as a component of future land use for RVAAP.

5.2 ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

5.2.1 Analysis Criteria

Each alternative described in Section 4.1 is evaluated against effectiveness, Implementability, and cost in this section. EPA has established the following nine evaluation criteria to address CERCLA criteria and statutory considerations:

- overall protection of human health and the environment;
- compliance with ARARs;
- long-term effectiveness and permanence;
- reduction of toxicity, mobility, or volume through treatment;
- short-term effectiveness;
- implementability;
- cost;
- state acceptance; and
- community acceptance.

The selected alternative must satisfy the “threshold criteria,” which include overall protection of human health and the environment and compliance with ARARs. Alternatives that do not meet these criteria cannot be selected. The following sections provide a brief discussion of each criterion.

The first criterion, **overall protection of human health and the environment**, assesses whether the alternative can adequately protect human health and the environment, over both the short and long terms, from unacceptable risks posed by contaminants at the site. Overall protection of human health and the environment draws on other factors assessed under the evaluation criteria—specifically, short-term effectiveness, long-term effectiveness, and permanence—and on compliance with ARARs. The criterion assesses how the source of contamination is to be reduced or controlled, how the site-related risks are to be reduced, and whether target levels would be attained.

Each alternative is assessed for its **compliance with ARARs** under federal environmental laws and state environmental or facility siting laws. Regulations and guidance that were screened for relevance to the remedial actions are presented in Chapter 3.0. A comprehensive list of ARARs is presented in Appendix A.

The **long-term effectiveness and permanence** criterion assesses the reliability of the remedial action in meeting the RAOs. The assessment of long-term effectiveness is made considering the factors described below.

The magnitude of the residual risk to human health and environmental receptors remaining from untreated waste or treatment residues left at the conclusion of the remedial activities. The characteristics of the waste to be considered should include its volume, toxicity, mobility, and propensity to bioaccumulate.

An assessment of the long-term reliability of engineering and institutional controls to provide continued protection from untreated waste or treatment residues, including an assessment of the type, degree, and adequacy of long-term management [including engineering controls, monitoring, and operations and maintenance (O&M)] required for untreated waste or treatment residues remaining at the site and the potential need for replacement of the action and the continuing need for repairs to maintain the performance of the remedy.

Reduction of toxicity, mobility, or volume through treatment addresses the degree to which actions employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of the hazardous substances. The ability of an alternative to reduce toxicity, mobility, or volume is not considered under this criterion unless the alternative accomplishes the reduction through treatment. The following specific factors are considered:

- treatment process;
- amount of hazardous materials that would be treated;
- degree of reduction in toxicity, mobility, or volume, including how the principal threat is addressed through treatment;
- degree to which the treatment is irreversible;
- type and quantity of treatment residuals that would remain following treatment; and
- degree to which the alternative satisfies the preference for treatment.

The **short-term effectiveness** of an alternative is evaluated relative to its effect on human health and the environment during implementation of the interim action. The short-tem effectiveness assessment is based on four key factors:

- short-term risks that might be posed to the community during implementation of an alternative,
- potential for impacts on workers during construction and the effectiveness and reliability of protective measures,
- potential environmental impacts of the action and the effectiveness and reliability of mitigative measures during implementation, and
- time until objectives are achieved.

Implementability refers to the ease or difficulty of deploying the alternatives. Specific factors used in assessing implementability include those listed below.

- 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 any necessary approvals and permits from other agencies (for off-site actions).

- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; necessary equipment and specialists and provisions to ensure any necessary additional resources; services and materials; and prospective technologies.

The **cost** of an alternative reflects the capital and O&M requirements and provides an estimate of its dollar cost. The costs estimated in this report are based on cost-estimating guides and engineering judgment. The primary methodology used is a quantity takeoff method in which cost are calculated based on a unit cost multiplied by a quantity. The cost estimates were initially developed using calendar year (CY) 2003 dollars, with no escalation or discount factors. Next, the costs were discounted to calculate the present-value costs. The present-value analysis is a method of evaluating expenditures, typically O&M costs that occur over different time periods. Present-value calculations allow for cost comparisons of different remedial alternatives on the basis of a single cost figure. A discount rate of 7% was used to approximate the marginal pretax rate of return on an average investment and has been adjusted to eliminate the effect of inflation. The capital costs have not been discounted because of their relatively short implementation duration. The costs presented in the detailed description of alternatives are prepared for guidance in project evaluation and implementation and based on present-value cost. They are believed to be accurate within a range between -30 and +50% of the actual costs, in accordance with EPA guidance. The actual costs for these actions could be higher than estimated because of unexpected site conditions and the potential for delays in taking the action. Correspondingly, costs could be lower if construction efficiencies are achieved. A summary of the nondiscounted cost, key parameters, and assumptions used in developing the cost are presented in Appendix B.

The potential alternatives have not been presented to the state or community to date; therefore, the state or community's acceptance/preference of an individual alternative is unknown. The state and community evaluation **criteria would be addressed in the record of decision.**

5.2.2 Alternative 1: No Action

5.2.2.1 Description

The no action alternative was developed to provide a baseline for comparison with other alternatives as required under CERCLA. No remedial actions would be undertaken to reduce, contain, or remove contaminated soil. Off-site migration of contaminants would not be mitigated under the no action alternative.

5.2.2.2 Overall protection of human health and the environment

This alternative would provide no protection of human health or of the environment from the site COCs. No effort would be taken to prevent or minimize human or environmental exposure to

contaminated soil. It should be noted, however, that contaminated soil is currently outside of the Mark 19 Range, so human health for the Range Maintenance Soldier is not in immediate danger.

5.2.2.3 Compliance with ARARs

The principal ARARs for remediation of the WBG are presented in Chapter 3.0. These federally enforceable standards would be protective of a potential future Range Maintenance Soldier who could be exposed to the COCs.

The no action alternative would not comply with chemical-specific ARARs. The concentrations in soil would remain above the RGO, and although natural attenuation would occur, the soil would not be confirmed to have been restored to Range Maintenance Soldier use standards.

5.2.2.4 Long-term effectiveness and permanence

The no action alternative would have no long-term effectiveness or permanence. Risks would essentially remain the same because no controls would be implemented to prevent potential exposure to the soil, there would be no treatment of the soil contaminants, and there would be no confirmation of any long-term reduction of contamination through natural attenuation.

5.2.2.5 Reduction of toxicity, mobility, or volume through treatment

The no action alternative does not meet the statutory requirement for treatment. Because no treatment would be implemented, there would be no reduction in toxicity, mobility, or volume; however, the COCs at the WBG would naturally attenuate to below remedial levels; therefore, there would be a gradual decrease in the volume or mass of contamination. Under the no action alternative; however, no monitoring would be performed to evaluate such decreases or mobility (further off-site migration). Some future impact/unknown factor at the site could potentially increase the toxicity, mobility, or volume of contamination at the site.

5.2.2.6 Short-term effectiveness

No impact to the environment or community would be expected to occur from implementation of this action. Because this alternative would not involve construction, there would be no impact to workers or the environment.

5.2.2.7 Implementability

No action is readily implementable because no remedial actions would be taken.

5.2.2.8 Cost

There are no costs associated with the no action option.

5.2.3 Alternative 2: HTRW Contamination Removal Concurrent with the Mark 19 Range MEC Removal Action – Excavation, Screen for Potential MEC, Composite Sampling, and Soil Disposition Options including Beneficial Re-use or Disposal

5.2.3.1 Description

A detailed description of Alternative 2 was presented in Section 4.1.2. Removal of contaminated soil would eliminate the potential contact of receptors at the sites, as required under CERCLA. The remedial actions would be undertaken to reduce, contain, or remove contaminated soil. Off-site migration of contaminants would be mitigated under this alternative.

5.2.3.2 Overall protection of human health and the environment

In general, the long-term protectiveness of this alternative is high for the Range Maintenance Soldier land use cleanup goals in soils. Removing soil containing contaminants above the RGOs would limit risks to within the CERCLA acceptable cancer risk range. This alternative is protective of human health under the Range Maintenance Soldier land use scenario.

Contact with users other than the Range Maintenance Soldier would be essentially eliminated because the site is controlled (security and fenced). Since the site is not being cleaned up for unrestricted use, land-use controls would be implemented, including land use restrictions controlling the future use of the site and activities that would restrict disturbing or removing on-site soils. This would also include prohibiting off-site movement of soils without further environmental documentation. The overall protection of human health and the environment for this alternative is dependent, therefore, on the establishment and maintenance of institutional controls. The institutional controls would be implemented through OHARNG or RVAAP in concurrence with Ohio EPA. This alternative would provide protection of human health through fencing, warning signs, and institutional controls placed on the use of on-site soils.

The current land use and future land use as a Mark 19 Range allow for minimal habitat for ecological receptors and, thus, minimal exposure. The remedial actions taken to protect human health also would reduce risks to ecological receptors that occupy or visit the site.

5.2.3.3 Compliance with ARARs

The principal ARARs for remediation of WBG are presented in Chapter 3.0 These federally enforceable standards would be protective of a potential future Range Maintenance Soldier who could be exposed to the COCs.

Alternative 2 would comply with chemical-specific ARARs. The concentrations in soil above RGOs would be removed. The soils would be confirmed to have been restored to Range Maintenance Soldier use standards.

5.2.3.4 Long-term effectiveness and permanence

Alternative 2, which includes excavation, MEC screening, and the beneficial re-use or disposal of soils is protective in the long term for Range Maintenance Soldier land use. However, it relies on land use controls to eliminate or reduce exposures to receptors associated with unrestricted land use. The long-term effectiveness of this approach is directly related to the adequacy and reliability of the established land use controls. Although the potential exists for land use controls to fail, it is reasonable to expect that with appropriate documentation and procedures as discussed in Section 5.3.2.2, land use controls could be successfully implemented and would be effective in protecting human health and the environment.

Under Alternative 2, contaminants would remain on-site above the soil cleanup goals for unrestricted land use; however, they would be below the cleanup goals for Range Maintenance Soldier land use. As long as soils remain on-site above unrestricted cleanup goals, site reviews would be conducted once every 5 years pursuant to requirements of CERCLA. The purpose of these reviews is to evaluate data obtained from ongoing monitoring and to provide information on the presence and behavior of contaminants, as well as to ensure that the engineering controls and land use controls are retaining their effectiveness.

5.2.3.5 Reduction of toxicity, mobility, or volume through treatment

No reduction in contaminant toxicity, mobility, or volume is achieved because no treatment process is proposed under this alternative.

5.2.3.6 Short-term effectiveness

Minimal risk to the community and current Army personnel would be minimal since WBG is an isolated site with controlled access. Air quality could be affected by the release of particulates during soil excavation and sifting activities. Air monitors would be installed to measure dust emissions during construction activities. Engineering controls would be implemented to ensure emissions do not exceed levels that could pose a risk to human health.

Potential occupational exposures to remedial construction workers could result from inhalation and ingestion of airborne particulates. Workers would follow an approved site-specific health and safety plan describing appropriate levels of personal protective equipment and decontamination procedures to minimize exposure to and the spread of contamination. The potential for worker exposure is mitigated through these measures.

Heavy machinery would be operated on-site during the implementation of this alternative. Workers would be at risk for accidents and injuries associated with the use of this equipment. These construction risks would be consistent with similar activities at non-contaminated construction sites. All machinery and equipment would be inspected after use and decontaminated if necessary. No occupational or safety barriers that would prevent the implementation of this remedy are foreseen.

Potential releases to the environment would be controlled with management and engineering practices. Hay bales and silt fences would be used to prevent soil transport in surface water runoff. Wetting surface materials with water or dust control chemicals would mitigate fugitive dust impacts. Covering storage piles with reinforced polyethylene covers could reduce the dust loads and prevent the spread of contaminants. Re-vegetating with grasses would restore the disturbed sites.

Remedial action would require less than 2 weeks to complete and would include a 30-day O&M period. Following completion of field remediation activities, implementation of land use controls for the site property, monitoring, and 5-year reviews would be conducted.

5.2.3.7 Implementability

Technically, this alternative is highly implementable. Excavation of impacted soils, screening for MEC materials, and on-site beneficial re-use or off-site disposal are conventional activities in construction projects of this kind. Multiple disposal facilities are available that could accept the waste. Resources are readily available for removing soil and standard excavation and construction equipment would be used. The MEC avoidance team approach for identifying and disposing of MEC has been implemented and subcontractors are available to perform MEC removal or detonation work.

