DRAFT FINAL

PROPOSED PLAN
FOR SITE-WIDE GROUNDWATER
FORMER BADGER ARMY AMMUNITION PLANT
BARABOO, WISCONSIN

Prepared for:

U.S. Army Environmental Command
2455 Reynolds Road
JBSA – Fort Sam Houston, TX 78234

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Prepared by:
SpecPro Professional Services, LLC
S7560 U.S. Highway 12
North Freedom, WI 53951

TABLE OF CONTENTS

FIGURES

TABLES

ACRONYMS

1,1,2-TCA	1,1,2-Trichloroethane
2,4-DNT	2,4-Dinitrotoluene
2,6-DNT	2,6-Dinitrotoluene
Army	Department of the Army
ARAR	Applicable or relevant and appropriate requirement
BAAP	Former Badger Army Ammunition Plant
BEST	Biologically Enhanced Subsurface Treatment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as Superfund: Amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA).
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CTET	Carbon Tetrachloride
DBG	Deterrent Burning Ground
DD	Decision Document
DERP	Defense Environmental Restoration Program
DNT	Dinitrotoluene
DoD	Department of Defense
EBS	Enhanced Biodegradation System
ES	Enforcement Standard
EVO	Emulsified Vegetable Oil
FFA	Federal Facility Agreement
FS	Feasibility Study
gpm	Gallons per minute
HHRA	Human Health Risk Assessment
HWTTU	Hazardous Waste Thermal Treatment Unit
IRM	Interim Remedial Measures
LUC	Land Use Control
MCL	Maximum Contaminant Level
MIRM	Modified Interim Remedial Measures
µg/l	Micrograms per liter
mg/l	Milligrams per liter
MNA	Monitored Natural Attenuation
NC	Nitrocellulose
NC Area	Nitrocellulose Production Area
NCP	National Oil and Hazardous Substances Contingency Plan
NG	Nitroglycerin
NR	Natural Resources
NPDWRs	National Primary Drinking Water Regulations
O&M	Operation and Maintenance
PAL	Preventive Action Limit
PBG	Propellant Burning Ground
PP	Proposed Plan

PSTS	Pilot-Scale Treatability Study
RA	Remedial Action
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RSL	Regional Screening Level
SPS	SpecPro Professional Services, LLC
SVE	Soil Vapor Extraction
SVOCs	Semi-volatile Organic Compounds
TCE	Trichloroethene or Trichloroethylene
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources
WAC	Wisconsin Administrative Code
WP&L	Wisconsin Power and Light
WWTP	Wastewater Treatment Plant

PROPOSED PLAN
for Site-Wide Groundwater

Former Badger Army Ammunition Plant
Baraboo, Wisconsin

DATES TO REMEMBER

Public Comment Period: _______ through _________, 2023
The Army will accept written comments on this Proposed Plan by letter or email during the public comment period. See page __ of this Proposed Plan for contact information and the location of the Administrative Record file.

Public Meeting: __________, 2023
The Army will hold a virtual public meeting to explain this Proposed Plan and the remedial alternatives evaluated in the Remedial Investigation/Feasibility Study (RI/FS) and to receive input from the community. Oral and written comments will be accepted at the meeting. The meeting will begin at 6 p.m. See page __ of this Proposed Plan for more information.

1.0 INTRODUCTION

This ***Proposed Plan,*** part of the ***Comprehensive Environmental Response, Compensation, and Liability Act*** (CERCLA) process (Figure 1), identifies the U.S. Army's proposed remedy for Site-Wide Groundwater at the Former Badger Army Ammunition Plant (BAAP). The BAAP is located in Sauk County, Baraboo, Wisconsin (Figure 2).

Site-wide groundwater investigations have identified four groundwater plumes: Central Plume, Deterrent Burning Ground (DBG) Plume, Nitrocellulose Production Area (NC Area) Plume, and Propellant Burning Ground (PBG) Plume.

