Final
November 2014

Proposed Plan for the Red Water Pond Areas FUDS Project No. G05OH001820

Former Plum Brook Ordnance Works Sandusky, Ohio

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US Army Corps of Engineers

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November 14, 2014

U.S. Army Engineer District, Nashville
ATTN: CELRN-EC-E (Ms. Paula Coleman)
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Subject: ***Submittal of the Final Proposed Plan for the Red Water Pond Areas DERP-FUDS Project No. G05OH001820 Former Plum Brook Ordnance Works, Sandusky, Ohio Contract No. W912QR-08-D-0013: Shaw Project Number 132458***

Dear Ms. Coleman:

In accordance with the requirements of Delivery Order No. DX03 of Contract No. W912QR-08-D-0013 awarded to CB&I Federal Services LLC, we are pleased to submit this Final Proposed Plan for the Red Water Pond Areas at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio. This final was prepared incorporating responses to the comments that were provided on the previous drafts by the Nashville, Louisville, and Huntington Districts, as well and the Environmental and Munitions Center of Expertise. This Proposed Plan was prepared consistent with U.S. Environmental Protection Agency guidance, communication with the USACE, and other PBOW proposed plans.

Enclosed are four copies of this final for your records. Copies have also been sent to those on the distribution list as indicated. Please note that 20 of the copies provided to Rick Meadows are for distribution to the public at the Red Water Pond Areas Public Meeting, scheduled for 7 p.m., November 20, 2014, at the Bowling Green State University Firelands Campus, Huron, Ohio.

Should you have any questions or require additional information regarding this submittal, please do not hesitate to contact me at (865) 694-7496.

Sincerely,

Steven. T. Downey, PE, PMP
Project Manager

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DISCIPLINE SIGN-OFF REVIEW

Client Name: U.S. Army Engineer District, Nashville; CELRN-EC-E

Project Description: Red Water Pond Areas Proposed Plan
Former Plum Brook Ordnance Works, Sandusky, Ohio

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NOTICE: By signature above, parties certify that the subject document has been prepared by and/or reviewed by them (as appropriate), that all review comments have been resolved, and that the document is ready for submittal.

Final
Proposed Plan for the
Red Water Pond Areas
DERP-FUDS Project No. G05OH001820
Former Plum Brook Ordnance Works, Sandusky, Ohio

Issued By U.S. Army Corps of Engineers
Huntington District

Prepared by CB&I Federal Services LLC

November 2014

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1.0 U.S. Army Corps of Engineers Announces Proposed Plan

This Proposed Plan identifies the Preferred Alternative for the cleanup of contaminated soil associated with the former Red Water Pond (RWP) Areas of the former Plum Brook Ordnance Works (PBOW), Sandusky, Ohio (Figure 1), and presents the rationale for this preference. The RWP Areas include the Pentolite Road Red Water Pond (PRRWP) Area and the West Area Red Water Ponds (WARWP) Area (Figure 2). The Preferred Alternative, as well as the other alternatives described herein, addresses the human health and ecological risks associated with soil exposure pathways. Specifically, this Proposed Plan presents a recommendation for remedial action for soils at the PRRWP Area. It also presents a recommendation for no action for other PRRWP Area environmental media and a recommendation for no action at the WARWP Area. This Proposed Plan also summarizes the cleanup of contaminated soils associated with the PRRWP Area that was performed as part of a Non-Time-Critical Removal Action (NTCRA) (McTech Corporation, 2009). Potential risks associated with exposure to groundwater underlying the RWP Areas are being addressed separately (U.S. Army Corps of Engineers [USACE], 2012).

DATES TO REMEMBER

Comment Period
November 20 through
December 22, 2014

Public Meeting
7 p.m., Thursday, November 20, 2014,
at Firelands Library
BGSU Firelands Campus
Foundation Hall
One University Drive
Huron, Ohio

U.S. Army environmental investigations and remediation at PBOW are administered under the Defense Environmental Restoration Program (DERP) Formerly Used Defense Sites (FUDS) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (U.S. Environmental Protection Agency [USEPA], 1990). The U.S. Secretary of Defense delegated authority through Headquarters, Department of the Army, to the U.S. Army Corps of Engineers (USACE) to administer the DERP-FUDS program. The U.S. Army is the lead agency under DERP, but the delegation made USACE the chief executor for environmental restoration activities at FUDS. The FUDS program was established under DERP and addresses releases or threatened releases attributable to Department of Defense (DOD) activities on FUDS properties. FUDS properties are properties that were owned by, leased to, or otherwise possessed by the United States and under the jurisdiction of the Secretary that were transferred from DOD control prior to 17 October 1986.

The Proposed Plan is a document issued by the USACE, the lead agency for environmental response actions under FUDS at PBOW, to fulfill public participation requirements as required under Section 117(a) of CERCLA and Section 300.430(f)(2) of the NCP. The public participation process affords the public a reasonable opportunity to submit written and oral comments on the alternative plans for remedial action at the sites.

The Preferred Alternative may be modified based on any new information or comments received during the designated public comment period. Therefore, the public is encouraged to review and comment on all information presented in the Proposed Plan or Administrative Record (AR) file. This Proposed Plan was prepared in coordination with the Ohio Environmental Protection Agency (Ohio EPA). The USACE is charged with planning and implementing environmental investigations and remedial actions at PBOW associated with past DOD activities. The Ohio EPA is the support agency pursuant to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1990).

This Proposed Plan is issued to accomplish the following:

- Provide basic background information about the site
- Describe all remedial options considered
- Identify the Preferred Alternative for soil associated with the PRRWP Area and explain reasons for the preference
- Solicit public review and comment on all alternatives
- Provide information on how the public can be involved in the remedy selection process.

The USACE, after coordinating with the Ohio EPA, will select a final remedy for the RWP Areas soil after the public has had an opportunity to comment on this Proposed Plan and all comments received have been reviewed and considered. The comment period for the Proposed Plan is from November 20 through December 22, 2014, and the public meeting will be held at 7 p.m. on Thursday, November 20, 2014, at the Firelands Library, Firelands Campus of Bowling Green State University (BGSU), Huron, Ohio. The remedy selected for the RWP Areas soil will be documented in a Decision Document.

Comments can be directed to:

U.S. Army Corps of Engineers,
Huntington District
Attn: CELRH-PM-PP-P (Mr. Rick Meadows)
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This Proposed Plan summarizes information presented in greater detail in documents contained in the AR file for the RWP Areas. Background documents for the RWP Areas are listed in Section 2.1 of this Proposed Plan and can be found in the AR file. These background documents are referenced within this Proposed Plan and are the basis of most of the information summarized herein. The USACE and the Ohio EPA encourage the public to review the pertinent documents in the AR file to gain a more comprehensive understanding of the RWP Areas and the associated site activities. The AR file, which contains information upon which the selection of the response action will be based, is maintained at the Huntington District Office, 502 Eighth Street, Huntington, West Virginia, 25701. A copy of the AR file is kept on compact disks at the local Public Repository for access by the public.

The local Public Repository of the AR file is:

Firelands Library
BGSU Firelands Campus
Foundation Hall
One University Drive
Huron, Ohio
Phone: 419-433-5560

Library hours vary throughout the year. Call for current hours. The AR file is maintained on compact disks; ask librarian at front desk for assistance.

2.0 Site Background

2.1 PBOW Description and History

PBOW is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland (Figure 1). Although located primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is generally bounded on the north by Bogart Road, on the south by Mason Road, on the west by Patten Tract Road, and on the east by U.S. Highway 250. The area surrounding PBOW is mostly agricultural and residential.

PBOW was established by the War Department as a government-owned, contractor-operated (GOCO) facility for the production of 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (DNT), and pentolite during World War II. The PBOW site originally consisted of approximately 9,100 acres, approximately 3,500 acres of which were used as a buffer area outside the facility fence line. The property was acquired in the name of the United States of America in 1941. The government contractor, Trojan Powder Company, operated the production facility from December 1941 until 1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during this period.

At the end of production in September 1945, PBOW was placed in standby operation status and the Army conducted decontamination and decommissioning activities. On December 17, 1945, the U.S. Army Ordnance Department (Ordnance Department) obtained physical control of the site. The Ordnance Department continued decontamination efforts until August 1946. In 1946, over 6,200 acres, 3,231 located within the fenced area, were transferred to the War Assets Administration (WAA), and approximately 2,800 acres were transferred to the Ravenna Arsenal. This 2,800-acre parcel, transferred to Ravenna Arsenal and referred to as the Magazine Area (and also the Plum Brook Depot), was transferred again in July 1947 to the Erie Ordnance Depot, LeCarne, Ohio (War Department, 1947). The Magazine Area included approximately 2,300 acres inside the fence line and 500 acres of the buffer area, outside of the fence line.

In 1949, the General Service Administration (GSA) took control of WAA's portion of the PBOW property, which included an indeterminate amount of acreage outside of the fence line due to conveyances by WAA to private landowners during the late 1940s and early 1950s. It is believed that farmers were given the opportunity to buy back land in the buffer area, outside the fence line.

In June 1954, the Army reacquired the 3,231 acres within the PBOW fence line that were previously transferred to the WAA and subsequently to GSA. From August 1954 to sometime in 1958, further decontamination was performed by the Army. The decontamination included removal of and disposal of contaminated surface and subsurface soil around the buildings and wooden and ceramic waste disposal lines containing TNT. This included thousands of pounds of TNT which were discovered in catch basins and removed and incinerated at the burning grounds.

Primary Background Documents for the Red Water Pond Areas

CB&I Federal Services LLC, 2014, Addendum for Red Water Pond Areas Focused Feasibility Study for Soil, FUDS Project No. G05OH001820, Updated Cost Tables, Final, Former Plum Brook Ordnance Works, November.

Shaw Environmental and Infrastructure, Inc., 2013a, ***Pentolite Road Red Water Pond Area Site Delineation Report,*** Final, Former Plum Brook Ordnance Works, May.

Shaw Environmental and Infrastructure, Inc., 2013b, ***Addendum for Red Water Ponds Focused Feasibility Study for Soil***, FUDS Project No. G05OH001820, Final, Former Plum Brook Ordnance Works, May.

U.S. Army Corps of Engineers (USACE), 2012, ***Proposed Plan for Groundwater, TNT and Red Water Pond Areas***, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, March.

McTech Corporation. (McTech), 2009, ***Interim Soil Removal Action Continuation Report Soil Excavation, Composting, and Disposal,*** Plum Brook Ordnance Works Pentolite Road Red Water Ponds Sandusky, Ohio, January.

U.S. Army Corps of Engineers (USACE), 2003, ***Final Action Memorandum for Pentolite Road Red Water Pond Area Interim Removal Action at the Plum Brook Ordnance Works, Sandusky, Ohio***, Huntington District, Huntington, West Virginia, June.

IT Corporation (IT), 2002, ***Red Water Pond Areas, Focused Feasibility Study for Soil***, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, December.

IT Corporation (IT), 2001, ***Final Red Water Pond Areas Baseline Ecological Risk Assessment, Former Plum Brook Ordnance Works, Sandusky, Ohio***, November.

IT Corporation (IT), 2000, ***Risk Assessment and Direct-Push Investigation of Red Water Pond Areas***, Final, Former Plum Brook Ordnance Works, Sandusky, Ohio, August.

Dames & Moore, Inc. (D&M), 1997, ***Red Water Ponds Focused Remedial Investigation Final Report, Plum Brook Ordnance Works, Plum Brook Station/NASA, Sandusky, Ohio,*** prepared for U.S. Army Corps of Engineers, Nashville District/Huntington District, April.

Two property use agreements were entered into by the Army and the National Advisory Committee for Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration (NASA), in March 1956 and January 1958, respectively. The first agreement was for approximately 500 acres on which NACA built a nuclear reactor. The second agreement gave NACA (NASA as of October 1958) use of an additional 2,700 acres within the fenced area but outside the Magazine Area, for a total of 3,231 acres under the two use agreements. At this time, NASA had use of all property inside the PBOW fence except the 2,300 acres in the Magazine Area. The Army declared this 3,231-acre property as excess in October 1958.

In September 1961, the Army declared the Magazine Area as excess, and NASA formally requested custody of the property in October 1961 (NASA, 1961). On March 15, 1963, accountability and custody of the PBOW property (6,031 acres) were transferred from the Department of the Army to NASA.

However, prior to NASA's acceptance of the property in March 1963, Ravenna Arsenal performed additional decontamination and subsequently certified 500 acres of the former PBOW property as decontaminated and suitable for unrestricted future use. This decontamination certification was only for the 500 acres in the former pentolite manufacturing area (area where NASA built the nuclear reactor) under the first use agreement. NASA identified additional DOD-related contamination in 1963, after transfer of the property. NASA performed further decontamination efforts and the removal of structures in 1964.

NASA has operated and maintained the property inside the fence line since 1963, and the facility currently located there is the NASA Glenn Research Center, Plum Brook Station. NASA operates the property as a space research facility in support of its John Glenn Research Center at Lewis Field, Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the site have been demolished or are currently on standby or inactive status. During 1967 through 1971, NASA purchased approximately 2,000 acres outside of the fence line from local farmers as "buffer." On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. This excess included approximately 1,500 acres of farmland outside the fence, including those acres purchased from farmers beginning in 1967, and was sold as farmland (NASA, 2013). Also, 46 acres outside of the fence in the northeast corner of the PBOW facility near the guard house were conveyed to the Perkins Township Board of Education for use as a bus transportation area. In addition, the 2,152 acres of PBOW declared excess included a 604-acre parcel in the western part of the fenced area known as "Parcel 59." This area, although previously declared excess, was not transferred and remains under NASA control. According to a NASA newsletter, NASA presently controls approximately 6,432 acres (NASA, 2013); this includes approximately 5,500 acres within the fence line and 900 acres outside of the fence which have been leased for agriculture (NASA, 2012).

The former PBOW FUDS property includes the entire 9,100 acres, but the only project areas that have been approved (or proposed) for the property are located within the fenced area (currently controlled by NASA). The fence generally runs along the patrol road. The area outside the fence was used as a buffer zone during the PBOW manufacturing period, and there is no known or suspected DOD-related contamination outside the fence line. The RWP Areas are within the former PBOW and current NASA fence line.