Land use controls are implementable. No technical difficulties are anticipated in establishing or maintaining monitoring programs or access controls.

5.2.3.8 Cost

The capital costs to expand the MEC removal footprint to excavate soil exceeding RGOs, screen for potential MEC, conduct composite sampling, and beneficially re-use soils as backfill would be approximately $46,000. The capital costs to excavate, screen for potential MEC, composite sampling, and dispose off-site would be approximately $54,000. The cost are based on the additional cost that the Mark 19 Range construction contractor would incur to excavate, screen for MEC, and beneficially re-use or dispose off-site. If disposal is required, the waste is anticipated to be non-hazardous and disposed in a Subtitle D facility. If waste classification samples determine the soils to be hazardous, an additional $15,000 would be added to the capital cost. The alternative was estimated to be complete in less than 2 weeks. Detailed costs for this alternative are presented in Appendix B.

O&M costs (for monitoring and land use controls) are estimated for a 30-year period and would be approximately $156,000. The imposition of land use controls and the implementation of a land use control plan are included in this cost. In addition, 5-year reviews are required throughout the costing period. See Appendix B for a detailed description of Alternative 2 O&M costs.

The total capital and O&M costs to excavate, screen for potential MEC, composite sample, and beneficially use soils as backfill would be approximately $202.000. The capital costs to excavate, screen for potential MEC, composite sample, and dispose off-site would be approximately $210,000 if disposed in a Subtitle D facility and $225,000 if disposed in a Subtitle C facility.

The present-value cost to complete Alternative 2, assuming soils are beneficially reused (in CY 2004 dollars), is approximately $110,000. The present-value cost to complete Alternative 2 assuming soils are disposed off-site (in CY 2004 dollars) is approximately $118,000 if disposed in a Subtitle D facility and $133,000 if disposed in a Subtitle C facility.

6.0 CONCLUSION/RECOMMENDATION

This FFS employed a streamlined alternative evaluation process based on the determined land use scenario. This process evaluated a range of alternatives, site-specific land use requirements (Mark 19 Range), technologies, and associated costs. The defined land use determined the extent of remediation necessary to achieve cleanup levels that would lower risk to protective levels.

Risk-based RGOs were estimated for all seven soil COCs and compared against the soils data at WBG. An analysis of individual sample results indicated that (1) there was no exceedance of the arsenic RGO; (2) a single location had soil concentrations that exceeded the RGOs for the five PAHs; and (3) four locations had RDX concentrations that exceeded its RGO. A removal of the one soil location where PAHs exceed their RGOs, accompanied by replacement with clean fill material, would result in EPCs less than RGOs for all COCs.

Ecological risk is present albeit the re-calculated HQs are mostly under 1 and, if not, mostly under 30 for conservative scenarios. Habitat alteration is expected to be intensive and extensive and resulting in vegetation removal (simpler or missing habitat), shorter food chains (simpler ecosystem), and lower exposure (fewer organisms). Biological measurements at WBG corroborate the HQs, i.e., low ecological risk.

Based on the available risk information a limited soil removal would lower human health risk to an acceptable level for the defined land use. The defined construction activities and MEC clearance will not impact the five defined areas that exceed RGOs. Since removal of these HTRW contaminated areas would result in EPCs less than RGOs for all COCs, excavation of these areas should occur concurrently with the planned MEC removal action.

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7.0 REFERENCES

American Cancer Society 2003. *Cancer Facts & Figures 2003*, available at www.cancer.org.

Efroymson, R.A., G.W. Suter, II, B.E. Sample, and D.S. Jones 1997. *Preliminary Remediation Goals for Ecological Endpoints*, ES/ER/TM-162/R2, Lockheed Martin Energy Systems, Oak Ridge National Laboratory, Oak Ridge, TN. 50 pp.

EPA (U.S. Environmental Protection Agency) 1989. *Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual (Part A)*, EPA/540/1-89/002, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 1990. *National Oil and Hazardous Substance Pollution Contingency Plan*, Final Rule, RF Vol. 55, No. 46, March 8, 1990, available from U.S. Government Printing Office, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 1991. *Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals*), OSWER Directive 9285.7-01B, Office of Emergency and Remedial Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 1992a. *Dermal Exposure Assessment: Principles and Applications, Interim Report*, EPA/600/8-91/011B, including Supplemental Guidance dated August 18, 1992, Office of Research and Development, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 1992b. *Supplemental Guidance to RAGS: Calculating the Concentration Term*, OSWER Directive 9285.7-081, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 1993a. *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons*, EPA/600/R-93/089, Office of Research and Development, Washington, D.C., July.

EPA (U.S. Environmental Protection Agency) 1993b. *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*, EPA/540-R-93-057, Publ. 9360.0-32, Office of Emergency and Remedial Response, Washington, D.C., August.

EPA (U.S. Environmental Protection Agency) 1996. *Soil Screening Guidance: User's Guide*, EPA/540/R-96/018, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 1997a. *Exposure Factors Handbook*, EPA/600/P-95/002Fa, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 1997b. *Health Effects Assessment Summary Tables (HEAST)*, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency) 2002a. *Risk Assessment Guidance for Superfund Vol. I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim*, OSWER 9285.7-02EP, September, 2001.

EPA (U.S. Environmental Protection Agency) 2002b. *Region 9 Preliminary Remediation Goals (PRGs)*, October 2002 update, created by Stanford J. Smucker and found on the World Wide Web at http:/www.epa.gov/region09/waste/sfund/prg/index.html.

EPA (U.S. Environmental Protection Agency) 2003. *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*, EPA-540-R-03-001, January.

EPA (U.S. Environmental Protection Agency) 2004. *Integrated Risk Information System (IRIS) Database*, Office of Research and Development, Washington, D.C.

Jacobs Engineering, Inc. 1989. *Environmental Protection Agency Technical Enforcement Support of Hazardous Waste Sites*.

MKM Engineers, Inc. (MKM) 2004a. *Explosive Safety Submission for the MEC Survey and Munitions Response of Winklepeck Burning Grounds, Ravenna Army Ammunition Plant, Ravenna, Ohio,* Contract No.: GS-10F-0542N, ORD#W52H09-04-F-5120, Revision 3, August.

MKM Engineers, Inc. (MKM) 2004b. *Draft Phase I MEC Density Survey After-Action Report, Winklepeck Burning Grounds, Ravenna Army Ammunition Plant, Ravenna, Ohio,* Contract No.: GS-10F-0542N, ORD#W52H09-04-F-5120, September.

MKM Engineers, Inc. (MKM) 2005a. *Draft Final Work Plan for Phase II MEC Clearance and Munitions Response at Winklepeck Burning Grounds, Ravenna Army Ammunition Plant, Ravenna, Ohio*. Contract No.: GS-10F-0542N, ORD#W52H09-04-F-5120, January. Revision 1.

MKM Engineers, Inc. (MKM) 2005b. *Draft Final Site Safety and Health Plan for Phase II MEC Clearance and Munitions Response at Winklepeck Burning Grounds, Ravenna Army Ammunition Plant, Ravenna, Ohio,* Contract No.: GS-10F-0542N, ORD#W52H09-04-F-5120, Revision 1, January.Mohr, E.T. 1998. Memorandum to Mr. John Jent "RE: Ravenna Army Ammunition Plant, Portage/Trumbull Counties, CERCLA Risk Assessment – Groundwater," December 7.

Morgan, Tim 1999. Tim Morgan, Natural Resources Manager, RVAAP, personal communication to SAIC, Oak Ridge, TN.

ODNR (Ohio Department of Natural Resources) and Ohio EPA (Ohio Environmental Protection Agency) 1996. *Rainwater and Land Development – Ohio's Standards for Strom Water Management, Land Development, and Urban Stream Protection.*

ODNR (Ohio Department of Natural Resources) 2002a. *Ohio's Endangered Species*, May 2002 update, available at http://www.dnr.state.oh.us/wildlife/resources/mgtplans/endangered.htm.

ODNR (Ohio Department of Natural Resources) 2002b. *Ohio's Species of Concern*, May 2002 update, available at http://www.dnr.state.oh.us/wildlife/resources/mgtplans/specofconcern.htm.

ODNR (Ohio Department of Natural Resources) 2002c. *Rare Native Ohio Plants 2002-2003 STATUS LIST*, available at http://www.dnr.state.oh.us/dnap/heritage/Rare_Species2002.htm.

OHARNG (Ohio Army National Guard) 2001. *Final Integrated Natural Resources Management Plan and Environmental Assessment for the Ravenna Training and Logistics Site and the Ravenna Army*

Ammunition Plant, Portage and Trumbull Counties, Ohio, prepared by AMEC Earth and Environmental, Louisville, KY, October.

SAIC (Science Applications International Corporation) 2001. *Remedial Investigation for Winklepeck Burning Grounds,* Army Corps of Engineers, Louisville.

SAIC (Science Applications International Corporation) 2003. *Report on the Biological Field-Truthing Effort at Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio.*

Suter, G.W. II, B.W. Cornaby, C.T. Hadden, R.N. Hull, M. Stack, and F.A. Zafran 1995. "An Approach for Balancing Health and Ecological Risks at Hazardous Waste Sites," *Risk Analysis* **15(2)**:221–231.

USACE (U.S. Army Corps of Engineers) 1996. *Facility-wide Preliminary Assessment (PA) for the Ravenna Army Ammunition Plant, Ravenna, Ohio.*

USACE (U.S. Army Corps of Engineers) 1997. *Soil Sample Analysis*, *Winklepeck Burning Grounds*, Memorandum to USACE Louisville District from Tom Jenkins, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), October 20.

USACE (U.S. Army Corps of Engineers) 1998. *Phase I Remedial Investigation Report for High-Priority Areas of Concern at the Ravenna Army Ammunition Plant, Ravenna, Ohio*, DACA62-94-D-0029, DO Nos. 0010 and 0022, Final, February.

USACE (U.S. Army Corps of Engineers) 1999. *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio,* DACA62-94-D-0029, D.O. 0060, Draft Final, July.

USACE (U.S. Army Corps of Engineers) 2000. *SAP Addendum No.1 for the Phase II Remedial Investigation at Winklepeck Burning Grounds at the RVAAP*.

USACE (U.S. Army Corps of Engineers) 2001a. *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio,* DACA62-94-D-0029, D.O. 0060, Final, April.

USACE (U.S. Army Corps of Engineers) 2001b. *Technical Memorandum Human Health and Ecological Risk Assessment Approach for the Load Line 1 and Winklepeck Burning Grounds Phase II Remedial Investigations at RVAAP*.

USACE (U.S. Army Corps of Engineers) 2003. *Report on the Field-Truthing Effort at Winklepeck Burning Grounds, Ravenna Army Ammunition Plant, Ravenna, Ohio,* F44650-99-D-0007, DO CY06, November.

USACE (U.S. Army Corps of Engineers) 2004a. *Phase III Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio,* DACA62-00-D-0001, DO CY08, Draft, October.

USACE (U.S. Army Corps of Engineers) 2004b. *RVAAP's Facility-Wide Human Health Risk Assessor's Manual*, January.

USACE (U.S. Army Corps of Engineers) 2004c. *Ravenna Facility-Wide Surface Water Study: Streams,* Developed by Ohio EPA, May.

USACE (U.S. Army Corps of Engineers) 2004d. *Ravenna Facility-Wide Surface Water Study: Ponds and Wetlands*, Developed by Ohio EPA, May.

USAEHA (U.S. Army Environmental Health Agency) 1983. *Hazardous Waste Management Study No. 37-26-0442-84 Phase II of AMC Open-Burning/Open-Detonation Grounds Evaluation, Ravenna Army Ammunition Plant, Ravenna, Ohio.*

USATHAMA (U.S. Army Toxic and Hazardous Materials Agency) 1978. *Installation Assessment of the Ravenna Army Ammunition Plant*, Report No.132.