This Proposed Plan identifies the Army's ***preferred alternative*** for achieving the ***remedial action objectives*** (RAOs) to address contaminated groundwater in the Central Plume, DBG Plume, and the PBG Plume and provides the rationale for this preference. Due to lack of risk, an evaluation of remedial alternatives was not conducted for the NC Area Plume.

Figure 1. Progression of the CERCLA Process

The Army's preferred alternative for the Central Plume, DBG Plume, and PBG Plume is Alternative 4: Active Groundwater Remediation – Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling). Alternative 4 would target remediating the impacted groundwater with elevated dinitrotoluene (DNT) concentrations. The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT). Alternative 4 is also expected to reduce the concentrations of volatile organic compounds (VOCs) that coexist within the targeted treatment areas for DNT. Alternative 4 would include in-situ bioremediation treatment utilizing a mix of permanent injection wells and temporary vertical injection wells to administer the nutrient-enriched emulsified vegetable oil (treatment product) into the contaminant plumes. The vertical injection locations would be located both within the BAAP property boundaries (on-site) and beyond the BAAP property boundaries (off-site). Alternative 4 would also include continued groundwater monitoring, on-site groundwater access restrictions, and a provision for an alternate water supply, where necessary.

This Proposed Plan summarizes the results of investigation activities, scope and role of the response action, and site risks. This Proposed Plan also provides a presentation of the RAOs and a summary of remedial alternatives found in the Remedial Investigation/Feasibility Study (RI/FS) for Site-Wide Groundwater at the Former Badger Army Ammunition Plant (June 2021), and other documents contained in the ***Administrative Record***.

Site documents are available for public review in the Administrative Record File and Information Repositories at two local libraries: Ruth Culver Community Library, 540 Water Street, Prairie du Sac, Wisconsin and George Culver Community Library, 615 Phillips Blvd, Sauk City, Wisconsin. Some of the documents from the Administrative Record are also available online at: https://aec.army.mil/index.php/baap.

The Army is issuing this Proposed Plan (PP) for public review, comment, and participation to fulfill part of its public participation responsibilities under Section 117(a) of the CERCLA of 1980 (42 U.S.C. §9601 et seq.) and under Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)(40CFR Part 300).

Under the Defense Environmental Restoration Program (DERP), the Department of Defense (DoD) has conducted investigation and cleanup activities at BAAP. The DoD Manual, DERP Management, dated March 9, 2012 outlines the policies and procedures the Army must follow when conducting environmental restoration.

The Army is the lead agency responsible for environmental cleanup of BAAP, under the oversight of the Wisconsin Department of Natural Resources (WDNR). This Proposed Plan was prepared in consultation with the WDNR. The WDNR is the lead oversight agency assisting the Army by providing technical support, project review, project comments, and oversight in accordance with CERCLA and the NCP.

After reviewing and considering input submitted during the 30-day public comment period, the Army, in consultation with the WDNR, will select the final remedy and document the decision through a Decision Document (DD). The public is encouraged to review and comment on the preferred alternative and the rationale provided for this preference, and all other presented remedial alternatives summarized in this Proposed Plan and presented in detail in the RI/FS. The Army, in consultation with the WDNR, may modify the proposed cleanup plan or may select another remedial alternative, based on new information or public comments received during the public comment period.

2.0 SITE BACKGROUND

The BAAP is located in south-central Wisconsin and the southeastern section of Sauk County, see Figure 2. The BAAP is located just south of Devil's Lake State Park and the Baraboo Range and approximately ¼ mile northwest of the Wisconsin River and Lake Wisconsin. The nearest cities are the Village of Prairie du Sac, approximately 2 miles to the south, and the City of Baraboo, approximately 4 miles to the north. The BAAP occupied 7,275 acres between State Highway 78 and US Highway 12. The Army has transferred most of the BAAP land to the following entities: Bluffview Sanitary District, Ho-Chunk Nation, United States Department of Agriculture, WDNR, and Wisconsin Department of Transportation. The land retained by the Army is comprised of two cemeteries and totals less than four acres. Currently, land uses at the BAAP are agriculture, grazing cows, industrial, and recreation.