2.2 Red Water Pond Areas Description and History

The USACE has investigated surface soil, subsurface soil, surface water, and sediment at both RWP Areas to determine whether former DOD activities have adversely affected PRRWP Area and WARWP Area environmental media. Surface soil in the investigation conducted in the RWP Areas is defined as soil that begins at a depth interval of 0 to 1 foot below ground surface (bgs), and subsurface soil is defined as soil sampled from a minimum depth of greater than 1 foot bgs. These investigations include the Focused Remedial Investigation (RI) (Dames & Moore, Inc. [D&M], 1997) and the Risk Assessment and Direct-Push Investigation (RADPI) (IT Corporation [IT], 2000). The results of these investigations are briefly summarized in the following paragraphs, along with the description and history of each RWP Area. It is noted that groundwater was also sampled and evaluated in the RWP Areas. Because a Proposed Plan for groundwater associated with the RWP Areas (and TNT Areas) has been issued and presented to the public on March 27, 2012, during a Public Meeting, the sampling and evaluation of groundwater is not discussed in this Proposed Plan.

2.2.1 PRRWP Area

The PRRWP Area is located in the north-central portion of PBOW, approximately 1,000 feet north of Maintenance Road and approximately 300 feet south of Pentolite Road (Figure 2). The unlined pond in this area received waste process water from Waste Water Treatment Plant No. 1 from 1942 until 1945 via an elevated discharge pipe. This waste originated from the manufacture of TNT at TNT Area A (TNTA) and TNT Area B (TNTB). The pond, which was apparently man-made, covered approximately 2 acres during plant operations. In 1977, retention dikes and sump pits were installed at the PRRWP Area in response to the observation of reddish-brown water in an adjacent surface ditch. In April and May 1977, approximately 60,000 gallons of the reddish-brown water were removed. The original basin was then backfilled and regraded so that the original pond area would be higher in elevation than the surrounding area; this was done to prevent ponding in the area of the original PRRWP footprint (D&M, 1997).

Elevated concentrations of nitroaromatic compounds were detected in PRRWP Area subsurface soil at one sampling location among the soil samples collected prior to the NTCRA (discussed below). Notably, TNT was detected at a concentration of 12,000 milligrams per kilogram (mg/kg) at a depth interval of 3 to 5 feet bgs and at a concentration of 340 mg/kg at a depth interval of 5 to 10 feet bgs. TNT was detected in only 3 of the remaining 71 pre-NTCRA subsurface soil samples and at low concentrations (less than 1 mg/kg in each case). TNT was detected in only 1 of 50 pre-NTCRA PRRWP surface soil samples and at a low concentration (0.27 mg/kg). The maximum detected concentration of any nitroaromatic compound in PRRWP

surface soil was 2.7 mg/kg 4-amino-2,6-dinitrotoluene, which was detected in only 1 of 50 samples. This concentration of 4-amino-2,6-dinitrotoluene is less than current human health-based levels used in risk assessment screening, which suggests negligible concern for human health. With the exception of subsurface soil at boring PB-RWPPR-S14, detected concentrations of nitroaromatics were generally low, and nitroaromatics were not detected in most of the PRRWP soil samples.

A NTCRA was initially implemented in 2003 as an interim action that involved the excavation of a TNT "hot spot" area. This NTCRA was based on the findings of the focused feasibility study (FFS) for RWP Areas soil (IT, 2002). TNT was identified as the only chemical of concern (COC) in the FFS. A TNT cleanup goal of 13.8 mg/kg was identified in the FFS and used as a basis for remediation in the NTCRA. During NTCRA removal, a previously unidentified dark soil seam was observed at a depth of approximately 4 to 5 feet. The initial samples from this seam yielded elevated TNT concentrations of up to 1,440 mg/kg, more than 100 times the cleanup goal. Other nitroaromatics were also detected in these initial seam samples, but at much lower concentrations (e.g., 1,3,5-trinitrobenzene at up to 39.1 mg/kg). Under the NTCRA, soil was removed over the full extent of this dark soil seam, which covered an area of approximately 0.6 acre (Figure 3), to meet the NTCRA TNT cleanup goal of 13.8 mg/kg for TNT. The NTCRA was completed in September 2008 (McTech Corporation, 2009).

Once the TNT cleanup criterion was met along the outside boundary represented by these test pits, which were completed in June 2004, the delineation of the extent of contamination for purposes of the NTCRA was regarded as complete. This area identified by the perimeter test pits was then excavated in 2007 and backfilled with clean material. After completion of the NTCRA, the analytical results of soil samples collected from the walls of the NTCRA excavation were reviewed (Shaw Environmental and Infrastructure, Inc. [Shaw] [a CB&I company], 2013a). During this review, it was discovered that concentrations of non-TNT nitroaromatics were higher than expected based on a comparison to the analytical results of the RI samples that were used in the PRRWP Area baseline human health risk assessment (BHHRA) (IT, 2000) and were identified by USACE as representing a potential human health risk. Therefore, USACE further delineated the contamination beyond the NTCRA excavation. Initial post-NTCRA delineation sampling using test pits was begun in May 2009. Subsequent step-out sampling was conducted using test pits and soil boring samples, which were collected over a combined depth interval of 1 to 10 feet bgs. The initial step-out samples were collected roughly 30 feet outside of the NTCRA boundary, and subsequent step-out samples were collected to further delineate contamination based on analytical results. The contamination delineation effort was completed in November 2010.

The delineation sample locations, including a comparison to remedial goals (RG), are shown on Figure 4. An RG is a chemical-specific concentration that is used as a cleanup goal for a remedial action. The RGs are further described in Chapter 6.0. The delineation sampling locations where at least one COC exceeds an RG are shown in red on this figure, and those for which none of the COC concentrations exceed the corresponding RGs are shown in black.

Based on the results of the delineation sampling and evaluation, an Addendum to the FFS was performed for the PRRWP Area (Shaw, 2013b). The FFS Addendum identified six additional nitroaromatic compounds as COCs, for a total of seven:

- 1,3-Dinitrobenzene
- 2-Amino-4,6-dinitrotoluene
- 4-Amino-2,6-dinitrotoluene
- 2,4-DNT
- 2,6-DNT
- 1,3,5-Trinitrobenzene
- TNT.

2.2.2 WARWP Area

The WARWP Area is located in the far western part of PBOW, approximately 500 feet north-northwest of TNT Area C (TNTC) (Figure 2). The two unlined ponds in this area received TNTC process waste water from Waste Water Treatment Plant No. 2 from 1942 until 1945 via an elevated discharge pipe. The WARWP Area consisted of an “east pond” and a “west pond,” which were apparently man-made. Together, these ponds covered approximately 7 acres. The east pond contained water from the 1940s until the late 1970s, when the berm between the two ponds was breached by NASA to drain the eastern pond. At present, the east pond is typically dry, with the exception of localized water near the location of the former berm. The west pond has existed since the 1940s. The west pond, together with residual water in the east pond (near the former berm), comprises approximately 3.5 acres.

Concentrations of nitroaromatics in WARWP Area subsurface soil were in the low parts per million or mg/kg (maximum of 6.3 mg/kg 2,4-DNT at WARP-DP13 at a depth of 8 to 10 feet bgs). All detections of nitroaromatics in WARWP Area surface soil were less than 1 mg/kg. Nitroaromatics were not detected in the majority of WARWP Area surface and subsurface soil samples.

Low concentrations (below 1 mg/kg) of several nitroaromatics were detected among the five WARWP Area surface water samples collected as part of the focused RI; a relatively higher

concentration of 3-nitrotoluene was detected in a sample collected in 1994 from a small ponded area east of the current pond (D&M, 1997). No nitroaromatics were detected in the four WARWP Area surface water samples collected during 1998 (IT, 2000).

Low concentrations (below 1 mg/kg) of several nitroaromatics were detected among the 12 WARWP Area sediment samples collected as part of the focused RI in 1994. No nitroaromatics were detected in the five WARWP sediment samples collected during the 1998 RADPI. Infrequent detections of nitroaromatics at low concentrations in the RADPI surface water and sediment samples indicate that contaminants associated with the former pond have not appreciably impacted surface water or sediment.

3.0 Site Characteristics

The site characteristics of the PRRWP Area and WARWP Area are described separately in Sections 3.1 and 3.2.

3.1 PRRWP Area

The historical pond was apparently man-made and unlined. No buildings or other man-made structures are currently present or known to have existed at the PRRWP Area, and there is no record or other indication of this area ever being used by NASA. Although the original pond comprised approximately 2 acres, the study area encompassed approximately 20 acres because of the reddish-brown water observed in this area in 1977 that was thought to have been potentially indicative of nitroaromatics contamination. The PRRWP Area is currently covered in old field vegetation, scrub/shrub, and moderate forest, with isolated areas of standing water with emergent wetland vegetation. The approximately 0.6-acre area in which the NTCRA was implemented (described below) was backfilled with clean material and seeded with Indian grass (*Sorghastrum nutans*, a native species). Seasonally ponded areas, which have been observed since the 1977 regrading activities, are present near the PRRWP Area but outside of the original PRRWP footprint. A drainage ditch, which has been observed as algae covered and containing a few inches of flowing water, is located along the eastern edge of the PRRWP Area.

As described in Section 2.2.1, elevated concentrations of nitroaromatics were found to be present in PRRWP Area soils that were sampled to a depth of 10 feet. Their presence is consistent with the former use of the area as a pond for TNT manufacturing process waste water. Some of the highest concentrations of nitroaromatics previously observed were associated with an approximately 1-foot-thick organic layer that was removed during the NTCRA. This layer was generally present at a depth of 4 to 5 feet below the surface. Some areas of similarly high nitroaromatics concentrations remain in the PRRWP Area, especially north and northeast of the former NTCRA excavation (Figure 4). As explained in Section 2.2.1, the sample locations with at least one COC that exceeds an RG are shown in red on this figure, and those for which all COC concentrations are less than the corresponding RGs are shown in black. The RGs are described in Chapter 6.0.

The maximum detected concentration of each COC in PRRWP Area subsurface soil, and the location of the maximum concentration, are listed below with the corresponding RG shown in parentheses:

- 1,3-Dinitrobenzene – 5,900 mg/kg at location 10014 (RG=6.1 mg/kg)
- 2-Amino-4,6-dinitrotoluene – 6,400 mg/kg at location 10102 (RG=15 mg/kg)
- 4-Amino-2,6-dinitrotoluene – 2,900 mg/kg at location 10102 (RG=15 mg/kg)
- 2,4-DNT – 22,000 mg/kg at location 10014 (5.6 mg/kg)
- 2,6-DNT – 3,000 mg/kg at location 10014 (1.6 mg/kg)
- 1,3,5-Trinitrobenzene – 27,000 mg/kg at location 10106 (220 mg/kg)
- TNT – 26,000 mg/kg at location 10102 (36 mg/kg).

Only limited surface and near-surface soil samples (0 to 2 feet bgs) were collected; the analytical results from these samples indicate that most of the surface and near-surface soil is unlikely to be impacted by nitroaromatics at concentrations exceeding the RGs. This finding is consistent with the presence of fill material when the former pond was backfilled and regraded (Section 2.2.1).

The estimated area to be remediated is 95,157 square feet, as shown on Figure 4, which excludes the NTCRA area. For purposes of volume and cost estimation, it is assumed that COC concentrations in the upper 2 feet of soil are less than the RGs and thus can be placed back on site without treatment. During the NTCRA, the average depth at which competent shale and/or groundwater was encountered was approximately 8 feet below the surface. The depth of 8 feet is also approximately 3 feet below the depth of the former pond bottom. The soil at a depth of 5 feet to 8 feet (i.e., below the former pond bottom) is assumed to be contaminated via leaching. Therefore, the volume of soil with COC concentrations that exceed RGs and requires remediation is 21,146 cubic yards (CY). This includes all soil within the remediation area (excluding the NTCRA area) at a depth range of 2 to 8 feet bgs (Shaw, 2013b).

No nitroaromatics or other chemicals interpreted as potentially site related were detected in any surface water or sediment samples associated with the PRRWP Area.

3.2 WARWP Area

As presented in Section 2.2.2, the WARWP Area included two unlined ponds that had consisted of approximately 7 acres during PBOW operations. The area adjacent to the pond is vegetated with mown grass, moderate forest, and mature forest. The west pond, together with residual water in the east pond (near the former berm), comprises approximately 3.5 acres. The area adjacent to the pond is vegetated with mown grass, moderate forest, and mature forest. The WARWP Area is not used by NASA, and no buildings are present. At present, the east pond is typically dry, with the exception of localized water near the location of the former berm.

Nitroaromatics were observed infrequently and only at low concentrations in WARWP Area environmental media. Consequently, no COCs were identified for the WARWP Area, and no remedial actions are recommended for the WARWP Area.

4.0 Scope and Role of the RWP Areas

One of DOD's specific goals for DERP-FUDS is to reduce risk to human health and the environment through implementation of effective, legally compliant, and cost-effective response actions. To that end, the environmental investigation of PBOW has been divided into 18 DERP-FUDS projects, to address the potential concerns presented by each area associated only with former DOD activities as mandated under DERP-FUDS. Separate closeout documents are required for each of the 18 DERP-FUDS projects. This current Proposed Plan specifically addresses only the RWP Areas (DERP-FUDS Project No. G05OH001820).

Once a DERP-FUDS site is closed out, NASA and the GSA may decide to make that site property available to public or private interests. This proposed plan focuses only on the RWP Areas, exclusive of the groundwater underlying the RWP Areas, which is covered under a separate DERP-FUDS project and separate decision document, as described below.

Currently, soil cleanup actions that have led to site closeout or that are expected to lead to site closeout once completed have been or are being implemented by the USACE under three other PBOW DERP-FUDS projects. Soil actions at two additional DERP-FUDS projects have been proposed; once implemented and complete, these are likewise expected to lead to site closures. Three other DERP-FUDS project sites have been closed out under no further action with State concurrence. Also, a decision for no further action concerning groundwater underlying the TNT and RWP Areas was signed 21 July 2014; this will lead to site closeout for that DERP-FUDS project. The status of the RWP Areas (DERP-FUDS Project No. G05OH001820) is presented in the following paragraph.

Red Water Pond Areas. An FFS for the RWP Areas soil was completed in December 2002. Remedial alternatives were developed and evaluated for PRRWP Area soil in the FFS because the human health risks associated with PRRWP Area soil were determined to be unacceptable under unrestricted land use. Because human health and ecological risks for WARWP Area soil were determined to be within acceptable levels for unrestricted land use, it was not necessary to develop remedial alternatives for the WARWP Area soil. An Action Memorandum was presented to the public in September 2002 for a NTCRA regarding PRRWP Area soil (USACE, 2003). An interim removal action at the PRRWP Area began in January 2003 under the NTCRA. During the NTCRA soil removal, the need for additional soil sampling was recognized, based on the discovery of a dark layer of contaminated soil. A windrow composting action was selected to remediate this soil under the NTCRA, which effectively reduced TNT concentrations in treated

soil to meet the NTCRA cleanup goal (see Section 2.2.1). Composting began in 2007 and was completed in September 2008. Post-NTCRA delineation sampling was performed in spring and summer 2009. Because of residual human health risks associated with non-TNT nitroaromatics detected in the post-NTCRA samples, additional delineation sampling was completed in November 2010. A final FFS Addendum that includes the additional delineation data and risk evaluation was submitted in May 2013. This Proposed Plan represents the next step in the FUDS site closure process.