APPENDIX A
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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Table A-1. Potential Chemical-specific ARARs and TBC Guidance for Winklepeck Burning Grounds

Media	Requirements	Prerequisite	Citation(s)
Surface and Sub-Surface Soils	The GDCS may apply to any property except for certain circumstances specified in OAC 3745-300-08 (B) (1). See below	The GDCS are not applicable to excavation of soils in WBG because remediation is not conducted under the Voluntary Action Program. The GDCS are not relevant and appropriate because the circumstances listed under OAC 3745-300-08 (B) (1) apply	OAC 3745-300-08 (B)(1)
	Property-specific risk-based standards must be determined in place of or in addition to GDCS if (1) the exposure pathways or exposure factors for the intended land use are not included in the development of GDCS for residential, commercial, or industrial scenarios considered for the GCDS; (2) the chemicals of concern at the property are not included in the GDCS; (3) radioactive materials are identified on the property; (4) PCBs subject to TSCA are identified on the property; or (5) important ecological resources on the property are impacted	Property-specific risk-based clean-up standards are applicable to WBG because the exposure scenarios for the intended land use are not considered in the development of the GDCS and certain chemicals of concern are not included in OAC 3745-300-08 (B) (3). Property-specific risk-based clean up standards are developed in accordance with CERCLA methodology. Applicable to WBG as a separate legal mandate under CERCLA Section 120 (a) (4)	OAC 3745-300-09 (B)(2)
Surface Waters and Wetlands	All waters of the state shall be free of suspended solids, floating debris, oil, scum, or toxic substances from human activity that create a nuisance, cause degradation, or adversely affect aquatic life. There may be no degradation of water quality that results in violation of the applicable water quality criteria or the impairment of existing uses. Wetlands-designated uses shall be maintained and protected such that degradation through direct, indirect, or cumulative impacts does not result in wetland use or function (see also Table A-3)	Applicable to activities in WBG that may impact waters of the state (connected drainageways) or wetlands, including isolated wetlands. Applicable to any CWA 401 certification, any non-point source of pollution that adds a regulated pollutant or any state-isolated wetland permit application (see also Table A-3). The applicant of subject activities must submit documentation, as required under OAC 3745-1-5 (B)(3). Submittal and review requirements do not apply to discharge to limited quality waters and discharges with less than 65 mg/L of total suspended solids	OAC 3745-1-04 OAC 3745-1-5 (B)(1) and (2) OAC 3745-1-5 (D) OAC 3745-1-54

ARAR = Applicable or relevant and appropriate requirement.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
CWA = Clean Water Act.
GDCS = Generic direct contact soils standard.
OAC = Ohio Administrative Code.
PCB = Polychlorinated biphenyl.
TBC = To be considered.
TSCA = Toxic Substances Control Act of 1976.
WBG = Winklepeck Burning Grounds.

Table A-2. Potential Action-specific ARARs and TBC Guidance for Winklepeck Burning Grounds

Action	Requirements	Prerequisite	Citation(s)
General Construction Standards—Site Preparation and Excavation			
Activities Resulting in the Emission of Particulate Matter, Dusts, Fumes, Gas, Mists, Smoke, etc. From a Hazardous Waste Facility	No owner/operator of a hazardous waste facility shall cause or allow the emission of any particulate matter, dusts, gas, fumes, mists, smoke, vapor, or odorous substances that interferes with the enjoyment of life or property by persons living or working in the vicinity of the facility. Any such action is considered a public nuisance	Applicable to excavation activities at WBG	ORC 3734.02 (I) OAC 3745-15-07 (A)
Activities Causing Fugitive Dust Emissions	Persons engaged in construction activities shall take reasonable precautions to prevent particulate matter from becoming airborne; reasonable precautions include, but are not limited to, the following: • the use of water or chemicals for control of dust during construction operations or clearing of land; and • the application of asphalt, oil, water, or suitable chemicals on dirt roads, materials stockpiles, and other surfaces, which can create airborne dusts No person shall cause, or allow, fugitive dust to be emitted in such a manner that visible emissions are produced beyond the property line	Applicable to fugitive emissions from demolition of existing buildings or structures, construction operations, grading of roads, or the clearing of land. Applicable to pre-construction clearing activities and excavation activities	OAC 3745-17-08 (B)
Open Burning of Landscaping Wastes During Clearing and Grubbing Activities	No person shall conduct open burning of land-clearing wastes in unrestricted areas without written permission from Ohio EPA. Open burning of land-clearing wastes may be conducted if (1) the fire is set only when atmospheric conditions will readily dissipate contaminants, (2) the fire does not create a visibility hazard, (3) the fire is located at least 1,000 ft from any inhabited building, and (4) an air curtain destructor or similar device is used to curtail emissions	Applicable to open burning of landscaping wastes during clearing and grubbing operations	OAC 3745-19-04

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Site Remediation that Causes Air Emissions of HAP Under 40 *CFR* 63	Site remediation activities must meet specified limits of 40 CFR 63, Subpart GGGGG, for emissions of HAP from process vents, remediation material management, and work practice standards	Applicable to site remediation activities at facilities that are major sources of HAPs and that have implemented MACT. CERCLA cleanup is exempt. Applicable to WBG only if RVAAP is a major source of HAPs. Orders which govern remediation include this exemption	40 *CFR* 63, Subpart GGGGG. Proposed July 30, 2002, with tentative final date of 8/31/03
Construction Activities Causing Storm Water Runoff (e.g., clearing, grading, and excavation)	Construction activities disturbing more than 1 acre must develop and implement a stormwater pollution prevention plan incorporating best management practices (including sediment and erosion controls, vegetative controls, and structural controls) in accordance with the requirements of the Ohio EPA General Permit for Construction Activities (Permit OHC 000002). An NOI shall be submitted 21 days prior to initiation of the construction activity	Applicable to stormwater discharges from land disturbances from a construction activity involving more than 1 acre. NOI must be submitted pursuant to DERR–00-RR-034, which indicates that no permit exemption equivalent to CERCLA Section 121(e) is available for non-NPL sites	40 *CFR* 122.26 OAC 3745-38-06
Removal of Contaminated Soils			
Removal or Remediation of Hazardous-contaminated Soils	The GDCS may apply to any property except for certain circumstances specified in OAC 3745-300-08 (B)(1). Property-specific risk-based standards must be determined in place of or in addition to the GDCS if (1) the exposure pathways or exposure factors fro the intended land use are not included in the development of the GDCS for residential, commercial, or industrial scenarios; (2) the chemicals of concern at the property are not included in the GDCS; (3) radioactive materials are identified on the property; (4) PCBs subject to TSCA are identified on the property; or (5) important ecological resources are identified on the property	The GDCS are not applicable to WBG because the action is not under the VAP. The GDCS are not relevant and appropriate because the exposure scenarios for the intended land use are not considered in the development of the GCDS and certain chemicals of concern are not included in OAC 3745-300-08 (B)(3). Property-specific risk-based clean-up standards will be developed in accordance with CERCLA methodology	OAC 3745-300-08 (B)(1) OAC 3745-300-09 (B)(2)

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	A miscellaneous unit must be closed in a manner that will ensure protection of human health and the environment. Closure of miscellaneous units must meet the general closure performance standard to close in a manner that minimizes the need for further maintenance, and that minimizes, controls, or eliminates the post-closure escape of hazardous wastes, hazardous constituents, leachate, or contaminated run-off to the ground, surface water, or atmosphere. If a treatment unit has contaminated soils or groundwater that cannot be completely removed or decontaminated during closure, then that unit must also meet the above requirements during post-closure care	Not applicable to burn pads within the HTRW activity. Applicable to Burn Pad 45. Relevant and appropriate to remediation and post-closure care of burn pads addressed by the HTRW activity	40 *CFR* 264.111 40 *CFR* 264.601 40 *CFR* 264.603 OAC 3745-55-11 OAC 3745-55-12 OAC 3745-55-14 OAC 3745-55-17 OAC 3745-57-91 OAC 3745-57-93
	No person shall engage in filling, grading, excavating, drilling, or mining on land where a hazardous waste or solid waste facility was operated without prior authorization from the director of the Ohio EPA	Not applicable to HTRW excavation activities in WBG because Burn Pad 37 and Building 1601 have closed in accordance with RCRA and other units are subject to remedial action. Potentially applicable to MEC activity. See OAC 3745-27-13 (C)	ORC 3734.02 (H) OAC 3745-27-13 (C)
	There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action	Applicable to stormwater management during pre-construction clearing in WBG. Potentially applicable treatment of excavated soils by screening. Applicable to placement of excavated materials in waste piles	DERR-00-RR-034
Waste Generation, Characterization, Segregation, and Storage—Excavated Soils and Buried Wastes, Sludge, Surface Features, Debris, and Secondary Wastes			
Generation and Characterization of Solid Waste *(all primary and secondary wastes)*	The generator must determine if the material is a solid waste, as defined in 40 *CFR* 261.2 and 40 *CFR* 261.4 (a). If the material is a solid waste, the generator must determine if the solid waste is a hazardous waste by:	Applicable to generation of a solid waste as defined in 40 *CFR* 261.2 and that is not excluded under 40 *CFR* 261.4 (a)	40 *CFR* 262.11 (a)(b)(c) OAC 3745-52-11 (A)(B)(C)(D)

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	• determining if the waste is listed under 40 *CFR* Part 261; or	Applicable to the generation and characterization of hazardous-contaminated soil and hazardous debris resulting from excavation. Process history and RCRA permit applications indicate that soils may contain K044-, K046-, and K047-listed wastes. Applicable to generation of decontamination wastewater	40 *CFR* 262.11 (a)(b)(c) OAC 3745-52-11 (A)(B)(C)(D)
	• determining if the waste exhibits characteristics by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used; and • determining if the waste is excluded under 40 *CFR* Parts 261, 262, 266, 268, and 273	Applicable to the generation and characterization of hazardous-contaminated soil and hazardous debris resulting from excavation. Site data indicate that soils contain metals at concentrations that exceed 20 times the TC limit and may exhibit the characteristics D005, D006, D007, and D008. Applicable to generation of decontamination wastewater	40 *CFR* 262.11 (a)(b)(c) OAC 3745-52-11 (A)(B)(C)(D)
	The generator must determine if the waste is restricted from land disposal under 40 *CFR* 268 *et seq.* by testing in accordance with prescribed methods or use of generator knowledge of waste	Applicable to the generation and characterization of hazardous-contaminated soil and hazardous debris resulting from excavation. Applicable to generation of decontamination wastewater	40 *CFR* 268.7 OAC 3745-270-07
	The generator must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 CFR 268.40, Subpart D	Applicable to the generation and characterization of hazardous-contaminated soil and hazardous debris resulting from excavation. Applicable to generation of decontamination wastewater	40 *CFR* 268.9 (a) OAC 3745-270-07 OAC 3745-270-09
	The generator must determine the underlying hazardous constituents [as defined in 40 *CFR* 268.2 (i)] in the waste	Applicable to the generation and characterization of RCRA characteristic hazardous waste (except D001 non-wastewaters treated by CMBST, RORGS, or POLYM. See 268.42, Table 1) and to hazardous-contaminated soils for their subsequent storage, treatment, or disposal	40 *CFR* 268.9 (a) OAC 3745-270-09