The Army constructed BAAP in 1942 to produce smokeless gunpowder and solid rocket propellant as munition components for World War II (1942 to 1945). Production also occurred during the Korean War (1951 to 1958) and Vietnam Conflict (1966 to 1975). Production of nitric acid, sulfuric acid, oleum, nitrocellulose (NC), and nitroglycerin (NG) occurred in support of munitions components production. Excess hazardous substances were disposed at primarily two locations on-site: the PBG and the DBG. The production and waste disposal practices during operational periods were burning and burial (landfills), and this impacted the groundwater beneath BAAP with multiple contaminants. The main groundwater contaminants are DNT and solvent-related VOCs.

The Army has conducted numerous site investigations and remedial actions at BAAP. Groundwater investigation activities at BAAP began in 1980. Site-wide groundwater investigations identified four groundwater plumes: Propellant Burning Ground (PBG) Plume, Deterrent Burning Ground (DBG) Plume, Central Plume, and Nitrocellulose Production Area (NC Area) Plume. Figure 2 displays the four groundwater plumes in relation to BAAP and the surrounding area.

2.1 Geology

The land surface features at BAAP are the result of glaciation. The terminal moraine, deposited by the leading edge of the last glacier, extends from north to south across the central portion of BAAP. The terminal moraine is visible from the western BAAP boundary as a 40-foot ridge. The Baraboo Range (ancient mountains) rises 500 feet above BAAP to the north. The Wisconsin River and Lake Wisconsin run along the eastern side of BAAP.

Underlying BAAP is approximately 200 feet of glacially deposited sediments. The upper 10 to 90 feet consists of a mixture of sand, silt, clay, and rock fragments (glacial till). Outwash sand and gravel or stream sediment (gravel, sand, or silt) lie beneath the till. Beneath the glacially deposited sediments is a mixture of sedimentary bedrock formations that contain sandstone, shale, siltstone, and dolomite. The Baraboo quartzite underlies the sedimentary formations throughout the BAAP area. Figures 3 and 4 are generalized geologic cross sections that show the thicknesses of the glacial sediments, bedrock layers, and groundwater depth.

2.2 Hydrogeology

Two major groundwater aquifers and one minor aquifer are present beneath BAAP: the surficial sand and gravel aquifer, the sedimentary bedrock (Eau Claire Formation), and the deeper sandstone aquifer (Mt. Simon Formation), respectively. The sand and gravel aquifer and the Eau Claire Formation are un-confined to semi-confined. A shale layer within the Eau Claire Formation acts as an aquitard beneath BAAP. An aquitard is a dense layer of bedrock that restricts groundwater from moving downward into bedrock that is more permeable.

The groundwater surface (water table), beneath BAAP, intersects the sand and gravel aquifer. Groundwater in the sand and gravel aquifer is highly conductive, meaning water flows faster between the soil particles. The high conductivity has created long and narrow groundwater contaminant plumes (see Figure 2). The general direction of groundwater flow is south to southeast, towards the Wisconsin River and Lake Wisconsin. Figure 5 depicts the groundwater contours at BAAP, both on-site and off-site. Lake Wisconsin is located north of the WP&L hydroelectric dam. The dam artificially raises the groundwater surface and influences groundwater flow across BAAP. Groundwater in the northeastern portion of BAAP discharges to Lake Wisconsin. Approximately three miles north of the dam, water from Lake Wisconsin can discharge back to groundwater. The height of water in Lake Wisconsin (774 feet) determines if groundwater recharges the lake. Below the dam, groundwater naturally discharges into the Wisconsin River. The dam has affected the paths of the groundwater contaminant plumes and their proximity to Lake Wisconsin.

3.0 PROPELLANT BURNING GROUND PLUME

3.1 Site Background

The PBG is located in the southwestern portion of BAAP. The PBG source areas are comprised of the following areas: PBG Waste Pits, 1949 Pit, Racetrack Area, and Landfill #1 (see Figure 2). The following sections describe the PBG sources in more detail.