TNT and RWP Areas Groundwater. A BHHRA of groundwater associated with the three former TNT Areas and two former RWP Areas was finalized in September 2006, and a feasibility study (FS) for groundwater associated with these areas was finalized in December 2008. An addendum to the groundwater FS was finalized in July 2011, and a Proposed Plan for no remedial action specific to groundwater was presented to the public on March 29, 2012. A Decision Document is currently being drafted, and a final no-action Decision Document is anticipated to be signed in 2014.

5.0 Summary of Potential Site Risks

A BHHRA and an ecological risk assessment were performed for PRRWP Area and WARWP Area soil, surface water, and sediment. Note that this BHHRA was conducted prior to implementation of the NTCRA. The results of these evaluations are summarized below. Additionally, a human health risk-based evaluation was performed on the post-NTCRA delineation samples, which were collected subsequent to the BHHRA and ecological risk assessments. The results of the delineation sample evaluation are also summarized in this chapter.

5.1 Human Health Risks

The BHHRA evaluated potential risks under the following potential human receptor scenarios (exposure pathways evaluated in parentheses):

- Long-term indoor worker (ingestion of surface soil; inhalation of indoor air concentrations originating from soil)
- Long-term groundskeeper (ingestion of surface soil; dermal exposure to surface soil; inhalation of particulates)
- Shorter-term construction worker (ingestion of total soil/sediment; dermal exposure to total soil/sediment; inhalation of particulates; dermal exposure to surface water)
- Long-term future resident (ingestion of total soil/sediment; dermal exposure to total soil/sediment; inhalation of particulates; incidental dermal exposure to surface water).

Figure 5 depicts the exposure pathways evaluated for each receptor in the BHHRA. Groundwater pathways are shown on Figure 5 to depict all potentially complete exposure pathways. However, groundwater risks are not summarized in this section, because as described in Chapter 2.0, groundwater is being addressed as a separate FUDS project in a separate proposed plan.

The incremental lifetime cancer risks (ILCR) that could result from a reasonable maximum exposure to potential carcinogenic (cancer-causing) chemicals detected in RWP Area environmental media were determined under each human receptor scenario. The risks from each chemical and exposure pathway (e.g., ingestion of soil, dermal exposure to soil, and inhalation of dust) were summed to calculate the combined risks to the individual receptor. The NCP states that acceptable exposure levels are generally concentrations that represent an excess upper bound lifetime cancer risk (or ILCR) to an individual between 1×10^{-6} (one in one million) and 1×10^{-4} (one in ten thousand). This range is referred to hereinafter as the "risk management range." ILCR values less than this range are regarded as "de minimis," or negligible. The ILCR results are also

compared to the PBOW cancer risk goal of 1×10^{-5}, which represents the logarithmic midpoint of the NCP risk management range. The PBOW ILCR goal is also an Ohio EPA policy which states that the 1×10^{-5} excess cancer risk level is "…to be used as both the level of acceptable excess cancer risk ... and for the development of remediation goals for a site" (Ohio EPA, 2009). This 1×10^{-5} ILCR level has been consistently applied to all PBOW sites for more than a decade, both as a basis for remedial action and for deriving cleanup goals.

Noncancer human health effects were characterized by estimating chemical-specific hazard quotients (HQ). The sum of the HQs for all contaminants that affect the same system of the body (e.g., liver, central nervous system) across all pathways is the hazard index (HI) for a particular receptor. As stated in the NCP, acceptable exposure levels for systemic toxicants (i.e., noncancer effects) are represented by concentration levels to which a human population may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety. Consistent with USEPA risk assessment guidance, this is generally determined by a comparison of the calculated HI to a value of 1. An HI value greater than 1 indicates a possible concern for potential adverse health effects; HI values equal to or less than 1 indicate that adverse health effects are unlikely. The overall ILCR and HI values for each environmental medium and each receptor are summarized in Table 1 for the PRRWP Area and in Table 2 for the WARWP Area. The following conclusions are drawn from the BHHRA results and uncertainty evaluation.

5.1.1 PRRWP Area Conclusions

- The site-related total ILCR (6×10^{-7}) from all groundskeeper exposure pathways to surface soil is within the risk management range and meets the PBOW ILCR goal. The site-related total HI (0.06) is less than the acceptable value of 1.
- The site-related total ILCR (3×10^{-7}) from oral exposure to surface soil and dust by the indoor worker is below the risk management range and meets the PBOW ILCR goal. The site-related total HI (0.03) is less than the acceptable value of 1.
- The site-related total ILCR (1×10^{-5}) from all construction worker exposure pathways to surface and subsurface soil is within the risk management range and meets the PBOW ILCR goal. The site-related total HI (104) exceeds the acceptable value of 1. The construction worker HI is virtually entirely associated with TNT.
- The site-related total ILCR (9×10^{-4}) from all future resident exposure pathways to surface and subsurface soil exceeds the risk management range and the PBOW ILCR goal. The site-related total HI (358) exceeds the acceptable value of 1. The resident HI and ILCR are virtually entirely associated with TNT.

- The sediment ILCR values for the construction worker (1×10^{-7}) and resident (2×10^{-7}) are less than the risk management range and the PBOW ILCR goal. The respective sediment HI values for these receptors (0.04 and 0.003) are less than the acceptable criterion of 1.
- No chemicals in surface water were identified for further evaluation in the BHHRA screening process, indicating that chemicals in surface water associated with the PRRWP Area are unlikely to contribute appreciably to risks of any potential receptor.

In summary, predicted levels of exposure to site-related chemicals in PRRWP Area combined surface and subsurface soil would have resulted in unacceptable levels of cancer risk and noncancer hazard to an on-site resident if the NTCRA had not been implemented. Exposure levels would likewise have resulted in unacceptable noncancer hazards to a construction worker without implementation of the NTCRA, but the construction worker cancer risks would have been at an acceptable level. Both cancer and noncancer risks to the groundskeeper and indoor worker would have been at acceptable levels, even if the NTCRA had not been performed. Results of the BHHRA are interpreted as indicating that site surface water and sediment would not pose any unacceptable human health risks.

The BHHRA results were used to identify TNT as the only chemical of concern (COC) for PRRWP Area soil. A COC is a site-related chemical that is at a sufficiently high concentration to require a response action. The BHHRA process was used to derive a residential-based cleanup goal of 13.8 mg/kg during the NTCRA for TNT (Section 2.2.1). No COCs were identified for surface water or sediment.

5.1.2 WARWP Area BHHRA Conclusions:

- The site-related total ILCR (7×10^{-6}) from all groundskeeper exposure pathways to surface soil is within the risk management range and meets the PBOW ILCR goal. The site-related total HI (0.01) is less than the acceptable value of 1.
- The site-related total ILCR (4×10^{-8}) from oral exposure to surface soil and dust by the indoor worker is below the risk management range and the PBOW ILCR goal. The site-related total HI (0.0003) is less than the acceptable value of 1.
- The site-related total ILCR (6×10^{-7}) from all construction worker exposure pathways to surface and subsurface soil is below the risk management range and the PBOW ILCR goal. The site-related total HI (0.2) is less than the acceptable value of 1.
- The site-related total ILCR (7×10^{-6}) from all future resident exposure pathways to surface and subsurface soil is within the risk management range and meets the PBOW ILCR goal. The site-related total HI (0.6) is less than the acceptable value of 1.

- The surface water ILCR values for the construction worker (2×10^{-8}) and resident (4×10^{-7}) are less than the risk management range and the PBOW ILCR goal. The respective surface water HI values for these receptors (0.09 and 0.04) are less than the acceptable criterion of 1.

- The sediment ILCR values for the construction worker (2×10^{-7}) and resident (3×10^{-7}) are less than the risk management range and the PBOW ILCR goal. The respective surface water HI values for these receptors (0.07 and 0.005) are less than the acceptable value of 1.

In summary, predicted levels of exposure to site-related chemicals in surface and subsurface soil, surface water, and sediment would not result in unacceptable levels of cancer or noncancer risk for any receptor. Therefore, no COCs were identified and no response action is required for the WARWP Area.

5.2 Ecological Risks

An ecological risk assessment, consisting of a screening-level ecological risk assessment (SLERA) and a baseline ecological risk assessment (BERA), was performed for the two RWP Areas (IT, 2000; 2001). The SLERA and BERA for the PRRWP Area were performed prior to performance of the NTCRA. A SLERA is performed to determine whether contamination associated with a site may adversely affect ecological receptors and necessitate a BERA.

The SLERA performed for the PRRWP Area and WARWP Area includes the following steps: problem formulation, exposure characterization, ecological effects characterization, and risk characterization. As part of the problem formulation step, both terrestrial and aquatic assessment receptors were identified to represent a variety of avian and mammalian receptor types and functions. The seven terrestrial assessment receptors and two aquatic assessment receptors quantitatively evaluated in the SLERA for exposure to site media are as follows:

Terrestrial Assessment Receptors

- Deer mouse (*Peromyscus maniculatus*, small omnivorous mammal)
- Short-tailed shrew (*Blarina brevicauda*, small insectivorous mammal)
- Eastern cottontail rabbit (*Sylvillagus floridanus*, medium-sized herbivorous mammal)
- Marsh wren (*Cistothorus palustrus*, small insectivorous bird)
- White-tailed deer (*Odocoileus virginianus*, large herbivorous mammal)
- Raccoon (*Procyon lotor*, medium-sized omnivorous mammal)
- Red-tailed hawk (*Buteo jamaicensis*, large carnivorous bird).

Aquatic Assessment Receptors

- Raccoon (*Procyon lotor*, medium-sized omnivorous semiaquatic mammal)
- Mallard duck (*Anas platyrhynchos*, avian aquatic omnivore).

A simplified terrestrial food web conceptual site model is provided as Figure 6, and a simplified aquatic food web conceptual site model is provided as Figure 7. No federal threatened or endangered species have been observed on site, but the marsh wren was selected as a surrogate species for the sedge wren (*Cistothorus platensis*), an Ohio endangered species that has been observed within a 2-mile radius of the PBOW facility. Areas of wetland vegetation were observed in both RWP Areas.

A predictive risk estimate was performed for each RWP Area using the seven terrestrial and two aquatic assessment species, assuming exposure to each chemical of potential ecological concern (COPEC) in the respective environmental media.

Based on the results of the RWP Areas SLERA, a BERA was subsequently performed for the PRRWP Area and WARWP Area. The BERA represents a refinement of the SLERA. For the RWP Areas BERA, this refinement included the collection and evaluation of tissue studies to derive bioconcentration factors, toxicity testing, and the development of background data sets for surface water and sediment.

The ecological risk assessment predictive estimate results for the PRRWP Area are presented in Table 3, and those for the WARWP Area are presented in Tables 4 and 5. The ecological risk assessment results for each RWP Area, including those for the SLERA and BERA, are summarized in Sections 5.2.1 and 5.2.2.

5.2.1 PRRWP Area Ecological Risk Assessment Conclusions

- Impacts to terrestrial plants appear to be insubstantial.
- Only a low potential for risk from exposure to PRRWP Area soil COPECs was found for terrestrial receptors, and only under the most conservative exposure assumptions.
- No site-related COPECs were determined to be present in surface water or sediment.

5.2.2 WARWP Area Ecological Risk Assessment Conclusions

- Impacts to terrestrial plants appear to be insubstantial.

- Polycyclic aromatic hydrocarbon (PAH) concentrations in one surface soil sample indicated some earthworm toxicity; however, survival was decreased by less than 30 percent. These PAHs may be generated by controlled burning, which is practiced at PBOW, or may be associated with vehicle traffic. Food chain modeling indicates some potential for ecological risk to the shrew associated with PAHs, but only under the most conservative assumptions. Given the weight of evidence, it is unlikely that WARWP Area soils represent an unacceptable concern to ecological populations.

- Iron concentrations in one sediment sample indicated the potential for ecological risk to the raccoon and heron through food chain modeling under the most conservative assumptions. Toxicity study results suggested some toxicity to benthic invertebrates. However, the maximum iron concentration detected in the sediment samples (24,200 mg/kg) likely results from the native background soil which comprises the substrate of the pond. Iron concentrations in PBOW background soil range up to 234,000 mg/kg (mean of 40,100 mg/kg). Thus, there appear to be no site-related impacts from contamination to sediment with regard to ecological receptors in the WARWP Area.

5.3 Delineation Sample Human Health Risk Calculations

As discussed in Chapter 3.0, delineation samples were collected outside of the NTCRA area during 2009 and 2010 in support of the FFS. These samples, which were analyzed for nitroaromatics only, were collected subsequent to completion of the BHHRA and SLERA; thus, the results of the delineation samples are not included in the risk assessment reports.

Although no formal risk assessment was performed on these samples, human health risk assessment calculations were used in the FS based on the results of these and the previously collected samples as a tool to aid in delineating the extent of contamination, as well as in the identification of post-NTCRA COCs. Sample-specific ILCR and HI values were estimated using risk-based levels as described in the site delineation report (Shaw, 2013a). These resulting values were compared to the PBOW ILCR ($ILCR \leq 1 \times 10^{-5}$) and HI ($HI \leq 1$) goals. They are also compared to the NCP risk management range. The following are observed from the risk-based evaluation of the post-NTCRA samples:

- Most of the initial step-out samples (i.e., closest to the NTCRA excavation boundary) had associated sample-specific HI values that exceed the threshold value of 1, with a maximum sample-specific HI value of greater than 1,000. The HI values for 15 of the initial samples were greater than a value of 10.

- Most of the initial step-out samples had associated sample-specific ILCR values that exceed the PBOW goal of 1×10^{-5}, with a maximum sample-specific ILCR value of 3×10^{-2}.

- A total of 30 step-out samples had sample-specific HI values that exceed the threshold criterion of 1.

- A total of 15 step-out samples had sample-specific ILCR values that exceed the PBOW ILCR goal of NCP risk management range of 1×10^{-6} to 1×10^{-4}.
- A total of 54 step-out samples had sample-specific ILCR values that exceed the PBOW ILCR goal of 1×10^{-5}.

It is emphasized that these ILCR values are not intended to represent a risk estimate for any specific locations, but rather they were used collectively as a tool, as described in the site delineation report, to aid in delineating contamination (Shaw, 2013a).

5.4 Basis for Action

It is USACE's current judgment that the Preferred Alternative identified in this Proposed Plan, or one of the other active measures considered in the Proposed Plan, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. No action is necessary for other PRRWP Area environmental media (surface water or sediment) or for the WARWP Area to protect human health or the environment because the RI did not reveal the presence of contamination that would pose a threat to human health and the environment.