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Treatment of Excavated Material by Screening	No owner or operator of a treatment, storage, or disposal facility shall in any way dilute a restricted waste to achieve compliance with the treatment standards of 40 *CFR* 268, Subpart D or in any way circumvent the prohibitions of 40 *CFR* 268, Subpart C	Applicable to screening of excavated soils if such soils contain a listed waste or exhibit a characteristic upon generation (excavation). Note that RCRA permitting requirements would also be applicable. See also permitting requirements at waste piles	40 *CFR* 268.3 (a) OAC 3745-270-03 (A)
Screening of Excavated Soils (physical treatment of hazardous-contaminated soils)	Chemical, physical, or biological treatment must comply with the requirements of 40 *CFR* 264.17 for treatment of ignitable, reactive, or incompatible wastes (relevant and appropriate)	Potentially applicable to screening of excavated soils if those soils contain listed wastes K044, K046 or K047. Note that RCRA permitting requirements would also be applicable. See also permitting requirements at waste piles	40 *CFR* 265.401 (a) OAC 3745-69-01 (A)
	Hazardous waste or treatment reagents must not be placed in the treatment process or equipment if they could cause the equipment or process to corrode, leak, rupture, or fail (relevant and appropriate)	Not applicable to treatment by screening based on the treatment process	40 *CFR* 265.401 (b) OAC 3745-69-01 (B)
	Where hazardous waste is fed continuously to the process, the process must be equipped with a means to stop this inflow (relevant and appropriate)	Not applicable to treatment by screening due to nature of the treatment process	40 *CFR* 265.401 (c) OAC 3745-69-01 (C)
	The waste feed cut-off systems, by-pass systems, drainage systems, and pressure-relief systems must be inspected daily (relevant and appropriate)	Not applicable to treatment by screening due to nature of the treatment process	40 *CFR* 265.403 (a)(1) OAC 3745-69-03 (A)(1)
	Data gathered from monitoring equipment must be checked at least once each day to ensure that the treatment process is being operated according to its design (relevant and appropriate)	Not applicable to treatment by screening due to nature of the treatment process	40 *CFR* 265.403 (a)(2) OAC 3745-69-03 (A)(2)
	The construction materials of the process, equipment, and confinement structure must be inspected weekly to detect corrosion or correct leakage (relevant and appropriate)	Applicable to treatment of excavated soils by screening if the soils contain listed wastes or exhibit a characteristic	40 *CFR* 265.403 (a)(3) and (a)(4) OAC 3745-69-03 (A)(3)

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	At closure, all hazardous waste and residues must be removed from the treatment process equipment and discharge confinement structure (relevant and appropriate)	Potentially applicable to screening of excavated soils if those soils contain listed wastes K044, K046, or K047, or the soils exhibit the TC for metals. Note that RCRA permitting requirements would also be applicable. See also permitting requirements at waste piles	40 *CFR* 265.404 OAC 3745-69-04
	Chemical, physical, or biological treatment of hazardous wastes in containers or tanks shall be conducted in accordance with the applicable requirements for those units	Potentially applicable to screening of excavated soils if those soils contain listed wastes K044, K046 or K047, or the soils exhibit the TC for metals. Note that RCRA permitting requirements would also be applicable. See also permitting requirements at waste piles	40 *CFR* 265.400 OAC 3745-69-01 (D)
Non-thermal Treatment of Hazardous Wastes in Containers or Tanks	Alternative design, operating, and closure standards may be established by the Ohio EPA Administrator for temporary tanks and containers used to treat or store remediation wastes and that are located within the contiguous facility boundary. In establishing such standards, the Administrator shall consider the length of time such unit will be in operation, the type of unit, volumes of waste to be managed, physical and chemical characteristics of the waste, potential for release from the unit, and the potential for exposure of human and environmental receptors	Potentially applicable to screening of excavated soils if those soils contain listed wastes K044, K046, or K047, or the soils exhibit the TC for metals. Treatment process (screening) may be designated as a temporary unit. Note that RCRA permitting requirements would also be applicable. See also permitting requirements at waste piles	40 *CFR* 264.553 (b) OAC 3745-57-73
	Temporary units may be authorized for treatment or storage of hazardous or mixed waste in containers or tanks for a period of 1 year	Potentially applicable to screening of excavated soils if those soils contain listed wastes K044, K046, or K047, or the soils exhibit the TC for metals. Treatment process (screening) may be designated as a temporary unit. Note that RCRA permitting requirements would also be applicable. See also permitting requirements at waste piles	40 *CFR* 264.553 (e) OAC-3745-57-73

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Accumulation of Hazardous Debris from Excavation and Screening. It is Assumed that any Debris Resulting from Excavation and Screening will be Accumulated for < 90 Days	A generator may accumulate for up to 90 days or conduct treatment of hazardous wastes in containers without an Ohio EPA permit. Generators that accumulate for 90 days or conduct on–site treatment of hazardous waste in containers must comply with the personnel training, preparedness and prevention requirements, and contingency plan requirements of 40 *CFR* 265.16; 40 *CFR* 265, Subpart C; and 40 *CFR* 265, Subpart D, respectively	Applicable to 90-day accumulation of debris from excavation and screening if such debris contains listed wastes or exhibits a characteristic	40 *CFR* 262.34 (a)(4) OAC 3745-52-34 (A)(4)
	Containers must be marked with the date upon which period of accumulation began and with the words "Hazardous Waste"	Applicable to 90-day accumulation of debris from excavation and screening if such debris contains listed wastes or exhibits a characteristic	40 *CFR* 262.34 (a)(2)(3) OAC 3745-52-34 (A)(2)(3)
	Containers holding hazardous wastes must be kept closed except to add or remove wastes and must not be managed in a manner that would cause them to leak. Containers of hazardous waste must be maintained in good condition and comparable with the waste stored therein. Containers holding ignitable or reactive wastes must be separated from potential ignition sources and located 50 ft from the property boundary	Applicable to 90-day accumulation of debris from excavation and screening if such debris contains listed wastes or exhibits a characteristic	40 *CFR* 264.171 40 *CFR* 264.172 40 *CFR* 264.173 40 *CFR* 264.176 40 *CFR* 264.17 OAC 3745-52-34 (A)(1)
Storage of Hazardous-contaminated Soil in a Waste Pile	Submission of Parts A and B of the RCRA Permit Application is required for owners/operators of any Hazardous Waste Management Unit. Specific submission requirements are provided at 40 *CFR* 270.13 and 270.14	Applicable to storage of soils from excavation if the soils contain listed wastes K044 through K047 or exhibit the TC. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders)	40 *CFR* 270.13 40 *CFR* 270.14 40 *CFR* 270.18 OAC 3745-50-44 OAC 3745-50-44 (C)(4)

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	Owners/operators of hazardous waste management facilities must comply with the General Facility Standards of 40 *CFR* 264, Subpart B concerning waste analysis, site security, inspection/ maintenance, personnel training, special precautions for management of ignitable or reactive wastes, and locations standards	Applicable to storage of soils from excavation if the soils contain listed wastes K044 through K047 or exhibit the TC. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action(unless permit exception is provided for by the orders)	40 *CFR* 264.13 to 40 *CFR* 264.18 OAC 3745-54-13 to OAC 3745-54-18
	Owners/operators of hazardous waste management facilities must comply with the Preparedness Standards of 40 *CFR* 264, Subpart C concerning alarms, communication systems, notification of local authorities, testing and maintenance of spill control and emergency response equipment, and aisle space	Applicable to storage of soils from excavation if the soils contain listed wastes K044 through K047 or exhibit the TC. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders)	40 *CFR* 264.31 to 40 *CFR* 264.38 OAC 3745-54-31 to OAC 3745-54-37
	Owners/operators of hazardous waste management facilities must comply with the Preparedness Standards of 40 *CFR* 264, Subpart D concerning development of a written contingency plan that designates the emergency coordinator, describes emergency and evacuation procedures, and identifies the emergency equipment to be maintained. Copies of the plan must be submitted to local authorities that would respond in the event of an emergency	Applicable to storage of soils from excavation if the soils contain listed wastes K044 through K047 or exhibit the TC. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders)	40 *CFR* 264.50 to 40 *CFR* 264.56 OAC 3745-54-52 to OAC 3745-54-56

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	Owners/operators of hazardous waste management facilities must comply with the Recordkeeping Standards of 40 *CFR* 264, Subpart E concerning maintenance of the operating record, manifest files, contingency plan, and closure plan	Applicable to storage of soils from excavation if the soils contain listed wastes K044 through K047 or exhibit the TC. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders)	40 *CFR* 264.70 to 40 *CFR* 264.77 OAC 3745-54-73 to OAC 3745-54-77
	Owners/operators of waste piles must implement a groundwater monitoring program in accordance with 40 *CFR* 264, Subpart F unless the unit is an engineered structure that does not receive liquid wastes or wastes containing free liquids and is designed to exclude precipitation and run-on/run-off. The unit must also have inner and outer layers of containment. Waste piles that are inside or under a structure that prevents wind dispersal and protects the pile from contact with precipitation or run-on are exempt from groundwater monitoring	Applicable to storage of soils from excavation if the soils contain listed wastes K044 through K047 or exhibit the TC. The provisions for groundwater monitoring are not considered relevant and appropriate to the operation of the waste piles if the soils do not contain hazardous wastes due to the limited nature of the action. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders)	40 *CFR* 264.90 to 40 *CFR* 264.100 OAC 3745-54-90 to OAC 3745-54-99 OAC 3745-55-01
	Upon closure of a hazardous waste management unit the owner/operator must comply with the general closure performance standard	Closure must be conducted in a manner that minimizes the need for further maintenance and controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground, to surface waters, or to the atmosphere. Applicable to waste piles used to store soils that contain hazardous wastes. Relevant and appropriate to waste piles that manage soils not containing hazardous wastes	40 *CFR* 264.111 OAC 3745-55-11

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	The owner/operator of a hazardous waste management unit must have a written closure plan that describes the steps and procedures to close the unit by decontamination or removal of all hazardous waste residues and contaminated equipment or structures, provides an estimate of the maximum inventory of wastes in the unit at any time, and includes a schedule for closure	Applicable to storage of soils from excavation if the soils contain listed wastes K044 through K047 or exhibit the TC. The provisions for the closure plan are not considered relevant and appropriate to the operation of the waste piles if the soils do not contain hazardous wastes due to the limited nature of the action. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided by the orders)	40 *CFR* 264. 112 OAC 3745-55-12
	Upon closure all contaminated structures, equipment, and soils must be properly disposed of or decontaminated	Applicable to waste piles used to store soils that contain hazardous wastes. Relevant and appropriate to waste piles that manage soils not containing hazardous wastes	40 *CFR* 264.114 OAC 3745-55-14
Storage of Hazardous-contaminated Soil in a Waste Pile	Waste piles must have a liner that is designed, constructed, and installed to prevent any migration of wastes out of the pile into the adjacent subsurface soils or groundwater	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils	40 *CFR* 264.251 OAC 3745-56-51
	Waste piles must have a liner constructed of materials that have appropriate chemical properties and sufficient strength to prevent failures due to pressure gradients, contact with the waste, climatic conditions, and the stress of daily operation	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils	40 *CFR* 264.251 OAC 3745-56-51
	Waste piles must be placed upon a base or foundation capable of supporting the liner and preventing failure of the liner due to settlement, compression, or uplift. Liners must be installed to cover all surrounding earth likely to contact the waste or leachate	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils	40 *CFR* 264.251 OAC 3745-56-51

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	Waste piles must be designed, constructed, and installed with a top liner (such as a geomembrane) that prevents migration of hazardous constituents into the liner and a bottom composite liner with a lower component constructed of at least 3 ft of compacted soil with a hydraulic conductivity of < 10^{-7} cm/sec	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils	40 *CFR* 264.251 OAC 3745-56-51
	Waste piles must be designed, constructed, and installed with a leachate collection and removal system between the liners that has a bottom slope of 1% and is constructed of granular drainage material with a thickness of ≥ 12 in. and a hydraulic conductivity ≥ 10^{-2} cm/sec. The leachate-collection system shall be chemically compatible with the wastes and leachate. The leachate-collection system shall be designed to minimize clogging. The leachate-collection system shall be constructed with sumps and liquid removal systems that ensure that the leachate depth over the liner does not exceed 12 in.	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils	40 *CFR* 264.251 OAC 3745-56-51
	Waste piles must be designed, constructed, and operated with a run-on control system with a capacity to control the water volume from a 24-hr, 25-year storm event	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils	40 *CFR* 264.251 OAC 3745-56-51
	Waste piles containing particulate matter must be covered or otherwise designed to control wind dispersal	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils	40 *CFR* 264.251 OAC 3745-56-51