3.1.1 PBG Waste Pits & 1949 Pit

The PBG Waste Pits consisted of three waste pits (WP-1, WP-2, and WP-3) and an open burning area. The Waste Pits were approximately 40 feet in diameter and 12-15 feet deep. The Army used the PBG Waste Pits from approximately 1949 to 1983. DNT and organic solvent-containing materials were disposed of at the PBG through open burning and burial during production periods. Impacted soil contained DNT, polycyclic aromatic hydrocarbons, benzene, carbon tetrachloride (CTET), and trichloroethylene (TCE). The 1949 Pit was a waste disposal area, active between 1949 and 1962, that contains approximately 58,080 cubic yards of construction materials, general waste, and propellant waste. The 1949 Pit was located directly west of the PBG Waste Pits (see Figure 2).

A soil vapor extraction (SVE) system operated at the PBG Waste Pits from 1997 to 1999 to remove solvent-related VOCs from the soil. After achieving satisfactory removal of VOCs, the SVE system was shut down. In 1998, a clay and geomembrane barrier cap was installed above the 1949 Pit. In

1999, approximately 2,280 cubic yards of soil were removed from the Waste Pits. The contaminated soil was incinerated off-site. From 2001 to 2005, the Biologically Enhanced Subsurface Treatment (BEST) system operated at the PBG Waste Pits. The BEST system was an in-situ remedial method that enhanced bacterial degradation of DNT by modifying soil conditions for naturally occurring bacteria. This increased the rate at which the bacteria consumed the DNT compounds. The BEST system extracted contaminated groundwater at each waste pit, treated the water with phosphate, and reinjected it into the soil column above each waste pit. Air injection wells added oxygen to the soil column. After sufficient DNT reductions in the soil and groundwater were observed, the BEST system was removed in 2008. In 2009, the PBG Waste Pits were capped with clay and a geomembrane barrier. This cap was horizontally tied into the cap over the 1949 Pit.

The WDNR requires the Army to maintain and annually inspect the caps over the PBG Waste Pits and 1949 Pit. Cap areas are inspected for erosion, settlement, undesirable vegetation, and other deficiencies. Annual cap and cover maintenance reports are submitted to the WDNR.

3.1.2 Racetrack Area

The Racetrack Area includes the former Hazardous Waste Thermal Treatment Unit (HWTTU) and consisted of an oval gravel road, three refuse pits, and burning plates. Waste propellants and organic solvent-containing materials were disposed at the Racetrack/HWTTU Area through open burning. In 1995, three-fourths of the Racetrack/HWTTU Area were covered with soil to prevent contact with residual lead in the soil. In 1998, contaminated soil from the remaining portion of the Racetrack Area was excavated and transported to an off-site disposal facility.

The WDNR requires the Army to maintain and annually inspect the soil cover over the Racetrack/HWTTU Area. The cover area is inspected for erosion, settlement, undesirable vegetation, and other deficiencies. Annual cap and cover maintenance reports are submitted to the WDNR.

3.1.3 Landfill #1

Landfill #1 is a closed demolition debris disposal facility located east of the PBG that was used between 1942 and 1959. Landfill #1 contains approximately 19,500 cubic yards of ash, slag, asphalt, concrete, wood, and other metallic and nonmetallic wastes. In 1997, a composite cap including two feet of clay and a geomembrane barrier was installed over Landfill #1.

The WDNR requires the Army to maintain and annually inspect the cap over Landfill #1. The cap area is inspected for erosion, settlement, undesirable vegetation, and other deficiencies. Annual cap and cover maintenance reports are submitted to the WDNR.

3.1.4 Groundwater Remediation

Between 1990 and 2015, groundwater remediation was performed in the PBG Plume. Groundwater was pumped from extraction wells in the sand and gravel aquifer, conveyed through underground pipes to treatment buildings, and then treated with granular activated carbon and air stripping. The treated groundwater was pumped through underground piping and then discharged to Lake Wisconsin/Wisconsin River. The extraction wells were located throughout the PBG Plume and within the BAAP boundary. Currently, groundwater contamination is being monitored through recurring sampling as directed by the WDNR.