6.0 Remedial Action Objective

The following remedial action objective (RAO) was developed in the FFS Addendum for PRRWP Area soil (Shaw, 2013b):

- Prevention of human exposure via direct contact (ingestion, inhalation, or dermal contact) to site soil containing the COCs at concentrations that exceed the RGs, which were developed assuming unrestricted land use.

The PRRWP Area RGs, presented in Table 6, were derived in the FFS Addendum for the COCs. As stated in the RAO, the RGs were developed with the assumption of residential land use. This assumption is appropriate because some of the property formerly owned by the U.S. Government as a buffer area around the PBOW property has been developed as residential property, and the other areas surrounding Plum Brook Station are rural and residential. Thus, if/when the RWP property is excessed, the land will likely be developed as residential.

In general, an RG may be based on an applicable or relevant and appropriate requirement (ARAR) or human health or ecological risks/hazards. Because no chemical-specific ARARs were identified for any of the COCs at the concentrations present, the RG for each PRRWP Area COC is based on human health risk.

The risk-based RGs were designed based on site-specific concentrations such that the cumulative cancer risk (i.e., ILCR) associated with residential exposure to the soil would not result in a cumulative cancer risk that exceeds the target ILCR goal of 1×10^{-5} or the target cumulative noncancer hazard of 1. The USACE is bound by the CERCLA/NCP cancer risk management range of 1×10^{-6} to 1×10^{-4}. The PBOW Project Delivery Team selected a target ILCR goal of 1×10^{-5}, which is the logarithmic midpoint of the cancer risk management range. This target ILCR goal can be used to initially set remediation goals, subject to possible modification in accordance with appropriate risk considerations. It is also noted that the Ohio EPA (2009) uses an ILCR of 1×10^{-5} as a target cancer risk goal. The noncancer RGs were derived so that the sum of the noncancer effects of those chemicals that affect the same target organ does not exceed the target HI goal of 1.

The RGs will be used statistically during excavation and confirmation sampling as part of a risk-based approach to aid in determining whether additional soil removal is required. This will involve the averaging of samples from each excavation and comparing the analytical results to the respective RGs. The exceedance of an RG level in an individual discrete sample will be

acceptable for an area of an excavation as long as the overall excavation site does not exceed the RG. Because Remedial Alternatives 2, 3, and 4 (Chapter 7.0) assume that the upper 2 feet do not require remediation, the RGs will be used as criteria to verify that this material is safe for on-site placement and does not need to be treated and/or disposed. Also, treated materials that meet the RG may be disposed of on site.

RAOs based specifically on ecological risk were not recommended for soil because the ecological risk assessment indicated a low potential for risk to ecological receptors.

7.0 Summary of the Remedial Alternatives

The following four remedial alternatives were developed and evaluated in the FFS Addendum for contaminated soil at the PRRWP Area:

- ***Alternative 1:*** No Action
- ***Alternative 2:*** Excavation and Off-Site Treatment/Disposal
- ***Alternative 3:*** Excavation, Windrow Composting, and Off-Site Disposal
- ***Alternative 4:*** Excavation, Alkaline Hydrolysis, and On-Site/Off-Site Disposal.

Each of the three action-based alternatives (Alternatives 2 through 4) would require the excavation of an estimated 28,195 CY of soil from the location shown on Figure 4 to a depth of 8 feet. The upper 2 feet of this soil is assumed to be clean. Thus, each of these three remedial alternatives includes the excavation of an estimated 7,049 CY of clean soil (0 to 2 feet) and an estimated 21,146 CY of contaminated soil (2 to 8 foot depth). Based on existing soil data from the PRRWP Area soil, an estimated volume of 5,639 CY may be classified as a characteristic hazardous waste due to anticipated 2,4-DNT concentrations, with the remaining 15,507 CY of contaminated soil assumed to be nonhazardous. The actual volume of hazardous soil will be confirmed during remediation through the use of toxicity characteristic leaching procedure (TCLP) testing. If during remediation any of the soil is determined to be nonhazardous based on TCLP results, the material may be disposed of at a nonhazardous waste landfill under Alternatives 2 through 4. Any nonhazardous disposal facility must be approved in advance by the USEPA as an appropriate facility to receive CERCLA waste (40 Code of Federal Regulations 300.440); the Ohio EPA will also be consulted. Unless the hazardous soil is first treated to render it nonhazardous, this material must be disposed of in a Resource Conservation and Recovery Act (RCRA) hazardous waste treatment, storage, and disposal facility (TSDF).

Alternatives 3 and 4 employ treatment technologies, whereas Alternative 2 includes only off-site disposal. The treatment technologies associated with Alternatives 3 and 4 address 2,4-DNT, which is the only COC that is a characteristic hazardous constituent. Whether it is sent off-site for disposal at a nonhazardous waste landfill or a hazardous waste landfill, the treated soil must comply with the land disposal restrictions (LDR) for any underlying hazardous constituents before placement into any land disposal unit. If material treated under Alternative 4 meets the RGs, these materials may be appropriately disposed of on site.

Based on the current data, the excavation is expected to be completed to a maximum depth of 8 feet below the surface. The extent of soil excavation needed to attain the RAO will be confirmed in the field by sampling and analysis of the excavation sidewalls and comparing the sample results to the RGs. Additional soil excavation may be required laterally if indicated by a comparison of the confirmation samples to the RGs. Additional removal of soil to a greater depth is not anticipated because the planned excavation to 8 feet is expected to extend to the water table. Characterization of the excavated soil as hazardous or nonhazardous waste will be confirmed by analysis using TCLP prior to disposal.

Each of the three action-based alternatives will include stockpiling of the upper 2 feet of soil. Before placement on site, this soil will be sampled to verify that it meets RGs and is nonhazardous.

7.1 Alternative 1 – No Action

A no-action alternative is developed as required by the NCP. Under this alternative, no remedial action or monitoring would be conducted for contaminated soil at the site. This alternative fails to meet the RAO for soil at the site.

The following estimated costs and durations are associated with Alternative 1:

Capital Cost: $0 K
Total Operation and Maintenance Costs: $0 K
Present Worth Cost: $0 K
Time to Implement: 0 Months
Time to Achieve RAO: (would not be met in the foreseeable future).

7.2 Alternative 2 – Excavation and Off-Site Treatment/Disposal

This alternative includes excavation of the contaminated soil from the areas depicted on Figure 4, segregation of soil that is hazardous due to elevated levels of 2,4-DNT, off-site treatment/disposal of hazardous soil at a RCRA TSDF, and off-site disposal of nonhazardous soil at a nonhazardous solid waste landfill.

The following estimated costs and durations are associated with Alternative 2:

Capital Cost: $8.6M
Annual Operation and Maintenance Costs: $0
Present Worth Costs: $8.6M
Time to Implement: 25 Months
Time to Achieve RAO: 25 Months.

7.3 Alternative 3 – Excavation, Windrow Composting, and Off-Site Disposal

This alternative includes excavation of the contaminated soil (Figure 4), windrow composting of hazardous 2,4-DNT-contaminated soil, and off-site disposal of the nonhazardous soil and treated material at a nonhazardous solid waste landfill.

Soil that initially fails the TCLP test for 2,4-DNT will be composted until the TCLP criterion for 2,4-DNT is met. Composting will be performed at the existing outdoor area, located adjacent to the PRRWP Area, which is specifically designed for the treatment of contaminated soil. During composting, the contaminated soil will be blended with amendments such as straw and manure, turned occasionally with a windrow compost turner, and kept moist. The nitroaromatic compounds are biodegraded and transformed into less toxic and less mobile compounds through a series of sequential aerobic and anaerobic treatments, which are facilitated by mixing the soil with the amendments and periodic turning of the compost.

After composting, the materials will be disposed of off site at a nonhazardous waste landfill.

The following estimated costs and durations are associated with Alternative 3:

Capital Cost: $9.4M
Annual Operation and Maintenance Costs: $0
Present Worth Costs: $9.4M
Time to Implement: 30 Months
Time to Achieve RAO: 30 Months.

7.4 Alternative 4 – Excavation, Alkaline Hydrolysis, and On-Site/Off-Site Disposal [PREFERRED ALTERNATIVE]

This alternative includes excavation of the contaminated soil (Figure 4), alkaline hydrolysis of hazardous 2,4-DNT-contaminated soil, and off-site disposal of contaminated nonhazardous soil and treated materials that do not meet RGs at a nonhazardous solid waste landfill. Treated materials that meet RGs may be disposed of either off site at a nonhazardous waste landfill, or may be placed on site.

Soils that initially fail the TCLP testing for 2,4-DNT will be treated with an alkaline chemical mixture (e.g., caustic soda) at the existing area designed for soil treatment, located adjacent to the PRRWP Area, until the TCLP criterion for 2,4-DNT is met. Chemicals will be mixed into the soil using an excavator, wheel loader, or compost turner. The nitroaromatics are chemically reacted to less toxic compounds. Alkaline hydrolysis treatment of this soil will continue until the

2,4-DNT TCLP criterion is met. Addition of the alkaline chemicals to the contaminated soil will result in the pH of this material being raised, at least temporarily. Therefore, addition of a neutralization agent (e.g., acetic acid) may be required to lower the pH for on-site disposal or for acceptance by a landfill. It is noted that compliance samples must be at a pH of $\leq$ 10 prior to analysis; thus, the samples must be adjusted if the pH of the treated material is higher than 10 at the time of sampling. The following estimated costs and durations are associated with Alternative 4:

Capital Cost: $8.1M
Annual Operation and Maintenance Costs: $0
Present Worth Costs: $8.1M
Time to Implement: 30 Months
Time to Achieve RAO: 30 Months.

As discussed previously, if chemical addition is not required to neutralize the pH of the material for disposal, a further cost savings may be realized.

8.0 Evaluation of the Alternatives

Each of the remedial alternatives for PRRWP Area soil was evaluated with respect to the following nine criteria, as required by the NCP at 40 Code of Federal Regulations 300.430 (e)(9)(iii). Criteria 1 and 2 are the threshold criteria, which must be met; Criteria 3 through 7 are the primary balancing criteria; and Criteria 8 and 9 are the modifying criteria.

Threshold Criteria

1. Overall Protectiveness of Human Health and the Environment
2. Compliance with ARARs

Primary Balancing Criteria

3. Long-Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment
5. Short-Term Effectiveness
6. Implementability
7. Cost

Modifying Criteria

8. State Support/Agency Acceptance
9. Community Acceptance.

The threshold criteria are requirements that a remedial alternative must meet to be eligible for selection. The five primary balancing criteria are used to determine the trade-offs among alternatives. The modifying criteria are public and state acceptance. Although the public and the State of Ohio have had opportunity for input throughout the RI/FS process for the RWP Areas and have previously accepted these technologies for other PBOW sites, these criteria are not finalized until conclusion of the public comment period on the RWP Areas Proposed Plan.

8.1 Threshold Criteria

Each of the three action-based alternatives (i.e., Alternatives 2 through 4) meets the threshold criteria for protection of human health and the environment and compliance with ARARs. Please note that no ARARs exist for Alternative 2. An ARAR is essentially a cleanup standard, standard of control, or other substantive requirement promulgated under federal environmental or state environmental or facility siting laws that specifically addresses a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site or that addresses problems or situations sufficiently similar to those encountered at the CERCLA site

that their use is well suited to the particular site. These ARARs (Table 7) include the Federal LDRs and the Special Federal Provision for Cleanup–Staging Piles. Alternative 1, no action, does not meet the threshold criterion for protection of human health and the environment. Thus, Alternative 1 is not regarded as viable for the PRRWP Area and is not further discussed in this evaluation of alternatives.

8.2 Primary Balancing Criteria

Alternatives 2 through 4 are equally effective in the long term because the contaminated soil would be treated and/or taken off site. Alternatives 3 and 4 would meet the preference for treatment technologies that result in a reduction in toxicity, mobility, or volume. Alternative 2 relies only on off-site disposal and assumes that, based on existing data, all materials would be treated at a RCRA/Toxic Substance Control Act TSDF to comply with the LDR requirements prior to disposal.

Each of the three action-based alternatives could be performed in 30 months or less upon commencement of field remediation activities. Alternative 2 is estimated to have the shortest duration (25 months). Alternatives 3 and 4 could be performed within the same time frames (approximately 30 months). Alternatives 2 through 4 can all be carried out safely without appreciable risk to remediation workers, NASA employees, or nearby residents. Although Alternative 4 requires the handling of hazardous chemicals (e.g., caustic soda) whereas the other alternatives do not, proper adherence to the safety and health plan that would be developed specifically for whatever alternative is selected allows for safe implementation of each alternative.

Alternatives 2 through 4 represent proven technological approaches, and each is regarded as implementable. Windrow composting, the primary technology of Alternative 3, has been used successfully at PBOW TNTB and at the PRRWP Area during the NTCRA. Alternative 2 is implementable, because it is simply off-site disposal/treatment. Alkaline hydrolysis, which is the primary technology for Alternative 4, has been demonstrated as effective in treating soil contaminated with TNT (greater than 99 percent destruction) and DNTs (approximately 97 percent destruction for 2,4-DNT). Alkaline hydrolysis has been used for contaminated soil from TNTC and TNTA.

Costs of the three action-based alternatives are as follows, from least to most expensive:

- Alternative 4 – $8.1M
- Alternative 2 – $8.6M
- Alternative 3 – $9.4M.

8.3 Modifying Criteria

The two modifying criteria, state acceptance and public acceptance, are not fully evaluated until the Responsiveness Summary of the Decision Document is complete. The evaluation in the Responsiveness Summary is based on state comment on the Proposed Plan, state comment during the public meeting and comment period, and public comment during the public meeting and public comment period.

It is noted that all of the technologies represented by the three action-based alternatives have been presented to the State of Ohio and the public in the past. Neither the State of Ohio nor the public has expressed concern over any of these technologies. Each of these technologies has been subsequently employed at different PBOW sites after opportunity for comment by the public and the State. Also, the Ohio EPA reviewed and had no comments on a draft of this Proposed Plan. However, it is emphasized that evaluation of the modifying criteria for the Preferred Alternative for the RWP Areas will be completed in the Responsiveness Summary of the RWP Areas Decision Document, based on public and State input provided specifically during the RWP Areas public meeting and public comment period.

9.0 Summary of the Preferred Alternative

9.1 PRRWP Area Soil

Alternative 4, Excavation, Alkaline Hydrolysis, and On-Site/Off-Site Disposal, is selected as the Preferred Alternative for PRRWP Area soil.

Alternative 4 is recommended over Alternative 1 because Alternative 1 does not meet the threshold criterion of protecting human health and the environment.