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	Waste piles that are inside or under a structure that provides protection from precipitation, run-on, and wind dispersal, and that holds wastes that do not contain free liquids or generate leachate, are not required to meet the liner and leachate collection system requirements or the groundwater monitoring provisions of 40 *CFR* 264, Subpart F	Applicable to waste piles that are engineered to be protected from precipitation, run-on, and wind dispersal where the wastes do not contain any free liquids and that store soils from excavation or construction and development of injection/monitoring wells	40 *CFR* 264.250 40 *CFR* 264.90 (b)(5)
	During construction, liners and cover system components must be inspected for uniformity, damage, or imperfections. During operation, a waste pile must be inspected weekly and after storms to detect signs of deterioration or improper operation of the run-on/run-off control systems, wind dispersal control systems, and leachate collection system. The volume of liquids collected from the leak detection system must be recorded weekly	Applicable to waste piles used to store soils that contain hazardous wastes. Relevant and appropriate to waste piles that manage soils not containing hazardous wastes.	40 *CFR* 264.254 OAC 3745-56-54
Placement of Hazardous-contaminated Soil in a Waste Pile	A prohibited waste may be land-disposed only if it meets the treatment standards of 40 *CFR* 268, Subpart D	Applicable to land disposal of hazardous wastes and hazardous debris by placement in a waste pile constituting land disposal by 40 *CFR* 268.2	40 *CFR* 268.7 OAC 3745-270-40
	Hazardous-contaminated soils must be treated according to the alternative treatment standards of 40 *CFR* 268.49 c) or according to the UTSs specified in 40 *CFR* 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal	Applicable to placement of soils that contain listed wastes or exhibit the TC in a waste pile	40 *CFR* 268.49 (b) OAC 3745-270-49

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Placement of Remediation Wastes Within a Staging Pile	Placement of hazardous remediation wastes into a staging pile or a waste pile designated as a CAMU does not constitute land disposal that is subject to 40 *CFR* 268 or the minimum technological requirements of 40 *CFR* 264.251 (c). The staging pile or CAMU must be designed to prevent or minimize releases of hazardous wastes or constituents and to minimize cross-media transfer. Staging piles may operate for up to 2 years	Potentially applicable to accumulation of solid, non-flowing, remediation waste that is used only during remedial operations. Designation of a storage pile as a CAMU is achieved by RCRA permit or provisions of corrective action orders. Storage piles may be designated as a CAMU if provided for by the orders. Note that Ohio EPA has proposed to adopt provisions for staging piles but that the revised rules have not been finalized (see also CAMUs)	40 *CFR* 264.554
Replacement of Hazardous-contaminated Soil in the Excavation	Disposal of RCRA-hazardous waste in a land-based unit	Applicable to land disposal, as defined in 40 *CFR* 268.2, of restricted RCRA waste. Applicable to disposal of exhumed hazardous wastes (i.e., soils and water from excavation and injection/monitoring well installation that exhibit a hazardous waste characteristic)	40 *CFR* 268.40 (a) OAC 3745-270-40
	Hazardous-contaminated soils must be treated according to the alternative treatment standards of 40 *CFR* 268.49 (c) or according to the UTSs specified in 40 *CFR* 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal	Applicable to land disposal, as defined in 40 *CFR* 268.2, of restricted hazardous soils	40 *CFR* 268.49 (b) OAC 3745-270-49

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Placement of Excavated Soil in a Storage Pile and Replacement of Excavated Soils in the Burn Pad Areas with Designation as a CAMU	A CAMU may be designated for the purpose of implementing corrective action. Placement of remediation wastes into a CAMU does not constitute land disposal and does not create a unit subject to minimum technology standards. The CAMU must facilitate implementation of the clean-up and not create unacceptable risks to human health or the environment. The CAMU must be closed in a manner that minimizes the need for future maintenance and controls, minimizes or eliminates the post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated run-off to the ground, surface waters, or air. Areas designated in the permit as CAMUs must incorporate requirements for excavation, treatment, containment, or capping of wastes, as appropriate	Applicable to placement of hazardous-contaminated soils in a storage pile designated as a CAMU and the replacement of hazardous contaminated soils into the excavation zones without attachment of the LDRs. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action. Designation of storage piles and excavation zones as CAMUs must be provided for by permit or within the provisions of the orders	OAC 3745-57-72 40 *CFR* 264.552 (e)(4)
Storage of Remediation Wastes Within a CAMU	A CAMU may only manage CAMU-eligible wastes, which include all solid and hazardous wastes, media, and debris that are managed for implementing cleanup	Potentially applicable for use at sites where remediation is occurring and hazardous waste or environmental media or debris is contaminated with a hazardous waste requiring storage or treatment. Note that Ohio EPA has proposed to adopt these conforming changes to the CAMU rules but that the rule changes are not finalized	40 *CFR* 264.552 (a) and (a)(1)
	Unless alternate design standards are approved, a CAMU must include a composite liner and a leachate collection system designed and constructed to maintain less than a 30-cm depth of leachate. The liner must consist of two components. The uppermost must consist of a minimum 30-mil FML and the lower component must consist of at least a 2-ft layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7}. FML components of HDPE must be at least 60 mil thick. The FML must be installed in direct and uniform contact with the compacted soil component	Not applicable to replacement of excavated hazardous-contaminated soils because such soils would be replaced only if RGOs are met. Note that Ohio EPA has proposed to adopt these conforming changes to the CAMU rules but that the rule changes are not finalized	40 *CFR* 264.552 (e)(3) 40 *CFR* 264.550 (g)

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	Unless the wastes will be placed in a CAMU for storage and/or treatment only, CAMU-eligible wastes that have been determined to contain principal hazardous constituents must be treated to the following standards: • for non-metals, 90% reduction in total principal hazardous constituent; and • for metals, 90% reduction in principal hazardous constituent concentration as measured in the leachate by TCLP analysis	Applicable to hazardous-contaminated soils replaced within the excavation with the excavation designated as a CAMU for purposes other than storage or treatment. Note that Ohio EPA has proposed to adopt these conforming changes to the CAMU rules but that the rule changes are not finalized	40 *CFR* 264.552 (e)(4)
	Groundwater monitoring that is sufficient to continue to detect and characterize the nature, direction, and movement of existing releases of hazardous constituents in groundwater must be conducted during operation. In addition, the groundwater monitoring must be able to detect and subsequently characterize releases of hazardous constituents to groundwater that may occur from areas of the CAMU in which wastes will remain in place after closure of the CAMU	Potentially applicable to replacement of excavated soils because contaminants have been previously detected in AOC monitoring wells	40 *CFR* 264.552 (e)(5) 40 *CFR* 264.552 (g)
Closure of the CAMU	Closure of a CAMU must be conducted in a manner that minimizes the need for further maintenance and controls, minimizes, or eliminates, to the extent necessary, to protect human health and the environment, for areas where wastes remain in place, post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground, to surface waters, or to the atmosphere. Closure of CAMUs must include provisions for the excavation, treatment, or capping, as appropriate	Applicable to hazardous-contaminated soils returned to the excavation with the excavation designated as a CAMU	40 *CFR* 264.552 (e)(6)

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Storage or Treatment of Water within a CAMU	CAMUs that are used only for the storage or treatment of hazardous wastes that must operate for time periods longer than those specified for staging piles must operate no longer than is necessary to achieve a timely remedy selected for the waste established by the EPA Regional Administrator, and • must facilitate a reliable, effective, and protective remedy; • must be designed so as to prevent or minimize release of hazardous waste or hazardous waste constituents into the environment and to minimize/control cross-media transfer through the use of liners, covers, and run-off/run-on controls, as appropriate; • ignitable or reactive waste must not be placed within a CAMU unless it is rendered non-ignitable or non-reactive, or is protected from ignition sources within the CAMU; • incompatible wastes must not be placed within a CAMU unless the wastes are segregated and protected from contact; and • at closure, all wastes, contaminated media or structures, and equipment must be removed from the CAMU (applicable)	Applicable for CAMUs utilized for treatment or storage of hazardous waste. Note that Ohio EPA has proposed to adopt these changes to the CAMU rules but that the rule changes have not been finalized	40 *CFR* 264.552 (f)
Generation and Storage of Wastewater from Equipment Decontamination (wastewater may contain listed wastes or exhibit a hazardous waste characteristic)	The generator must determine if the wastewater contains listed wastes or exhibits a characteristic, and must characterize the pollutants sufficiently to meet the waste acceptance criteria of the receiving facility. See previous requirements concerning the generation/characteristic of solid wastes	Applicable to generation of wastewater from equipment decontamination	40 *CFR* 262.11 OAC 3745-52-11 (A)(B)(C)(D)

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Storage of Decontamination Wastewater in Tanks	Tank systems must have adequately designed foundation structural supports, seams, walls, and connections to ensure that the system has sufficient structural strength to prevent collapse, rupture, or failure. The tank system shall be constructed from materials that are compatible with the waste to be treated and shall be provided with corrosion protection to prevent collapse, rupture, or failure	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.192 OAC 3745-55-92
	The operator must ensure that proper handling procedures are adhered to during installation of a new tank system. Prior to covering, enclosing, or placing a new tank system or component in use, a qualified installation inspector or independent professional engineer must inspect the system for weld breaks, punctures, scrapes of protective coatings, cracks, or corrosion	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.192 OAC 3745-55-92
	All new tank systems and ancillary equipment must be tested for tightness prior to being covered, enclosed, or placed in use	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.192 (c) OAC 3745-55-92
	Ancillary equipment must be supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.192 (e) OAC 3745-55-92

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	The owner/operator must provide the type and degree of corrosion protection recommended by an independent corrosion expert	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.192 (f) OAC 3745-55-92
Secondary Containment Systems for Treatment of Hazardous Wastes in Tanks	Tank systems shall be provided with secondary containment that is constructed or lined with materials that are compatible with the wastes to be placed in the tank system	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.193
	Secondary containment liner and vault systems must be designed and operated to contain 100% of the capacity of the largest tank within its boundary. Secondary containment liner and vault systems must be designed to prevent run-on or infiltration of precipitation into the secondary containment systems. The containment system must have sufficient capacity to contain the precipitation from a 24-hr, 25-year storm event. Secondary liner and vault systems must be free of cracks and gaps. Secondary vault systems must be provided with chemically resistant water stops at all joints and provided with an interior coating or lining that is compatible with the waste	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.193 OAC 3745-55-93

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	Secondary containment systems must be provided with leak-detection capable of detecting failure of the primary or secondary containment structures or the presence of accumulated liquid in the containment system within 24 hrs	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.193 (c)(3) OAC 3745-55-93
	The secondary containment system must be sloped to drain and remove liquids resulting from spills leaks or precipitation. Spilled or leaked wastes must be removed from the secondary containment system within 24 hrs	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.193 (c)(4) OAC 3745-55-93
	Hazardous wastes or treatment reagents must not be placed in a tank system if they could cause the tank, its ancillary equipment, or the containment system to rupture, leak, corrode, or otherwise fail	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.194 (a) OAC 3745-55-94
	The operator of the tank system must use appropriate controls to prevent spills and overflows, including spill prevention controls (i.e., dry disconnects), overflow prevention controls (level sensors or alarms), and maintenance of sufficient freeboard to prevent overtopping	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.194 (b) OAC 3745-55-94

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
	The owner/operator must comply with 40 *CFR* 264.196 if spills or overflows occur	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.194 (c) OAC 3745-55-94
	The owner/operator must conduct daily inspections of the aboveground portions of the tank system, monitoring and leak detection system data, and the secondary containment	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate	40 *CFR* 264.195 OAC 3745-55-95
Temporary Tank Storage of Wastewaters from Decontamination Activities Where Those Wastewaters Contain Listed Wastes not Excluded Under 40 *CFR* 26.31(a)(2) or Exhibit a Hazardous Waste Characteristic	Temporary tanks used to store hazardous remediation wastes may be designated as temporary units. The temporary unit must be located within the contiguous property under the control of the owner/operator where the waste was generated. For temporary units, the Ohio EPA Administrator may replace the design, operating, and closure standards of 40 *CFR* 264 with alternative requirements that are protective of human health and the environment. Temporary units are authorized to operate for up to 1 year	Potentially applicable to storage of hazardous wastewaters prior to application to the soils returned to the excavation. Allows temporary storage without berms to meet all technical standards for permitted units. Designation of the tank as a TU is achieved by permit or within the provision of the orders	40 *CFR* 264.553 (a) 40 *CFR* 264.553 (d) OAC 3745-57-73
Temporary Tank Storage of Wastewaters from Decontamination Activities Where Those Wastewaters Contain Listed Wastes not Excluded Under 40 *CFR* 26.31(a)(2) or Exhibit a Hazardous Waste Characteristic	The requirements for hazardous waste tank systems of 40 *CFR* 264, Subpart J do not apply to tanks that store or treat hazardous wastewaters that are part of a wastewater treatment facility subject to Section 402 or 307(b) of the CWA	Applicable to tank systems that store or treat hazardous wastewaters prior to discharge to a POTW or surface water under Sections 307 or 402 of the CWA	40 *CFR* 264.1 (g)(c)