IRM

The Interim Remedial Measures (IRM) groundwater pump and treat system operated between 1990 and 2012. The IRM pumped between 310 to 350 gallons per minute (gpm) of contaminated groundwater from the PBG Plume. Six extraction wells were located near the PBG Waste Pits and approximately ¾ mile to the south. From 1998 to 2012, only the two extraction wells near the PBG Waste Pits were in operation. In 2012, the WDNR authorized shut down of the IRM due to diminishing returns in groundwater contaminant removal and that further operation would not be cost-effective. In 2014, the IRM extraction wells were abandoned and the IRM building demolished.

MIRM

A second system, the Modified Interim Remedial Measures (MIRM) groundwater pump and treat system, operated between 1996 and 2015. The MIRM pumped between 2,400 to 3,000 gpm of contaminated groundwater from the PBG Plume. From 1996 to 2005, six extraction wells were located along the southern BAAP boundary. These six extraction wells were placed to capture groundwater before it crossed the BAAP boundary to the south. In 2005, optimization of the MIRM extraction well network was performed to remove groundwater contaminants between the PBG Waste Pits and the BAAP boundary. This optimization was intended to reduce the concentration of contaminants in the groundwater. From 2005 to 2015, the MIRM utilized five extraction wells along the middle of the PBG Plume. In 2015, the WDNR authorized shut down of the MIRM citing diminishing returns in groundwater contaminant removal and that further operation would not be cost-effective. In 2016, the MIRM extraction wells were abandoned and the groundwater treatment equipment removed from the MIRM building.

3.2 Groundwater Quality Regulations

Both the USEPA and State of Wisconsin have published groundwater quality regulations related to groundwater. The USEPA has established National Primary Drinking Water Regulations (NPDWRs) that set mandatory water quality standards for drinking water contaminants. These are enforceable standards called "maximum contaminant levels" (MCLs) which are established to protect the public against consumption of drinking water contaminants that present a risk to human health.

Wisconsin Statute Ch. 160, Groundwater Protection Standards, was adopted to minimize the concentration of polluting substances in groundwater through the use of numerical standards in all groundwater regulatory programs. Under Ch. 160, the WDNR must establish state groundwater quality standards based on recommendations from the Wisconsin Department of Health Services. The Wisconsin groundwater standards are published in Chapter NR 140, Wisconsin Administrative Code. Chapter NR 140 references enforceable standards called Enforcement Standards (ESs) and Preventive Action Limits (PALs) for groundwater in Wisconsin. The NR 140 ESs are used to define contaminants of potential concern and areas warranting remedial action. The NR 140 PALs serve to inform the WDNR of potential groundwater contamination problems and to establish the level of groundwater contamination at which the WDNR is required to commence efforts to control the contamination. The NR 140 ES concentrations are equal to or more stringent than the USEPA MCLs. Further references to groundwater standard exceedances will reference the NR 140 ES.

3.3 Groundwater Contamination

As described above, the sources of groundwater contamination are the former PBG Waste Pits, 1949 Pit, Racetrack Area, and Landfill #1. The PBG Plume is approximately 3½ miles long and ½ mile wide and extends south beyond the BAAP boundary. South of BAAP, the plume turns southeast towards the Wisconsin River due to the influence of the WP&L dam. The Army has collected groundwater samples within and surrounding the PBG Plume from 1982 to present, characterizing the nature and extent of groundwater contamination. Groundwater contamination resides mainly in the surficial sand and gravel aquifer. There have been VOCs detected in off-site monitoring wells screened at the top of the bedrock.