Alternative 4 is recommended over Alternative 2 because it utilizes on-site treatment to satisfy the statutory preference for alternatives that reduce the toxicity, mobility, or volume of contamination through treatment. Alternative 2 does not utilize on-site treatment.

Alternatives 2, 3, and 4 provide equal protection for human health and the environment. However, Alternative 4 ($8.1M) is recommended over Alternatives 2 ($8.6M) and 3 ($9.4 M) because Alternative 4 would cost less to implement.

Based on information currently available, the USACE believes the Preferred Alternative meets the threshold criteria and provides the best balance of trade-offs among the other alternatives with respect to the balancing and modifying criteria. The USACE expects Alternative 4 to satisfy the following statutory requirements of CERCLA Section 121(b): (1) be protective of human health and the environment; (2) comply with ARARs (Table 7); (3) be cost-effective; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element. In addition, the DERP Manual (DOD, 2012) directs that, “The DOD Component should consider and implement green and sustainable remediation opportunities in current and future remedial activities when feasible.” Also, the Army emphasizes the use of best management practices for “… characterization or remedy approaches based on site conditions” (USACE, 2012). Alternative 4 uses green and sustainable remediation in that it allows a beneficial reuse of the treated soil (if RGs can be met) as fill material for the excavation, thus conserving landfill space and reducing vehicle emissions through the reduction of materials that must be disposed of off site. Alternative 4 uses best management practices through the use of different treatment/disposal options for hazardous versus nonhazardous soils. The Preferred Alternative is subject to change after the public comment period as the result of input by the State of Ohio or the public. This change would be reflected in the RWP Areas Decision Document, and the

comments providing the basis for such change would be recorded in the Responsiveness Summary of the Decision Document.

9.2 PRRWP Area Surface Water and Sediment

No action is necessary for surface water and sediment because of negligible to low human health risks and low potential for adverse ecological effects.

9.3 WARWP Area Soil, Surface Water, and Sediment

No action is necessary for this site because of negligible to low human health risks and low potential for adverse ecological effects.

10.0 Community Participation

A level of community relations activities that is consistent with CERCLA, SARA, and the NCP is required for DERP-FUDS projects. The objective of the community relations program at PBOW is to provide a mechanism for the communication and exchange of information among Army agencies, government agencies, and residents of local communities and those adjacent to Plum Brook downgradient from PBOW. In January 1997, a Restoration Advisory Board composed of local citizens with varying backgrounds, along with members from the USACE, NASA, and the Ohio EPA, was established to promote a two-way dialog to keep local citizens informed about site progress and to allow them the opportunity to provide input to DERP-FUDS project decisions. The USACE and Restoration Advisory Board follow the community relations plan (International Consultants, Inc., 1999), which was developed in 1999 and is updated each year.

In compliance with CERCLA (Section 113), the USACE has developed the AR file to provide documentation as to how and why decisions specific to the remediation of the site are made. The AR file contains these final documents as well as all others for the PBOW site. Currently, these final documents are located in the AR file at the USACE Huntington District Office (Huntington, West Virginia) and at the Public Repository located at the Firelands Library, BGSU Firelands Campus (Huron, Ohio). All documents are available for public viewing at the Firelands Library and at the USACE Huntington District Office.

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TABLES

Table 1

Summary of Total Hazard Index and Total Cancer Risk from Site-Related Chemicals of Potential Concern
Pentolite Road Red Water Pond Area[a]
Former Plum Brook Ordnance Works, Sandusky,Ohio

	Groundskeeper		Indoor Worker		Construction Worker		On-Site Resident[b]	
Contaminant Source	Total HI[c]	Total ILCR[d]	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR
Surface Soil	0.063	6.21E-07	0.027	2.82E-07	NA	NA	NA	NA
Total Soil[e]	NA[f]	NA	NA	NA	*104*	1.12E-05	*358*	*8.50E-04*
Surface Water[g]	NA	NA	NA	NA	NA	NA	NA	NA
Sediment[g]	NA	NA	NA	NA	NA	NA	NA	NA
Total across all media[h]	**0.06**	**6E-07**	**0.03**	**3E-07**	***104***	**1E-05**	***358***	***9E-04***

HI = hazard index; ILCR = incremental lifetime cancer risk

[a]Risks and hazards are based on conditions prior to implementation of the Non-Time Critical Removal Action, completed in September 2008.
[b]The BHHRA includes both a childhood and adult resident exposure scenarios. For noncancer effects, the HI value (see footnote c) for childhood exposure is shown for Total HI because it is higher (more health protective) than the adult value from the BHHRA. The Total ILCR (see footnote d) is the summed ILCR values for both child and adult scenarios which, unlike noncancer HI values, are regarded as additive throughout the lifetime of an individual.
[c]The HI is a measure of noncancer hazard for an exposed individual.
[d]The ILCR is the estimated extra cancer risk which an individual encounters based on exposure to a site.
[e]Total soil is combined surface and subsurface soil.
[f]NA = Not applicable.
[g]Summed total HI and ILCR are rounded to one significant figure.
[h]The surface water and sediment were screened out, indicating minimal risk/hazard.

Notes:
1. HI values equal to or less than 1 are unlikely to result in adverse noncancer human health effects for any member of the exposed population and are regarded as acceptable.
2. The PBOW Project Delivery Team uses an ILCR value of 1E-5 (1 in 100,000) as a goal. At this level ILCR values are generally regarded by the Ohio EPA as acceptable.
3. The NCP identifies ILCR values less than 1E-6 (1 in 1,000,000) as negligible, and ILCR values of 1E-6 (1 in 1,000,000) through 1E-4 (1 in 10,000) are within the NCP acceptable range. It is noted that the average lifetime cancer risk of the general U.S. population is approximately 400,000 in 1,000,000 (or 4,000 in 10,000).
4. ***Shaded italics*** indicates that the noncancer hazard is unacceptable, or that the cancer risk value exceeds the NCP acceptable range (1E-6 to 1E-4).

Source: IT, 2000.

Table 2

Summary of Total Hazard Index and Total Cancer Risk from Site-Related Chemicals of Potential Concern
West Area Red Water Ponds Area
Former Plum Brook Ordnance Works, Sandusky, Ohio

	Groundskeeper		Indoor Worker		Construction Worker		On-Site Resident	
Contaminant Source	Total HI[a]	Total ILCR[b]	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR
Surface Soil	0.013	7.09E-06	0.0003	3.85E-08	NA	NA	NA	NA
Total Soil[c]	NA[d]	NA	NA	NA	0.22	5.84E-07	0.62	1.51E-05
Surface Water	NA	NA	NA	NA	0.089	2.28E-08	0.044	4.36E-07
Sediment	NA	NA	NA	NA	0.067	2.14E-07	0.005	3.05E-07
Total across all media[f]	**0.01**	**7E-06**	**0.0003**	**4E-08**	**0.4**	**8E-07**	**0.7**	**2E-05**

[a]The hazard index (HI) is a measure of noncancer hazard for an exposed individual.
[b]The incremental lifetime cancer risk (ILCR) is the estimated extra cancer risk which an individual encounters based on exposure to a site.
[c]Total soil is combined surface and subsurface soil.
[d]NA = Not applicable.

HI = hazard index; ILCR = incremental lifetime cancer risk

[a]Risks and hazards are based on conditions prior to implementation of the Non-Time Critical Removal Action, completed in September 2008.
[b]The BHHRA includes both a childhood and adult resident exposure scenarios. For noncancer effects, the HI value (see footnote c) for childhood exposure is shown for Total HI because it is higher (more health protective) than the adult value from the BHHRA. The Total ILCR (see footnote d) is the summed ILCR values for both child and adult scenarios which, unlike noncancer HI values, are regarded as additive throughout the lifetime of an individual.
[c]The HI is a measure of noncancer hazard for an exposed individual.
[d]The ILCR is the estimated extra cancer risk which an individual encounters based on exposure to a site.
[e]NA = Not applicable.
[f]Summed total HI and ILCR are rounded to one significant figure.
[g]The surface water and sediment were screened out, indicating minimal risk/hazard.

Notes:
1. HI values equal to or less than 1 are unlikely to result in adverse noncancer human health effects for any member of the exposed population and are regarded as acceptable.
2. The PBOW Project Delivery Team uses an ILCR value of 1E-5 (1 in 100,000) as a goal. At this level ILCR values are generally regarded by the Ohio EPA as acceptable.
3. The NCP identifies ILCR values less than 1E-6 (1 in 1,000,000) as negligible, and ILCR values of 1E-6 (1 in 1,000,000) through 1E-4 (1 in 10,000) are within the NCP acceptable range. It is noted that the average lifetime cancer risk of the general U.S. population is approximately 400,000 in 1,000,000 (or 4,000 in 10,000).
4. *Italics* (non-bolded) apply only to cancer risks and indicate that the value exceeds the the 1E-5 PBOW Project Delivery Team goal.
5. ***Bold italics*** indicates that the noncancer hazard is unacceptable, or that the cancer risk value exceeds the NCP acceptable range (1E-6 to 1E-4).

Notes:
1) HI values equal to or less than 1 are unlikely to result in adverse noncancer human health effects for any member of the exposed population and are regarded as acceptable.
2) ILCR values between 1E-6 (1 in 1,000,000) and 1E-4 (1 in 10,000) are generally regarded as acceptable. Risks less than 1E-6 are regarded as very minimal, and risks greater than 1E-4 indicates a need for cleanup (or further study if appropriate). It is noted that the average lifetime cancer risk of the general American population is estimated as about 300,000 in 1,000,000.
3) None of the HI or ILCR values exceed the criteria for acceptability.

Source: IT, 2000.

Table 3

Terrestrial Receptors Ecological Hazard Index Summary for Pentolite Road Red Water Pond Area[a] Former Plum Brook Ordnance Works, Sandusky, Ohio

Media	Terrestrial Receptor						
	Deer Mouse	Rabbit	Shrew	Marsh Wren	Raccoon	Deer	Hawk
Soil[b] EHI[c]	0.06 - 2.7	0.07 - 3.2	0.01 - 0.3	0.01 - 0.5	0.05 - 2.2	0.002 - 0.03	0.0011
Risk Drivers:	94% 1,3-DNB (plant intake for RME)	94% 1,3-DNB (plant intake for RME)	—	—	94% 1,3-DNB (plant intake for RME)	—	—
Surface Water EHI	—[d]	—	—	—	—	—	0.0007
Risk Drivers:	—	—	—	—	—	—	—
Total Receptor EHI	0.06 - 2.7	0.07 - 3.2	0.01 - 0.3	0.01 - 0.5	0.05 - 2.2	0.002 - 0.03	0.0018

[a] Details presented in the ecological risk assessment (IT, 2000; 2001). Ecological hazards are based on conditions prior to implementation of the Non-Time Critical Removal Action, completed in September 2008.

[b] All receptors exposed to surface soil, except burrowing shrew exposed to surface and subsurface soil via ingestion of soil and ingestion of terrestrial invertebrates, and deer exposed to surface and subsurface soil via ingestion of plants (e.g., tree leaves) that have translocated COPEC(s) via deep feeder roots.

[c] Lower end of the range is the CTE EHI; upper end of the range is the RME EHI.

[d] No hazard estimate due to COPEC(s) screened out due to background or low frequency of detection, or COPEC(s) toxicity values not available.

Notes :

(1) EHI values are generally interpreted as follows:
<1 – No probable adverse ecological effects
1 to 10 – Low potential for adverse ecological effects
10 to 100 – Substantial potential for adverse ecological effects
>100 – Highest potential for adverse ecological effects.

(2) CT and RME approach assumptions include differences in the exposure point concentrations; toxicity values; interclass toxicity uncertainty factor; and method of calculation of site-specific soil-to-invertebrate biological accumulation factors.

(3) Risk driver percentage based on intake pathway indicated.

COPEC - Constituent of potential ecological concern.
CTE - Central tendency exposure.
1,3-DNB - 1,3-Dinitrobenzene.
EHI - Ecological hazard index.
RME - Reasonable maximum exposure.

Sources: IT, 2000; 2001.

Table 4

Terrestrial Receptors Ecological Hazard Index Summary for West Area Red Water Ponds Area[a] Former Plum Brook Ordnance Works, Sandusky, Ohio

Media	Terrestrial Receptor						
	Deer Mouse	Rabbit	Shrew	Marsh Wren	Raccoon	Deer	Hawk
Soil[b] EHI[c]	0.006 - 0.5	0.002 - 0.15	0.03 - 2.5	—[d]	0.006 - 0.5	0.0006 - 0.03	0.0013
Risk Drivers:	—	—	100% - PAHs (invertebrate intake)[e]	—	—	—	—
Surface Water EHI	0.003 - 0.3	0.003 – 0.15	0.002 - 0.2	0.01 - 1.0	0.008 - 0.6	0.003 - 0.3	0.0049
Risk Drivers:	—	—	—	—	—	—	—
Total Receptor EHI	0.009 - 0.8	0.005 – 0.3	0.03 - 2.7	0.01 - 1.0	0.01 - 1.2	0.004 - 0.3	0.0062

[a] Details presented in ecological risk assessment (IT, 2000; 2001).
[b] All receptors exposed to surface soil, except burrowing shrew exposed to surface and subsurface soil via ingestion of soil and ingestion of terrestrial invertebrates, and deer exposed to surface and subsurface soil via ingestion of plants (e.g., tree leaves) that have translocated COPEC(s) via deep feeder roots.
[c] Lower end of the range is the CTE EHI; upper end of the range is the RME EHI.
[d] No hazard estimated. COPEC(s) screened out due to background or low frequency of detection, or COPEC(s) toxicity values not available.
[e] PAHs are not regarded as site-related. They were detected in only two soil samples and at low concentrations.

(1) EHI values are generally interpreted as follows:
<1 – No probable adverse ecological effects
1 to 10 – Low potential for adverse ecological effects
10 to 100 – Substantial potential for adverse ecological effects
>100 – Highest potential for adverse ecological effects.
(2) Central tendency and reasonable maximum exposure approach assumptions include differences in exposure point concentrations; toxicity values; interclass toxicity uncertainty factor; and method of calculation of site-specific soil-to-invertebrate biological accumulation factors.
(3) Risk drivers percentage is based on intake pathway indicated.

COPEC - Constituent of potential ecological concern.
CTE - Central tendency exposure.
EHI - Ecological hazard index.
PAH - Polycyclic aromatic hydrocarbon.
RME - Reasonable maximum exposure.

Sources: IT, 2000; 2001.