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Off-site Disposal of Waste—Excavated Soils, Debris, and Secondary Wastes			
Disposal of RCRA-Hazardous Waste in a Land-based Unit (i.e., lead, other debris, and soils exhibiting the TC or that contain listed waste)	RCRA-restricted waste may be land-disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* 268.40 before land disposal	Applicable to land disposal, as defined in 40 *CFR* 268.2, of restricted RCRA waste. Applicable to disposal of exhumed hazardous wastes (i.e., soils and water from excavation and injection/monitoring well installation that exhibit a hazardous waste characteristic)	40 *CFR* 268.40 (a)
	Hazardous debris may be land-disposed if it meets the requirements in the table "Alternative Treatment Standards for Hazardous Debris" at 40 *CFR* 268.45 before land disposal or the debris is treated to the waste-specific treatment standard provided in 40 *CFR* 268.40 for the waste contaminating the debris	Applicable to land disposal, as defined in 40 *CFR* 268.2, of restricted RCRA-hazardous debris	40 *CFR* 268.45 (a)
	Hazardous-contaminated soils must be treated according to the alternative treatment standards of 40 *CFR* 268.49 (c) or according to the UTSs specified in 40 *CFR* 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal	Applicable to land disposal, as defined in 40 *CFR* 268.2, of restricted hazardous soils	40 *CFR* 268.49 (b) OAC 3745-270-49
Off-site Shipment of Hazardous Wastes, Debris, or Hazardous-contaminated Soils	A generator who transports or offers hazardous wastes for off-site transport must prepare a Uniform Hazardous Waste Manifest	Applicable to the off-site shipment of soils or wastewater that contain listed wastes or that exhibit the TC	40 *CFR* 262.20 OAC 3745-52-20
	Before transporting or offering a hazardous waste for transport, the generator must package the waste, label the package, and placard the carrier in accordance with DOT requirements	Applicable to the off-site shipment of soils or wastewater that contain listed wastes or that exhibit the TC	40 *CFR* 262.30 to 40 *CFR* 262.33 OAC 3745-52-30 to OAC 3745-52-33
Post-closure Transfer of the Property	Prior to sale, lease, or transfer of the property from DoD control, a notation to the deed must be recorded that indicates that the property has been used as a disposal facility and that its use is restricted in accordance with the approved closure/post-closure plan	Applicable to transfer of a solid waste disposal facility	40 *CFR* 264.119 OAC 3745-55-19

Table A-2. Potential Action-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Action	Requirements	Prerequisite	Citation(s)
Treatment of Contaminated Wastewater at a POTW	No industrial user may introduce any discharge to a POTW that will pass through or interfere with the operation of the treatment works. Indirect discharges must comply with the specific prohibitions of the pretreatment program	Applicable to discharge of wastewater to the local POTW	OAC 3745-3-04
	The POTW shall control, through permit or similar means, the contribution of pollutants by each industrial user to assure compliance with the pretreatment standards and requirements	Applicable to discharge of wastewater to the local POTW	OAC 3745-3-03

ARAR = Applicable or relevant and appropriate requirement.
CAMU = Corrective action management unit.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
CFR = *Code of Federal Regulations*.
CWA = Clean Water Act.
DERR = Division of Emergency and Remedial Response (Ohio EPA).
DoD = U.S. Department of Defense.
DOT = U.S. Department of Transportation.
FML = Flexible membrane liner.
GDCS = Generic direct contact soils standard.
HAP = Hazardous air pollutant.
HDPE = High-density polyethylene.
HTRW = Hazardous, toxic, and radioactive waste.
MACT = Maximum achievable control technology.
MEC = Munitions and explosives of concern.
NOI = Notice of Intent.
NPL = National Priorities Listing.
OAC = Ohio Administrative Code.
Ohio EPA = Ohio Environmental Protection Agency.
ORC = Ohio Revised Code.
PCB = Polychlorinated biphenyl.
POTW = Publicly Owned Treatment Works.
RCRA = Resource Conservation and Recovery Act.
RI = Remedial investigation.
RVAAP = Ravenna Army Ammunition Plant.
TBC = To be considered.
TC = Toxicity characteristic.
TCLP = Toxic characteristics leaching procedure.
TSCA = Toxic Substances Control Act.
UTS = Universal treatment standard.
VAP = Voluntary Action Program.
WBG = Winklepeck Burning Grounds.

Table A-3. Potential Location-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
	Wetlands		
Presence of Jurisdictional Wetlands as Defined in 40 *CFR* 230.3, 33 *CFR* 328.3(a), and 33 *CFR* 328.4	The discharge of dredged or fill material into waters of the United States, including jurisdictional (adjacent) wetlands, is prohibited if there is a practical alternative that would have less adverse impact. No discharge shall be permitted that results in violation of state water quality standards, violates any toxic effluent standard, and/or jeopardizes an endangered species or its critical habitat. No discharge will be permitted that will cause significant degradation of waters of the United States. No discharge is permitted unless mitigation measures have been taken in accordance with 40 *CFR* 230, Subpart H. Compensatory mitigation for loss of wetlands shall be provided for wetlands > 0.25 acre. Compensatory mitigation shall be at a ratio of 2:1 for restoration, 4:1 for creation and enhancement, and 10:1 for preservation	Applicable to actions that involve the discharge of dredged or fill material into waters of the United States, including jurisdictional (adjacent) wetlands. Applicable to excavation and replacement of excavated material in jurisdictional wetlands	40 *CFR* 230, Subpart H
Waters of the State, as Defined in ORC 6111.01	There may be no degradation of water quality that results in violation of the applicable water quality criteria or the impairment of existing uses	Applicable to activities in WBG that may impact waters of the state (connected drainageways). Applicable to any non-point source of pollution that adds a regulated pollutant or any state-isolated wetland permit application. The applicant of subject activities must submit documentation, as required under OAC 3745-1-5 (B)(3). Submittal and review requirements do not apply to discharge to limited quality waters and discharges with less that 65 mg/L of total suspended solids	OAC 3745-1-04 OAC 3745-1-5 (B)(1) and (3) OAC 3745-1-5(D) OAC 3745-1-54

Table A-3. Potential Location-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
Waters of the State (wetlands), as Defined in OAC 3745-1-02	The discharge of dredged or fill material into waters of the state is prohibited if there is a practical alternative that would have less adverse impact. Projects that involve discharge of dredged or fill material to waters of the state must obtain CWA Section 401 Water Quality Certification from Ohio EPA. Projects qualifying for NWP must comply with the CWA Section 401 Certification General Limitations and Conditions issued May 2002. Temporary or permanent impacts to Category 1 and 2 wetlands are limited to 0.5 acre. Mitigative measures, including wetlands delineation, as required by OAC 3745-1-50 through 54 must be implemented. Project activities that do not qualify for NWP must comply with individual CWA Section 401 Certification	Relevant and appropriate to actions involving discharge of dredged or fill materials into waters of the State. Applicable to excavation and replacement of excavated material in Category 1 through 3 wetlands in WBG	33 *CFR* 323 33 *CFR 330* OAC 3745-32-01 to 3745-32-05
Presence of Wetlands, as Defined in OAC 3745-1-02	The filling or discharge of dredged material into less than 0.5 acre of Category 1 or 2 isolated wetlands must comply with the General Permit conditions. Wetlands delineation shall be performed. Only non-contaminated dredge or fill material may be placed in the subject wetland. Mitigation shall be provided at a ratio of 2:1 for non-forested wetlands and 2.5:1 for forested wetlands	Applicable to actions involving discharge of dredged or fill materials into isolated Category 1 and 2 wetlands. Potentially applicable to excavation and replacement of excavated material in WBG	ORC 6111.021
Presence of Wetlands, as Defined in OAC 3745-1-02	The wetland-designated use shall be maintained and protected such that degradation through direct, indirect, or cumulative impacts does not result in the loss of wetland acreage or functions. Each wetland shall be assigned a category by Ohio EPA. Wetland use shall be maintained unless there is no practical alternative that would have less adverse impact. Mitigation shall be provided in accordance with the ratios indicated in OAC 3745-1-54 (F)	Applicable to excavation and replacement of excavated material in WBG	OAC 3745-1-54

Table A-3. Potential Location-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
Location within a Floodplain	Activities that are taken within a floodplain shall avoid, to the extent possible, the long- and short-term adverse effects associated with occupancy and modification of floodplains. Measures shall be taken to mitigate adverse effects of actions in a floodplain, including measures to reduce the risk of flood loss, minimize the impact of floods on human safety and health, and restore/preserve the beneficial values of the floodplain. Structures constructed in a floodplain shall meet the standards and criteria set forth in the regulations promulgated by the Federal Insurance Administration pursuant to the National Flood Insurance Act of 1968	Applicable to federal actions that involve potential impacts to, or take place within, floodplains	40 *CFR* 6.302 40 *CFR* 6, Appendix A Executive Order 11988
Floodplains			
	The potential effects of any action taken in a floodplain shall be evaluated (such as including loss of floodplain/floodway storage capacity). Any new construction shall implement actions that mitigate floodplain impacts (such as provision of compensatory floodplain/floodway storage capacity and preventing the increase in flood height or velocity)		
Endangered, Threatened, or Rare Species			
Presence of Federally Endangered or Threatened Species, as Designated in 50 *CFR* 17.11 and 17.12, or Critical Habitat of Such Species	Actions that jeopardize the existence of a listed species, or result in the destruction or adverse modification of critical habitat, must be avoided, or reasonable and prudent mitigation measures taken. The lead agency must determine whether T&E species or their critical habitat are present and conduct informal consultation with the U. S. Fish and Wildlife Service. Determination that T&E species or their critical habitat may be impacted by the proposed action requires preparation of a biological assessment to determine the extent of any possible impacts	The requirement is applicable to the extent that the Army must determine if T&E species, or their critical habitat, are present	16 *U.S.C.* 1531 *et seq.*, Sect. 7 (a)(2)

Table A-3. Potential Location-specific ARARs and TBC Guidance for Alternative 2, Winklepeck Burning Grounds (continued)

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
Presence of State-listed T&E Species	Prohibits actions that result in taking of state-listed plant or animal species, such as actions that jeopardize the continued existence of a listed species or result in destruction or adverse modification of its critical habitat	Although not directly applicable to the Army, the requirement is relevant and appropriate because state-listed T&E species are present	OAC 1501-18-1 (03) OAC 1501-31-23 (01) ORC 1518.02 ORC 1531.25

ARAR = Applicable or relevant and appropriate requirement.
CFR = Code of Federal Regulations.
CWA = Clean Water Act.
Ohio EPA = Ohio Environmental Protection Agency.
NWP = Nation-wide permit.
OAC = Ohio Administrative Code.
ORC = Ohio Revised Code.
T&E = Threatened and endangered.
TBC = To be considered.
U.S.C = United States Code.
WBG = Winklepeck Burning Grounds.