Table 5

Aquatic Receptor Ecological Hazard Index Summary for West Area Red Water Ponds Area[a] Former Plum Brook Ordnance Works, Sandusky, Ohio

Media	Aquatic Receptor	
	Great Blue Heron	Raccoon
Sediment EHI[b]	0.4 - 26	0.37 - 20
Risk Drivers:	100% Iron (Sediment intake, for RME)	100% Iron (Sediment intake, for RME)
Surface Water EHI	0.002 - 0.2	0.004 - 0.3
Risk Drivers:	—	—
Total Receptor EHI	0.4 - 26	0.4 - 21

[a] Details presented in the ecological risk assessment.
[b] Lower end of the range is the CTE EHI; upper end of the range is the RME EHI.

(1) EHI values are generally interpreted as follows:
<1 – No probable adverse ecological effects
1 to 10 – Low potential for adverse ecological effects
10 to 100 – Substantial potential for adverse ecological effects
>100 – Highest potential for adverse ecological effects.
(2) CTE and RME approach assumptions include differences in exposure point concentrations; toxicity values; interclass toxicity uncertainty factors; and method of calculation of site-specific surface water-to-fish and sediment-to-invertebrate biological accumulation factors.
(3) Risk driver percentage is based on intake pathway indicated.

CTE - Central tendency exposure.
EHI - Ecological hazard index.
RME - Reasonable maximum exposure.

Sources: IT, 2000; 2001.

Table 6

Remedial Goals for Soil
Pentolite Road Red Water Pond Area
Former Plum Brook Ordnance Works
Sandusky, Ohio

COC	RG (mg/kg)	Basis of RG[a]	RSL nc/c[b] (mg/kg)	HQ of RG	ILCR of RG
1,3-Dinitrobenzene	6.1	noncancer hazard	6.1/NA	1	NA
2-Amino-4,6-dinitrotoluene	15[c]	noncancer hazard	150/NA	0.1	NA
4-Amino-2,6-dinitrotoluene	15[c]	noncancer hazard	150/NA	0.1	NA
Combined aminodinitrotoluenes	30[c]	noncancer hazard	NA/NA	0.2	NA
2,4-Dinitrotoluene	5.6[d]	cancer risk	120/0.72	0.05[e]	8E-6
2,6-Dinitrotoluene	1.6[d]	cancer risk	61/0.72	0.03[e]	2E-6
Combined dinitrotoluenes	7.2[d]	cancer risk	NA/0.72	NA	1E-5
1,3,5-Trinitrobenzene	220	noncancer hazard	2200/NA	0.1	NA
2,4,6-Trinitrotoluene	36	noncancer hazard	36/19	1	2E-6
Total HI/ILCR				**1[f]**	**1E-5[g]**

[a] Refer to Section 6.0 of the text for discussion.
[b] RSL values are from U.S. Environmental Protection Agency (EPA), 2011, ***Regional Screening Levels, Supporting Table for Residential Soil***, June, current version on line at www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_tables/index.htm. The noncancer hazard-based RSL supporting values are set at an HQ of 1, and the cancer risk-based RSL supporting values are set at an ILCR of 1E-6.
[c] RG values of 2-amino-4,6-dinitrotoluene (2-ADNT) and 4-amino-2,6-dinitrotoluene (4-ADNT) may alternatively be added (30 mg/kg combined) as the RG for combined ADNT isomers. Please note that the toxicities of these two compounds are evaluated based on the same chronic reference dose and their other chemical-specific parameters are essentially equal.
[d] RG values of 2,4- and 2,6-dinitrotoluene (DNT) may alternatively be added (7.2 mg/kg combined) as the RG for DNT isomers. Please note that these two compounds are evaluated based on the same cancer slope factor and their other chemical-specific parameters are essentially equal.
[e] RG derived on the basis of carcinogenicity of dinitrotoluene mixture; noncancer effects are *de minimis* (HQ<0.1).
[f] The total HI is rounded to one significant figure and considers additivity of COCs affecting the same target organ. The target organ of TNT is the liver and is assumed to be additive with the noncancer effects of 2,4-DNT (biliary tract), 2,6-DNT (liver), and the aminodinitrotoluene (ADNT) isomers (biliary tract). The noncancer effects of TNT are not additive with those of the other COCs (i.e., 1,3-dinitrobenzene [1,3-DNB] and 1,3,5-trinitrobenzene [1,3,5-TNB]), because the other COCs have different target organs with respect to their critical effects. The maximum HI at the respective RGs for TNT, the DNT isomers, and the ADNT isomers is 1.28 prior to rounding. 1,3-DNB affects the spleen and its effects are regarded as additive with 1,3,5-TNB, which also shares this same target organ. The HI at the respective RGs for 1,3-DNB and 1,3,5-TNB would be 1.1 prior to rounding.
[g] The total ILCR considers the cancer effects of all carcinogenic COCs, which includes the DNT isomers and TNT. The total ILCR at the respective RGs is 1.2E-5 prior to rounding.

COC - Chemical of concern.
HI - Hazard index; sum of HQ values.
HQ - Hazard quotient.
ILCR - Incremental lifetime cancer risk.
mg/kg - Milligrams per kilogram.
NA - Not applicable.
RG - Remedial goal.
RSL - Regional screening level.
nc/c - Noncancer hazard-based value/cancer risk-based value.

Table 7

Applicable and Relevant or Appropriate Requirements for Remedial Action
Pentolite Road Red Water Pond Area
Former Plum Brook Ordnance Works
Sandusky, Ohio

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
U.S. Environmental Protection Agency	Soil	Federal Land Disposal Restriction Alternative Treatment Standards for Contaminated Soil (40 CFR 268.49)	Applicable	Rules specify treatment standards for contaminated soil that contains a hazardous waste.	Remedial alternatives will comply with the treatment standards for contaminated soil that is placed back on site if the soil is managed outside the contiguous area of contamination.
U.S. Environmental Protection Agency	Soil	Federal Special Provisions for Cleanup – Staging Piles (40 CFR 264.554)	Applicable	Rule identifies requirements for temporary storage of solid, non-flowing hazardous remediation waste that is not in a containment building.	Remedial alternatives will comply with these requirements by observing the standards and design criteria for staging piles.

CFR – Code of Federal Regulations.

FIGURES

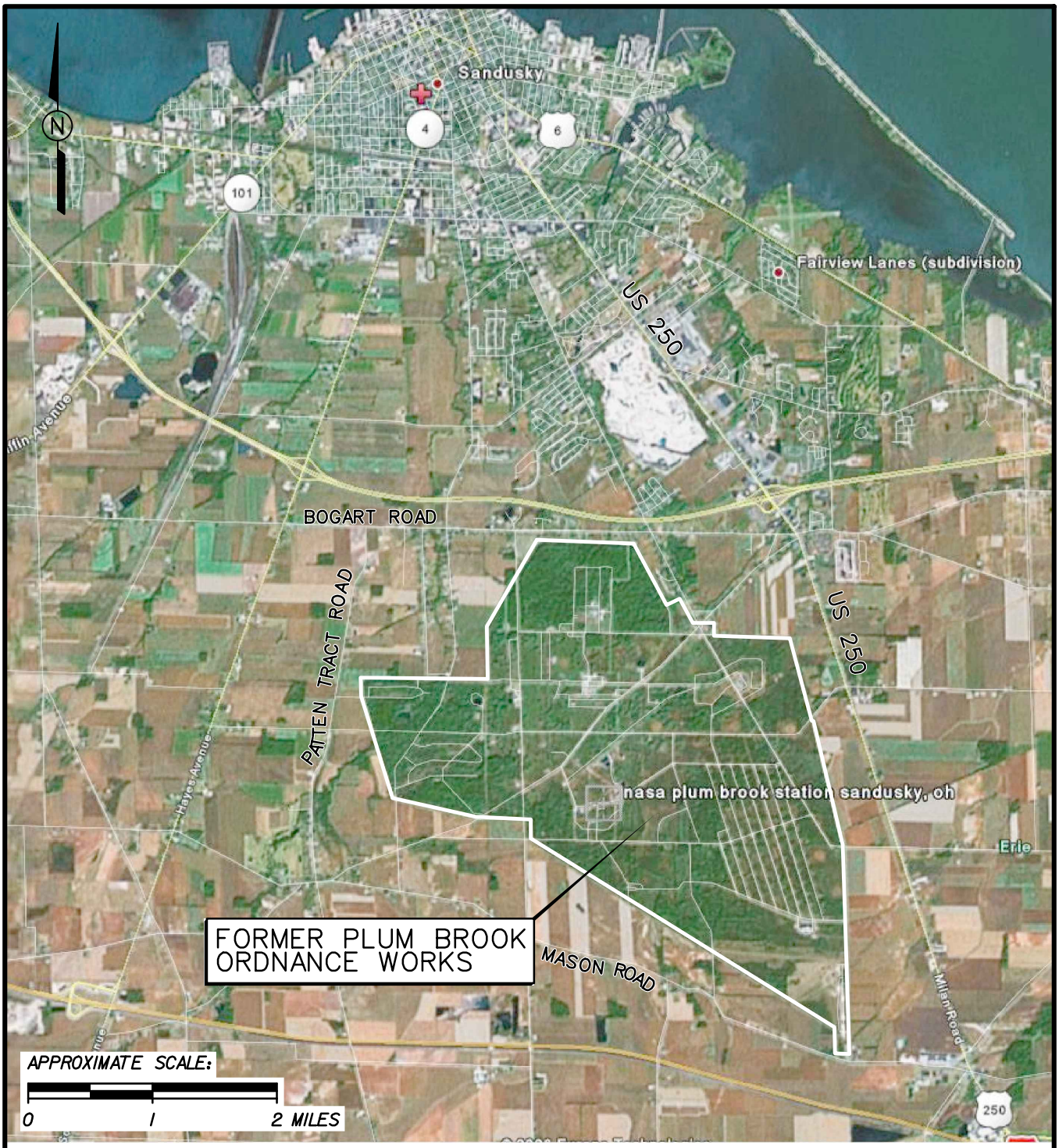

FIGURE 1
PBOW VICINITY MAP

RED WATER POND AREAS
PROPOSED PLAN
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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NOTES:

1. SNAKE ROAD BURNING GROUND AREA WAS ALSO REFERRED TO AS "SNAKE ROAD BURN PIT", "SCHEID ROAD BURNING GROUNDS", AND "DISPOSAL AREA THREE".
2. FORMER REACTOR FACILITY CONSTRUCTED BY NASA POST WWII AND IS IDENTIFIED FOR LOCATION PURPOSES ONLY. DEMOLITION OF THE REACTOR WAS COMPLETED BY NASA IN 2012.

LEGEND:

- AREA OF CONCERN
- APPROXIMATE LOCATION OF SEWER LINES
- POND
- CREEK, DITCH, CONVEYANCE
- FORMER RAILROAD
- ROAD
- FENCE
- FACILITY BOUNDARY

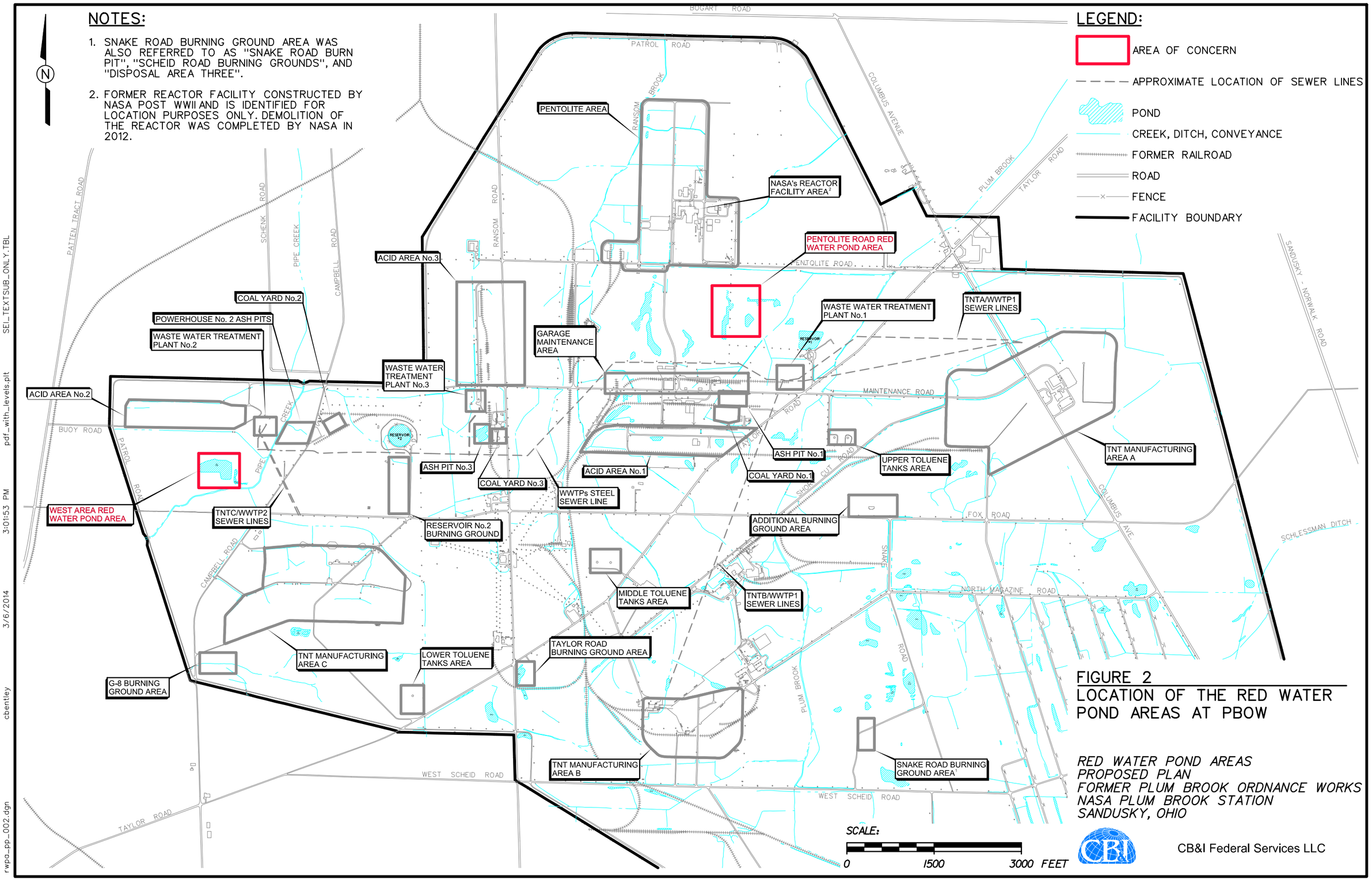

FIGURE 2
LOCATION OF THE RED WATER POND AREAS AT PBOW

RED WATER POND AREAS
PROPOSED PLAN
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

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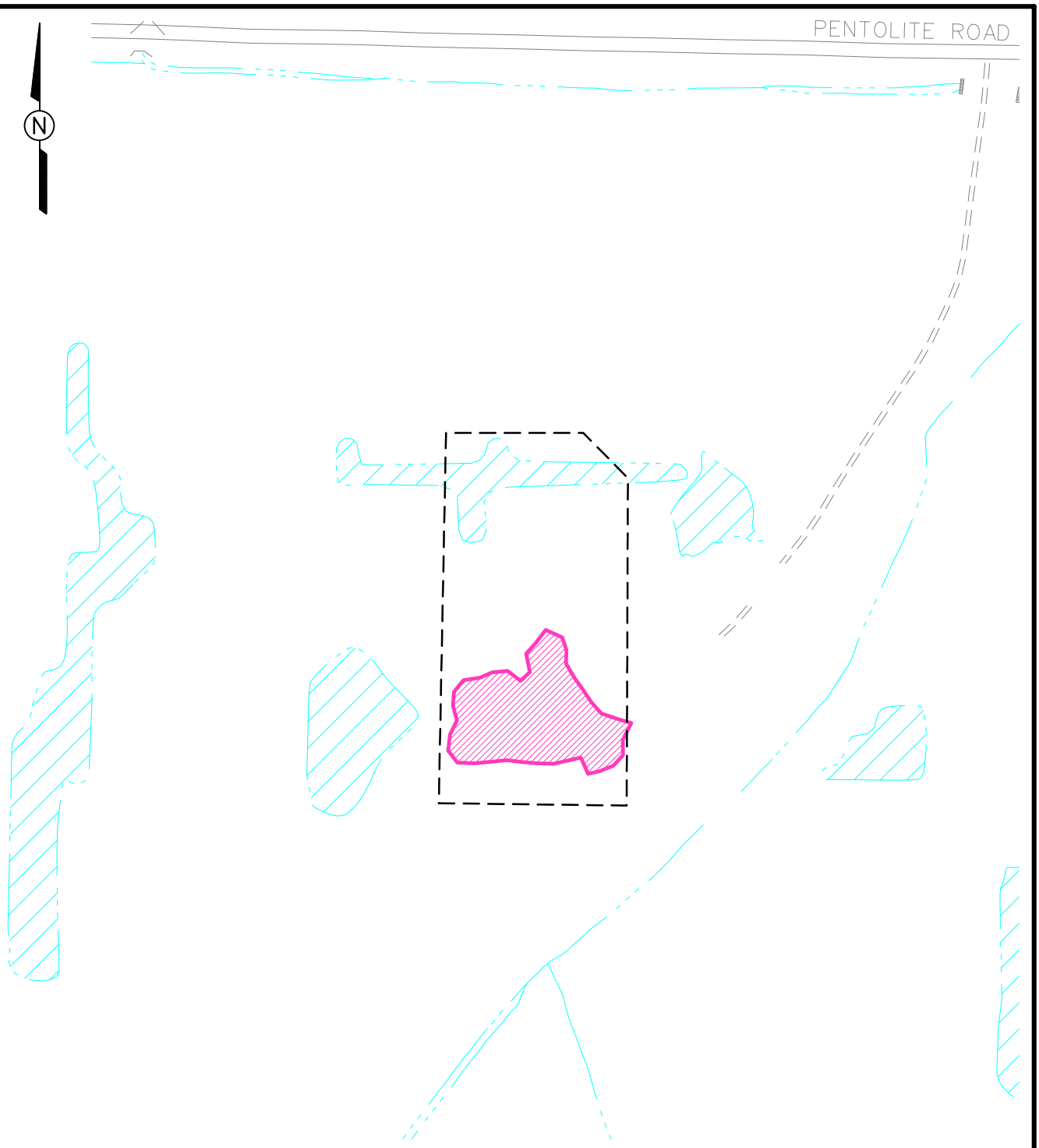

LEGEND

- APPROXIMATE HISTORICAL LOCATION OF POND
- CREEK, DITCH, CONVEYANCE
- POND, SURFACE WATER
- COMPLETED TNT SOIL REMOVAL AREA

SCALE:

0 200 400 FEET

FIGURE 3

LOCATION OF THE PRRWP AREA NONTIME CRITICAL REMOVAL ACTION EXCAVATION

RED WATER POND AREAS
PROPOSED PLAN
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

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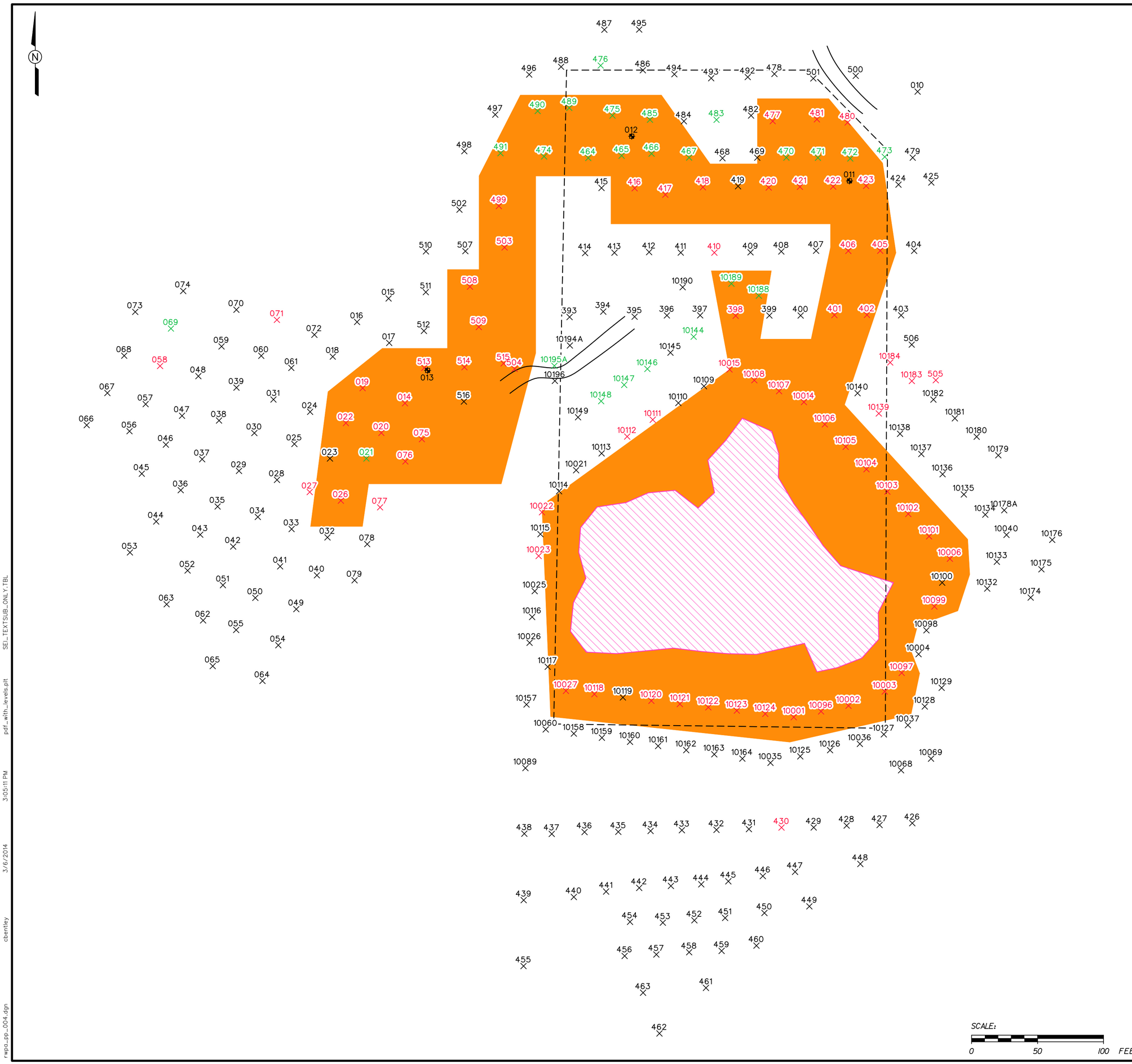

LEGEND:

- INTERPRETED EXTENT OF POND BASED ON AN HISTORICAL DRAWING
- GRAVEL ROAD
- SURFACE DRAINAGE
- SURFACE WATER
- COMPLETED TNT SOIL REMEDIATION AREA FOR NONTIME CRITICAL REMOVAL ACTION
- SHALLOW SOIL BORING LOCATION (SEE NOTE 3)
- "BLACK" SAMPLE LOCATION: NO REMEDIAL GOAL (RG) EXCEEDANCES
- "RED" SAMPLE LOCATION: AT LEAST ONE RG EXCEEDANCE
- "GREEN" INDICATES LOCATION WHERE ONLY SCREENING DATA WERE COLLECTED AND THE TOTAL NITROAROMATICS CONCENTRATION EXCEEDS 10 mg/kg (SEE NOTE 5)
- SOIL BERMS
- ESTIMATED EXTENT OF SOIL REQUIRING REMEDIAL ACTION

NOTES:

1. LOCATION OF SAMPLE 10194A IS APPROXIMATE.
2. NUMEROUS OTHER LOCATIONS WERE STAKED BUT, BASED ON TEST KIT SCREENING AND/OR LABORATORY RESULTS OF SAMPLES AT ADJACENT LOCATIONS, THE FIELD TEAM DETERMINED THAT SAMPLE COLLECTION WAS NOT NECESSARY. TEST KIT RESULTS FOR TOTAL NITROAROMATICS CONCENTRATIONS ARE PRESENTED ON FIGURE 5-1 OF THE SITE DELINEATION REPORT (SHAW 2013a).
3. SHALLOW SOIL BORING SAMPLES WERE COLLECTED AT 0-3 FT. BELOW GROUND SURFACE (BGS). OTHER SAMPLES WERE COLLECTED AT 0-10 FT. BGS OR 1-10 FT. BGS.
4. RG EXCEEDANCES AT LOCATIONS OUTSIDE OF THE ESTIMATED REMEDIAL ACTION AREA ONLY MARGINALLY EXCEED AN RG.
5. BASED ON COMPARISON OF SCREENING DATA TO LAB DATA FROM THE SAME LOCATION, CONCENTRATIONS GREATER THAN 10 MILLIGRAMS PER KILOGRAM (mg/kg) WERE IDENTIFIED AS MORE LIKELY TO HAVE ELEVATED LABORATORY RESULTS. THIS 10 mg/kg VALUE IS NOT REGARDED AS A "BRIGHT LINE" CRITERION, BUT IS A GENERAL OBSERVATION.

Remedial Areas and Volumes

	Remedial Area (SQ FT)	Remedial Depth (FT)	Remedial Volume (BCY)	Remedial Volume (LCY)
Clean Soil	95,157	2	7,049	9,164
Nonhazardous Soil		6	15,507	20,159
Hazardous Soil			5,639	7,331
Total		8	28,195	36,654

Remedial area does not include earlier NTCRA excavation.

FIGURE 4
ESTIMATED EXTENT OF SOIL REQUIRING REMEDIAL ACTION

RED WATER POND AREAS
PROPOSED PLAN
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

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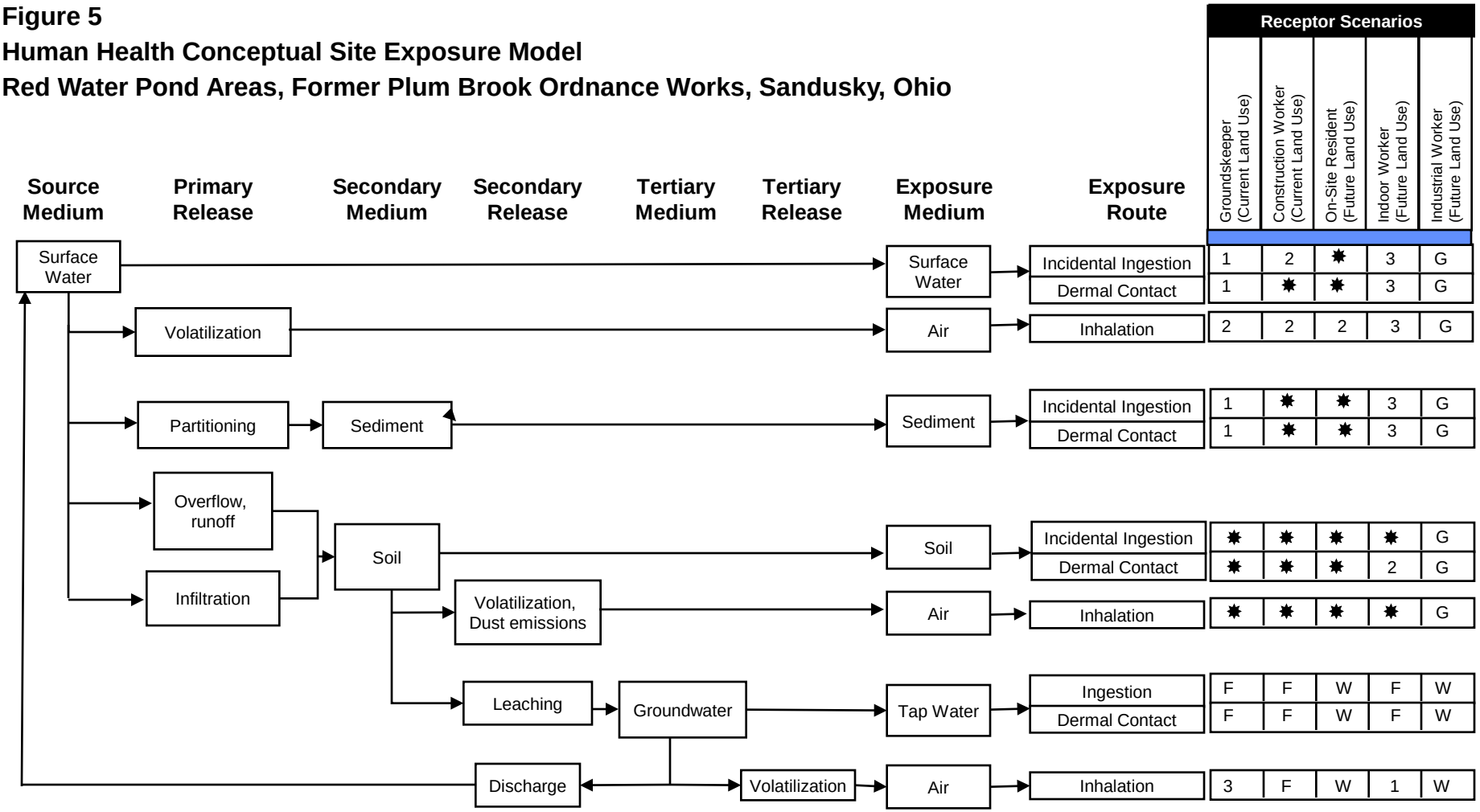
Figure 5
Human Health Conceptual Site Exposure Model
Red Water Pond Areas, Former Plum Brook Ordnance Works, Sandusky, Ohio