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APPENDIX B
COST ANALYSIS

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Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
Summary of Alternatives

HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action

ALTERNATIVES		Treatment Duration	Non Discounted Cost		
			Capital Cost	O&M Cost	Total
1	No Action	0	$0	$0	$0
2A	Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.	30 yr	$46,226	$155,942	$202,169
2B	Excavation, Screen for Potential UXO, Composite Sampling, and Disposal.	30 yr	$54,328	$155,942	$210,271

ALTERNATIVES		Treatment Duration	Discounted Cost		
			Capital Cost	O&M Cost	Total
1	No Action	0	$0	$0	$0
2A	Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.	30 yr	$46,226	$63,403	$109,629
2B	Excavation, Screen for Potential UXO, Composite Sampling, and Disposal.	30 yr	$54,328	$63,403	$117,731

Non Discounted Lifecycle Cost for Alternatives

HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action

ALTERNATIVES		Non Discounted Cost										
		YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
2A	Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.	$46,226	$2,794	$2,794	$2,794	$2,794	$14,815	$2,794	$2,794	$2,794	$2,794	$14,815
2B	Excavation, Screen for Potential UXO, Composite Sampling, and Disposal.	$54,328	$2,794	$2,794	$2,794	$2,794	$14,815	$2,794	$2,794	$2,794	$2,794	$14,815

ALTERNATIVES		Non Discounted Cost										
		YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15	YEAR 16	YEAR 17	YEAR 18	YEAR 19	YEAR 20	YEAR 21
2A	Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.	$2,794	$2,794	$2,794	$2,794	$14,815	$2,794	$2,794	$2,794	$2,794	$14,815	$2,794
2B	Excavation, Screen for Potential UXO, Composite Sampling, and Disposal.	$2,794	$2,794	$2,794	$2,794	$14,815	$2,794	$2,794	$2,794	$2,794	$14,815	$2,794

ALTERNATIVES		Non Discounted Cost										
		YEAR 22	YEAR 23	YEAR 24	YEAR 25	YEAR 26	YEAR 27	YEAR 28	YEAR 29	YEAR 30	Total	
2A	Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.	$2,794	$2,794	$2,794	$14,815	$2,794	$2,794	$2,794	$2,794	$14,815	$202,169	
2B	Excavation, Screen for Potential UXO, Composite Sampling, and Disposal.	$2,794	$2,794	$2,794	$14,815	$2,794	$2,794	$2,794	$2,794	$14,815	$210,271	

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2A - Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Capital Cost			
Land Use Controls			
Base Master Planning Documents	hrs	120	Assume 120 hrs to review and revise BMP Documents or similar.
Legal/Technical Labor	$/hr	80	
Site Prep			
Civil Survey	day	0.5	Survey excavation and asbuild (0.5 days). Means 01107 700 1100.
Civil Survey	$/day	925	
As Built Drawings	hours	4	
As Built Drawings	$/hr	50	
Silt Fences	lf	100	Vinyl, 3' High with 7.5' Posts
Silt Fences	$/lf	3.53	ECHOS 18050206
Mobilization Equipment	$/lot	0	ECHOS 33010114
Site Visit			
Sedan, Automobile, Rental	days	0.25	
Sedan, Automobile, Rental	$/day	61	ECHOS 33010108
Per Diem (per person)	days	0.25	
Per Diem (per person)	$/day	114	ECHOS 33010202
Senior UXO Supervisor (SUXOS)	hrs	2	
Senior UXO Supervisor (SUXOS)	$/hr	78.15	ECHOS 33040921
UXO Staff Engineer	hrs	2	
UXO Staff Engineer	$/hr	73.65	ECHOS 33040925
Airfare	ea	0.0	
Airfare	$/ea	750	ECHOS 33041101
Other Direct Costs	$/lot	652	ECHOS 33240101
Excavation			
Excavate Soils	hrs	4	Crawler-mounted, 4.0 CY, Koehring 1166 Hydraulic Excavator.
Excavate Soils	$/hr	314.15	ECHOS 17030234
UXO Vehicle Modification	days	0.50	
UXO Vehicle Modification	$/day	86	ECHOS 33040515
Sifting			
Dump Truck	hrs	4	12 CY Dump.
Dump Truck	$/hr	110.18	ECHOS 17030285
Sand Bags	ea	0	
Sand Bags	$/ea	0.58	ECHOS 17030427

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2A - Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Wheel Loader	hrs	4.00	0.75 CY. Loader
Wheel Loader	$/hr	129.90	ECHOS 17030436
Per Diem (per person)	day	4	8 @ 0.5 days ea
Per Diem (per person)	$/day	114.00	ECHOS 33010202
UXO - Vehicle Modification	day	0.50	
UXO - Vehicle Modification	$/day	85.46	ECHOS 33040515
Trommel Screener	day	0.50	
Trommel Screener	$/day	801.75	ECHOS 33040662
Grizzly Shaker Unit	day	0.50	
Grizzly Shaker Unit	$/day	535.12	ECHOS 33040663
UXO Technician II	hrs	4	Includes sifting and geophysical surveys.
UXO Technician II	$/hr	48.95	ECHOS 33040934
UXO Technician III (UXO Supervisor)	hrs	4	Includes sifting and geophysical surveys.
UXO Technician III (UXO Supervisor)	$/hr	60.12	ECHOS 33040935
Conveyor	day	0.50	61.5' Automatic, 45 FPM, Horizontal 24" Belt, Center Drive.
Conveyor	$/day	515.54	ECHOS 33188402
Other Direct Costs	$/lot	1,053	ECHOS 33240101
Man-Lift	day	0.50	Scissor, 26' High, 1500# capacity.
Man-Lift	$/day	153.67	ECHOS 33341006
<u>Conformational Sampling</u>			
Confirmation Samples - Field	ea	16	Obtain 16 RDX samples from excavations at former burn pads 66, and 67 (3 locations @ 5 samples each) and 1 sample from storage pile.
Confirmation Samples - Lab	ea	22	Obtain 22 PAH & RDX samples from excavations at former burn pads 61, 66, and 67 (4 locations @ 5 samples ea) and 1 sample from 2 storage pile.
Confirmation Sample Materials	ea	38	Reference ECHOS 33 02 0401/0402 for disposable sampling and decon materials.
Confirmation Sample Materials	$/ea	17.75	
Confirmation Sampling Labor	hrs	48	Includes 2 FTE sampling over a 2 day period and 1 day for travel.
Confirmation Sampling Labor	$/hr	60	
Confirmation Sample Analysis - Field	$/ea	800	Analyze samples for RDX (16 @ $50).
Confirmation Sample Analysis - Lab	$/ea	3,910	Analyze samples for SVOCs (7 @ 250) and RDX (18 @ $120). Includes 10% duplication samples.
Data Management	hrs	19	Data validation
Data Management	$/hr	60	
<u>Backfill</u>			
Backfill with Excavated Soils	cy	40	CAT 950, 3.00 CY
Backfill with Excavated Soils	$/cy	1.78	ECHOS 17030401
General Area Cleanup	acre	0.1	
General Area Cleanup	$/acre	500	ECHOS 17040101
Area Preparation	acre	0.1	
Area Preparation	$/acre	109.40	ECHOS 18050101
Hydroseeding	acre	0.1	
Hydroseeding	$/acre	731.65	ECHOS 18050401
Fertilize	acre	0.1	Hydro Spread
Fertilize	$/acre	218.55	ECHOS 18050408
Demobilize Equipment	$/lot	0.00	

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2A - Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Work Plans			
Site Specific Workplan	$/ls	700	Assume 10% of Work Plan cost is attributed to project. 10 hrs @ $70/hr
Explosive Safety Submission	$/ls	560	Assume 10% of Work Plan cost is attributed to project. 8 hrs @ $70/hr
UXO Removal Report	$/ls	700	Assume 10% of Work Plan cost is attributed to project. 10 hrs @ $70/hr
O&M			
Site Inspection and Maintenance	years	30	
Site Inspection	events	30	Inspect site annually.
Site Inspections	hrs	16	Inspect site and interview site management regarding soil disturbance activities. Complete checklist and letter report.
Field Labor	$/hr	45	
Site Maintenance	events	30	Assume $500/yr for fence/signs. Assume $500/ for reseeding and erosion control measures.
Site Maintenance	$/yr	1,000	
CERCLA Reviews			
CERCLA 5-Year Reviews	events	6	Assume 5 year reviews for 30 years.
CERCLA 5-Year Reviews	$/event	7,400	Assume 80 hours/review @ $80/hr. Add $1,000 misc expenses.

Notes:

1. All Capital Cost for Vehicle Modifications was assumed to be 0.2% of the total cost per day.
2. All daily equipment rentals were assumed to be 5% of the monthly rental.

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2A - Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.
Cost Estimate

CAPITAL COST **$46,226**

Activity (unit)	Quantity	Unit Cost	Total
Land Use Controls			
Base Master Planning Documents	120	$80.00	$9,600
Site Work			
Civil Survey (day)	0.50	$925.00	$463
As Built Drawings (hrs)	4.00	$50.00	$200
Silt Fences (lf)	100.00	$3.53	$353
Mobilization Equipment (lot)	0.00	$0.00	$0
Site Visit			
Sedan, Automobile, Rental (days)	0.25	$61.00	$15
Per Diem (day)	0.25	$114.00	$29
Senior UXO Supervisor (hrs)	2.00	$78.15	$156
UXO Staff Engineer (hrs)	2.00	$73.65	$147
Airfare (ea)	0.00	$750.00	$0
Other Direct Costs (lot)	1.00	$652.00	$652
Excavation			
Excavate Soils (hrs)	4.00	$314.15	$1,257
UXO Vehicle Modification (days)	0.50	$85.50	$43
Sifting			
Dump Truck (hrs)	4.00	$110.18	$441
Sand Bags (ea)	0.00	$0.58	$0
Wheel Loader (days)	4.00	$129.90	$520
Per Diem (days)	4.00	$114.00	$456
UXO - Vehicle Modification (days)	0.50	$85.46	$43
Trommel Screener (days)	0.50	$801.75	$401
Grizzly Shaker Unit (days)	0.50	$535.12	$268
UXO Technician II (hrs)	4.00	$48.95	$196
UXO Technician III (UXO Supervisor) (hrs)	4.00	$60.12	$240
Conveyor (days)	0.50	$515.54	$258
Other Direct Costs ($/lot)	1.00	$1,053.25	$1,053
Man-Lift (days)	0.50	$153.67	$77

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2A - Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.
Cost Estimate

CAPITAL COST

Activity (unit)	Quantity	Unit Cost	Total
Conformational Sampling			
Confirmation Sample Materials (ea)	38	$17.75	$675
Confirmation Sampling Labor (hrs)	48	$60.00	$2,880
Confirmation Sample Analysis - Field (lot)	1	$800.00	$800
Confirmation Sample Analysis - Lab (lot)	1	$3,910.00	$3,910
Data Management (hrs)	19	$60.00	$1,140
Backfill			
Backfill with Excavated Soils (cy)	40.00	$1.78	$71
General Area Cleanup (acre)	0.10	$500.00	$50
Area Preparation (acre)	0.10	$109.40	$11
Hydroseeding (acre)	0.10	$731.65	$73
Fertilize (acre)	0.10	$218.55	$22
Demobilize Equipment (lot)	1.00	$0.00	$0
Work Plans			
Site Specific Workplan	1	$700.00	$700
Explosive Safety Submission	1	$560.00	$560
UXO Removal Report	1	$700.00	$700
Subtotal			$28,457
Design		4%	$1,138
Office Overhead		5%	$1,423
Field Overhead		15%	$4,269
Subtotal			$35,287
Profit		6%	$2,117
Contingency		25%	$8,822
Total			$46,226

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2A - Excavation, Screen for Potential UXO, Composite Sampling, and Beneficial Reuse.
Cost Estimate

OPERATION AND MAINTENANCE **$155,942**

Activity (unit)	Quantity	Unit Cost	Total Cost	Present Value
Site Longterm O&M (Years 0-30)				
Site Inspection and Maintenance				
Site Inspection (years)	30	$720	$21,600	$9,655
Site Maintenance (years)	30	$1,000	$30,000	$13,409
CERCLA Reviews				
CERCLA 5-Year Reviews (event)	6	$7,400	$44,400	$15,968
Subtotal O&M			$96,000	$39,031
Design		4%	$3,840	$1,561
Office Overhead		5%	$4,800	$1,952
Field Overhead		15%	$14,400	$5,855
Subtotal			$119,040	$48,399
Profit		6%	$7,142	$2,904
Contingency		25%	$29,760	$12,100
Total			$155,942	$63,403

TOTAL ALTERNATIVE CAPITAL AND O&M COST (Non Discounted Cost) **$202,169**

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2B - Excavation, Screen for Potential UXO, Composite Sampling, and Offsite Disposal
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Capital Cost			
Land Use Controls			
Base Master Planning Documents	hrs	120	Assume 120 hrs to review and revise BMP Documents or similar.
Legal/Technical Labor	$/hr	80	
Site Prep			
Civil Survey	day	1	Survey excavation and asbuild (0.5 days). Means 01107 700 1100.
Civil Survey	$/day	925	
As Built Drawings	hours	4	
As Built Drawings	$/hr	50	
Silt Fences	lf	100	Vinyl, 3' High with 7.5' Posts
Silt Fences	$/lf	3.53	ECHOS 18050206
Mobilization Equipment	$/lot	0	ECHOS 33010114
Site Visit			
Sedan, Automobile, Rental	days	0.25	
Sedan, Automobile, Rental	$/day	61	ECHOS 33010108
Per Diem (per person)	days	0.25	
Per Diem (per person)	$/day	114	ECHOS 33010202
Senior UXO Supervisor (SUXOS)	hrs	3	Includes sifting and geophysical surveys.
Senior UXO Supervisor (SUXOS)	$/hr	78.15	ECHOS 33040921
UXO Staff Engineer	hrs	3	Includes sifting and geophysical surveys.
UXO Staff Engineer	$/hr	73.65	ECHOS 33040925
Airfare	ea	0.0	
Airfare	$/ea	750	ECHOS 33041101
Other Direct Costs	$/lot	652	ECHOS 33240101
Excavation			
Excavate Soils	hrs	4	Crawler-mounted, 4.0 CY, Koehring 1166 Hydraulic Excavator.
Excavate Soils	$/hr	314.15	ECHOS 17030234
UXO Vehicle Modification	days	0.50	
UXO Vehicle Modification	$/day	86	ECHOS 33040515
Sifting			
Dump Truck	hrs	4	12 CY Dump.
Dump Truck	$/hr	110.18	ECHOS 17030285
Sand Bags	ea	0	
Sand Bags	$/ea	0.58	ECHOS 17030427

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2B - Excavation, Screen for Potential UXO, Composite Sampling, and Offsite Disposal
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Wheel Loader	hrs	4.00	0.75 CY. Loader
Wheel Loader	$/hr	129.90	ECHOS 17030436
Per Diem (per person)	day	4	8 @ 0.5 days ea
Per Diem (per person)	$/day	114.00	ECHOS 33010202
UXO - Vehicle Modification	day	0.50	
UXO - Vehicle Modification	$/day	85.46	ECHOS 33040515
Trommel Screener	day	0.50	
Trommel Screener	$/day	801.75	ECHOS 33040662
Grizzly Shaker Unit	day	0.50	
Grizzly Shaker Unit	$/day	535.12	ECHOS 33040663
UXO Technician II	hrs	4	
UXO Technician II	$/hr	48.95	ECHOS 33040934
UXO Technician III (UXO Supervisor)	hrs	4	
UXO Technician III (UXO Supervisor)	$/hr	60.12	ECHOS 33040935
Conveyor	day	0.50	61.5' Automatic, 45 FPM, Horizontal 24" Belt, Center Drive.
Conveyor	$/day	515.54	ECHOS 33188402
Other Direct Costs	$/lot	1,053	ECHOS 33240101
Man-Lift	day	0.50	Scissor, 26' High, 1500# capacity.
Man-Lift	$/day	153.67	ECHOS 33341006
Conformational Sampling			
Confirmation Samples - Field	ea	16	Obtain 16 RDX samples from excavations at former burn pads 66, and 67 (3 locations @ 5 samples each) and 1 sample from storage pile.
Confirmation Samples - Lab	ea	22	Obtain 22 PAH & RDX samples from excavations at former burn pads 61, 66, and 67 (4 locations @ 5 samples ea) and 1 sample from 2 storage pile.
Confirmation Sample Materials	ea	38	Reference ECHOS 33 02 0401/0402 for disposable sampling and decon materials.
Confirmation Sample Materials	$/ea	17.75	
Confirmation Sampling Labor	hrs	48	Includes 2 FTE sampling over a 2 day period and 1 day for travel.
Confirmation Sampling Labor	$/hr	60	
Confirmation Sample Analysis - Field	$/ea	800	Analyze samples for RDX (16 @ $50).
Confirmation Sample Analysis - Lab	$/ea	3,910	Analyze samples for SVOCs (7 @ 250) and RDX (18 @ $120). Includes 10% duplication samples.
Data Management	hrs	19	Data validation
Data Management	$/hr	60	
Offsite Disposal			
Dump Charges	cy	40	Assume all soils disposed offsite.
Dump Charges	$/cy	64.37	ECHOS 17020401
Wheel Loader	hrs	4	CAT 910, 1.25 CY,
Wheel Loader	$/hr	107.36	ECHOS 17030220
Dump Truck	hrs	16	12 cy and 30 mi RT haul
Dump Truck	$/hr	118.92	ECHOS 17030284

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2B - Excavation, Screen for Potential UXO, Composite Sampling, and Offsite Disposal
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Restoration			
General Area Cleanup	acre	0.1	
General Area Cleanup	$/acre	500	ECHOS 17040101
Area Preparation	acre	0.1	
Area Preparation	$/acre	109.40	ECHOS 18050101
Hydroseeding	acre	0.1	
Hydroseeding	$/acre	731.65	ECHOS 18050401
Fertilize	acre	0.1	Hydro Spread
Fertilize	$/acre	218.55	ECHOS 18050408
Demobilize Equipment	$/lot	0.00	
Work Plans			
Site Specific Workplan	$/ls	700	Assume 10% of Work Plan cost is attributed to project. 10 hrs @ $70/hr
Explosive Safety Submission	$/ls	560	Assume 10% of Work Plan cost is attributed to project. 8 hrs @ $70/hr
UXO Removal Report	$/ls	700	Assume 10% of Work Plan cost is attributed to project. 10 hrs @ $70/hr
O&M			
Site Inspection and Maintenance	years	30	
Site Inspection	events	30	Inspect site annually.
Site Inspections	hrs	16	Inspect site and interview site management regarding soil disturbance activities. Complete checklist and letter report.
Field Labor	$/hr	45	
Site Maintenance	events	30	Assume $500/yr for fence/signs. Assume $500/ for reseeding and erosion control measures.
Site Maintenance	$/yr	1,000	
CERCLA Reviews			
CERCLA 5-Year Reviews	events	6	Assume 5 year reviews for 30 years.
CERCLA 5-Year Reviews	$/event	7,400	Assume 80 hours/review @ $80/hr. Add $1,000 misc expenses.

Notes:

1. All Capital Cost for Vehicle Modifications was assumed to be 0.2% of the total cost per day.
2. All daily equipment rentals were assumed to be 5% of the monthly rental.

Winklepeck Burning Grounds (WBG) Feasibility Study
Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
HTRW Contamination Removal Concurrent with the Planned Mark 19 Practice Range UXO Removal Action
Alternative 2A - Excavation, Screen for Potential UXO, Composite Sampling, and Offsite Disposal
Cost Estimate

CAPITAL COST **$54,328**

Activity (unit)	Quantity	Unit Cost	Total
Land Use Controls			
Base Master Planning Documents	120	$80.00	$9,600
Site Work			
Civil Survey (day)	1	$925.00	$463
As Built Drawings (hrs)	4	$50.00	$200
Silt Fences (lf)	100	$3.53	$353
Mobilization Equipment (lot)	1	$0.00	$0
Site Visit			
Sedan, Automobile, Rental (days)	0.25	$61.00	$15
Per Diem (day)	0.25	$114.00	$29
Senior UXO Supervisor (hrs)	3.00	$78.15	$234
UXO Staff Engineer (hrs)	3.00	$73.65	$221
Airfare (ea)	0.00	$750.00	$0
Other Direct Costs (lot)	1.00	$652.00	$652
Excavation			
Excavate Soils (hrs)	4.00	$314.15	$1,257
UXO Vehicle Modification (days)	0.50	$85.50	$43
Sifting			
Dump Truck (hrs)	4.00	$110.18	$441
Sand Bags (ea)	0.00	$0.58	$0
Wheel Loader (days)	4.00	$129.90	$520
Per Diem (days)	4.00	$114.00	$456
UXO - Vehicle Modification (days)	0.50	$85.46	$43
Trommel Screener (days)	0.50	$801.75	$401
Grizzly Shaker Unit (days)	0.50	$535.12	$268
UXO Technician II (hrs)	4.00	$48.95	$196
UXO Technician III (UXO Supervisor) (hrs)	4.00	$60.12	$240
Conveyor (days)	0.50	$515.54	$258
Other Direct Costs ($/lot)	1.00	$1,053.25	$1,053
Man-Lift (days)	0.50	$153.67	$77

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Cost Estimate

CAPITAL COST

Activity (unit)	Quantity	Unit Cost	Total
Conformational Sampling			
Confirmation Sample Materials (ea)	38	$17.75	$675
Confirmation Sampling Labor (hrs)	48	$60.00	$2,880
Confirmation Sample Analysis - Field (lot)	1	$800.00	$800
Confirmation Sample Analysis - Lab (lot)	1	$3,910.00	$3,910
Data Management (hrs)	19	$60.00	$1,140
Offsite Disposal			
Dump Charges (cy)	40	$64.37	$2,575
Wheel Loader (hrs)	4	$107.36	$429
Dump Truck (hrs)	16	$118.92	$1,903
Restoration			
General Area Cleanup (acre)	0.10	$500.00	$50
Area Preparation (acre)	0.10	$109.40	$11
Hydroseeding (acre)	0.10	$731.65	$73
Fertilize (acre)	0.10	$218.55	$22
Demobilize Equipment (lot)	1.00	$0.00	$0
Work Plans			
Site Specific Workplan	1	$700.00	$700
Explosive Safety Submission	1	$560.00	$560
UXO Removal Report	1	$700.00	$700
Subtotal			$33,445
Design		4%	$1,338
Office Overhead		5%	$1,672
Field Overhead		15%	$5,017
Subtotal			$41,472
Profit		6%	$2,488
Contingency		25%	$10,368
Total			$54,328

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Cost Estimate

OPERATION AND MAINTENANCE	**$155,942**

Activity (unit)	Quantity	Unit Cost	Total Cost	Present Value
Site Longterm O&M (Years 0-30)				
Site Inspection and Maintenance				
Site Inspection (years)	30	$720	$21,600	$9,655
Site Maintenance (years)	30	$1,000	$30,000	$13,409
CERCLA Reviews				
CERCLA 5-Year Reviews (event)	6	$7,400	$44,400	$15,968
Subtotal O&M			$96,000	$39,031
Design		4%	$3,840	$1,561
Office Overhead		5%	$4,800	$1,952
Field Overhead		15%	$14,400	$5,855
Subtotal			$119,040	$48,399
Profit		6%	$7,142	$2,904
Contingency		25%	$29,760	$12,100
Total			$155,942	$63,403

TOTAL ALTERNATIVE CAPITAL AND O&M COST (Non Discounted Cost)	**$210,271**

Comment Responses
Revised Final Focused Feasibility Study for the Winklepeck Burning Grounds, Ravenna Army Ammunition Plant, Ravenna Ohio, October 2004
Rev. 03/23/05

Cmt. No.	Page No.	Comment	Recommendation	Response
Ohio EPA DERR NEDO (Eileen Mohr/Todd Fisher/Laurie Moore/Bonnie Buthker)				
1	Executive Summary	Executive Summary is missing.	Please include Executive Summary. This should include changes as indicated in Response to Comments (see comment responses to #4 and #5 on CRT).	Agree. The Executive Summary has been included with the requested changes incorporated.
2	Section 1.5.3 Ecology, pages 1-14 and 1-16.	The following species are no longer on the State Endangered Species list: Common Barn owl, Little Blue heron, and Canada warbler.	Please make the appropriate changes to the text. Please consult http://www.dnr.state.oh.us/wildlife/resources/mgtplans/endangered.htm for updated information.	Agree. The text has been updated to reflect the current State Endangered Species affected.
3	Section 1.5.3 Ecology, page 1-16	The following species are no longer on the State Potentially Threatened species list: Round-leaf sundew, Closed gentian, Blunt mountain-mint, Large cranberry, and Weak sedge.	Please make the appropriate changes to the text. Please consult http://www.ohiodnr.com/dnap/heritage/Rare_Species2004.htm for updated information.	Agree. The text has been updated to reflect the current State Potentially Threatened Species affected, as posted on http://www.dnr.ohio.gov/dnap/heritage/Rare_Species2002.htm.
4	Section 1.5.3 Ecology, page 1-16 and 1-17	The following species are no longer on the Ohio State Species of Concern list: Smooth Green snake, Solitary vireo, and Red-shouldered hawk	Please make the appropriate changes to the text. Please consult http://www.dnr.state.oh.us/wildlife/resources/mgtplans/specofconcern.htm for updated information.	Agree. The text has been updated to reflect the current State Species of Concern affected.