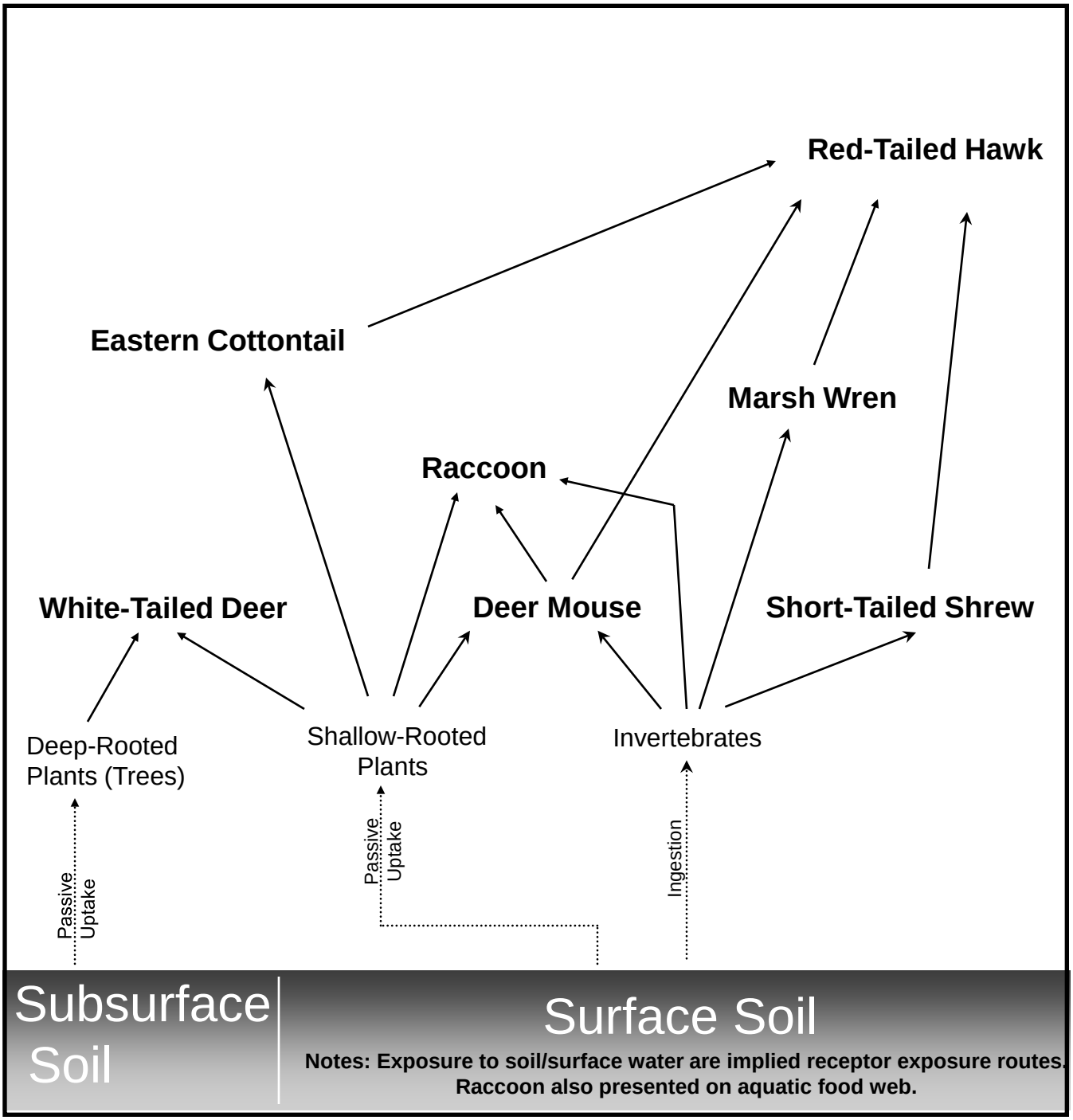


✸ = Complete exposure pathway evaluated in the Red Water Ponds baseline human health (BHHRA) risk assessment.
1 = Contact with this medium, although possible, is not part of this receptor's normal or expected activities; therefore, contact would be sporadic and is not quantified.
2 = Although theoretically complete, this pathway is not quantified as explained in the BHHRA.
3 = There is no plausible pathway for exposure to this medium.
G = Receptor evaluated for exposure to groundwater only; groundwater is not directly addressed in this Proposed Plan.
F = No current exposure. Exposure of future industrial worker to groundwater would be representative of future groundwater exposure for this receptor, but groundwater is not directly addressed in this Proposed Plan.
W = Complete pathway evaluated in the groundwater risk assessment; groundwater is not directly addressed in this Proposed Plan.

Source: IT, 2000.

Figure 6

Simplified Terrestrial Food Web Model
Red Water Pond Areas
Former Plum Brook Ordnance Works, Ohio



Source: IT, 2000.

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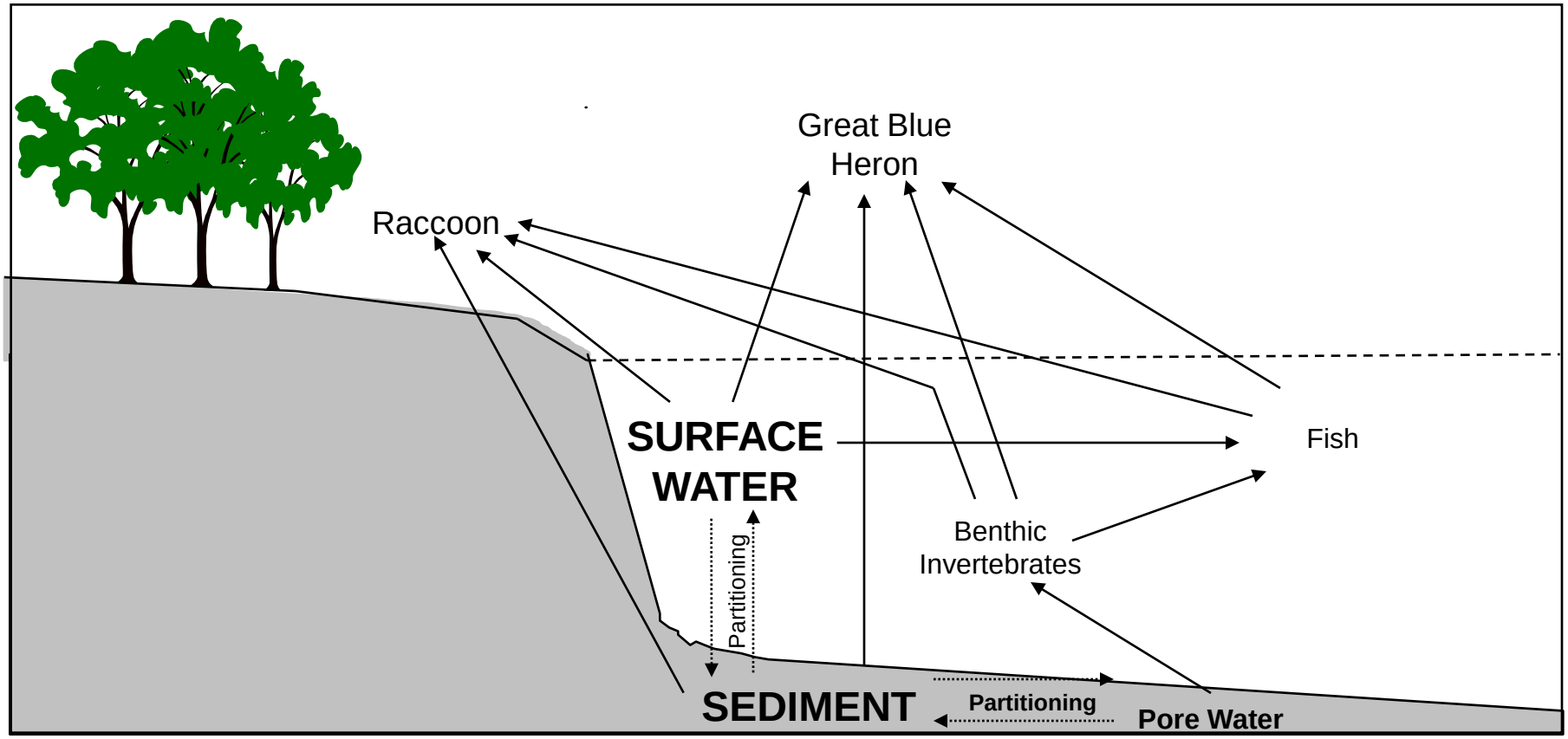
Figure 7

Simplified Aquatic Food Web Model
Red Water Pond Areas
Former Plum Brook Ordnance Works, Ohio



Note: Raccoon also presented on terrestrial food web.

Source: IT, 2000.

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GLOSSARY

Glossary

Administrative Record (AR) – The body of reports, official correspondence, and other documents that establish the official record of the analysis, cleanup, and final closure of a site.

Alkaline Hydrolysis – Involves the addition of an alkaline reagent to increase the pH of nitroaromatic-contaminated soil, thereby promoting the breakdown of nitroaromatic compounds to less toxic reaction products.

Applicable or Relevant and Appropriate Requirement (ARAR) - The federal and state environmental laws that a selected remedy must meet. These requirements may vary among sites and remedial alternatives.

Chemical of Concern (COC) – A chemical that is present at a concentration that warrants a remedial action to address contamination. To be identified as a COC, a chemical's concentration must be resultant from former DOD activities. A chemical may be identified as a COC based on potential adverse human health or ecological effects, or on the basis of noncompliance with a chemical-specific ARAR.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) – CERCLA was enacted by Congress in 1980 and amended by the Superfund Amendments and Reauthorization Act in 1986. CERCLA provides federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites and established the Superfund Trust Fund.

Defense Environmental Restoration Program (DERP)-- The Defense Environmental Restoration Program (DERP) was established to address properties that have been contaminated by Department of Defense activities. This includes the cleanup of Formerly Used Defense Sites (FUDS).

Formerly Used Defense Sites (FUDS) - Facility or site which was under the jurisdiction of the Secretary of Defense and owned by, leased to, or otherwise possessed by the United States at the time of actions leading to contamination by hazardous substances and transferred from DOD control prior to 17 October 1986.

Hazard Index (HI) – A numerical value derived through human health risk assessment calculations by summing the HQ values for multiple chemicals across exposure pathways within an environmental medium for a given human receptor. The HI is used to determine whether exposure level to that medium is likely to result in any adverse noncancer health effects. The HI values from multiple environmental media may be summed to yield the total HI for the receptor.

Hazard Quotient (HQ) – The ratio of the modeled human intake dose rate of a contaminant in an environmental medium (or media), as estimated in the baseline human health risk assessment, to a reference dose rate that has previously been verified as, or otherwise accepted as, unlikely to result in adverse health effects for any individuals. The intake dose rate and the reference dose rate are over a similar exposure time period (e.g., chronic).

Incremental Lifetime Cancer Risk (ILCR) **–** Calculated in human health risk assessment as the incremental or "extra" cancer risk associated with a given exposure scenario that an exposed individual is estimated to incur.

Land Disposal Restrictions (LDR) **–** A federal EPA Program of rules and regulations created by Congress to ensure that toxic constituents present in hazardous waste are properly treated before hazardous waste is land disposed.

Nitroaromatic Compound **–** An aromatic compound containing a nitro ($-NO_3$) substituent. In this report nitroaromatic compounds include toluene compounds containing one or more nitro groups resulting from trinitrotoluene (TNT) manufacturing, including dinitro- and mononitrotoluene by-products. Nitrated benzene compounds are also nitroaromatic compounds.

Non-Time-Critical Removal Action (NTCRA) **–** Non-time-critical removal actions are conducted at Superfund sites when the lead agency determines, based on the site evaluation, that a removal action is appropriate and a planning period of at least six months is available before on-site activities must begin. NTCRAs are intended to address priority risks and reduce the time frames to achieve risk reduction.

Remedial Action Objective (RAO) **–** The RAOs provide a general description of what the remedial action is expected to accomplish.

Remedial Goal (RG) **–** An acceptable contaminant-specific level that is protective of human health and the environment and meets any chemical-specific ARARs that may exist. RGs are site-specific and are established in the Decision Document. They are used to determine the areal extent of a site that must be remediated.

Toxicity Characteristic Leaching Procedure (TCLP) **–** A federal EPA testing protocol that is designed to determine the mobility of organic and inorganic analytes present in liquid, solid, and multiphasic wastes. TCLP is designed to simulate landfill conditions as water and other liquids leach through landfills.

Windrow Composting **–** Use of bulking agents (e.g., wood chips, straw) and nutrient sources (e.g., manure, yard wastes, wood processing wastes) added to soil to sustain microorganisms capable of degrading organic contaminants (e.g., nitroaromatic compounds). The composted materials are maintained in long, narrow rows and watered and turned regularly with a specialized compost turner to promote aeration and control temperature.

ACRONYMS AND ABBREVIATIONS

Common acronyms and abbreviations used in this Proposed Plan are defined below:

AR	Administrative Record
ARAR	applicable or relevant and appropriate requirement
BERA	baseline ecological risk assessment
bgs	below ground surface
BGSU	Bowling Green State University
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (also referred to as "Superfund")
COC	chemical of concern
COPEC	chemical of potential ecological concern
CY	cubic yard
D&M	Dames and Moore, Inc.
DERP	Defense Environmental Restoration Program
DNT	dinitrotoluene
DOD	U.S. Department of Defense
FFS	focused feasibility study
FS	feasibility study
FUDS	Formerly Used Defense Sites
GSA	General Services Administration
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
IT	IT Corporation
LDR	land disposal restriction
mg/kg	milligram per kilogram
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NTCRA	non-time-critical removal action
Ohio EPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works
PRRWP	Pentolite Road Red Water Pond
RADPI	risk assessment and direct-push investigation
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RG	remedial goal
RI	remedial investigation
RWP	Red Water Pond
SARA	Superfund Amendments and Reauthorization Act of 1986
Shaw	Shaw Environmental & Infrastructure, Inc.
SLERA	screening level ecological risk assessment
TCLP	toxicity characteristic leaching procedure
TNT	2,4,6-trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B

TNTC	TNT Area C
TSDF	treatment, storage, and disposal facility
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WAA	War Assets Administration
WARWP	West Area Red Water Ponds