Detected concentrations from groundwater samples collected from 2015 to 2018 were compared to the Wisconsin Chapter NR 140 ES and PAL (screening levels). The RI/FS summarized the groundwater data. The following chemicals exceeded the screening levels and identified as contaminants of potential concern (COPCs) for the PBG Plume:

Table 3.1
Groundwater COPCs
Propellant Burning Ground Plume

Contaminants of Potential Concern (COPCs)	Maximum Concentration 2015 - 2018	Chapter NR 140 Wisconsin Groundwater Quality Standards		Well & Date of Maximum Concentration
		Preventive Action Limit (PAL)	Enforcement Standard (ES)	
2,4-Dinitrotoluene [(1)]	33	0.005	0.05	PBN-8202A (5/14/18)
2,6-Dinitrotoluene [(1)]	270	0.005	0.05	PBN-8202A (5/14/18)
Total Dinitrotoluene [(2)]	420.294	0.005	0.05	PBN-8202A (5/14/18)
Bromodichloromethane	0.16	0.06	0.6	PBN-9301C (4/23/18)
Carbon Tetrachloride	29	0.5	5	PBN-9101C (4/9/15)
Chloroform	4.3	0.6	6	PBN-8502A (9/28/15)
Ethyl Ether	6,900	100	1,000	PBN-9304D (4/14/15)
Nitrate	4.6	2	10	PBM-0002 (9/20/17)
Trichloroethene	9.6	0.5	5	PBN-9101C (4/9/15)

Notes:

(1) The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (Total DNT).

(2) Total DNT consists of isomers (2,3-DNT; 2,4-DNT; 2,5-DNT; 2,6-DNT; 3,4-DNT; 3,5-DNT)

All concentration values are expressed in micrograms-per-liter (µg/l)

The PBG Plume shown in Figure 6 represents the area where the groundwater COPCs have been identified above the NR 140 ES or PAL (2015-2018). Figure 6 also displays the current monitoring well and residential well sampling frequencies associated with the PBG Plume.

Historically, CTET, ethyl ether, and TCE have defined the boundaries of VOC contamination. These three VOCs help monitor VOCs migrating from the PBG. All six DNT isomers (2,3-DNT, 2,4-DNT, 2,5-DNT, 2,6-DNT, 3,4-DNT, and 3,5-DNT) have been detected in the PBG Plume. Total DNT concentrations help monitor DNT migrating from the PBG. Figures 7, 8, 9, and 10 are isoconcentration maps for CTET, ethyl ether, TCE, and total DNT, respectively. The isoconcentration maps were prepared using all groundwater data collected during 2018. The green shaded areas indicate where the COPC is above the NR 140 PAL. The blue shaded areas indicate where the COPC is above the NR 140 ES.

The extent of CTET contamination shown on Figure 7 covers the largest area compared to ethyl ether, total DNT, or TCE. CTET concentrations near the PBG sources are lower than areas farther south (downgradient). The highest concentration of CTET, detected in 2018, was in monitoring well PBN-9101C located off-site and near the Wisconsin River.

The extent of ethyl ether contamination shown on Figure 8 is broken into two small areas downgradient of the PBG sources. Ethyl ether is not present near the PBG sources. The highest concentration of ethyl ether, detected in 2018, was in monitoring well SPN-9104D located at the BAAP boundary.

The extent of TCE contamination shown on Figure 9 is narrow but still extends from the PBG sources down to the Wisconsin River. TCE concentrations near the PBG sources are much lower than areas farther south (downgradient). The highest concentration of TCE, detected in 2018, was in monitoring well PBN-9101C located off-site and near the Wisconsin River.

The extent of total DNT contamination shown on Figure 10 is broken into three separate areas, near the PBG, by the BAAP boundary, and near the Wisconsin River. The extensive groundwater pumping may have caused the separation of the total DNT contamination. The total DNT isoconcentrations shown on Figure 10 are broken into three-color designations. The green shaded areas indicate where total DNT is above the NR 140 PAL [0.005 micrograms-per-liter (µg/l)]. The blue shaded areas indicate where total DNT is above the NR 140 ES (0.05 µg/l) but below 1.0 µg/l. The red shaded area displays where total DNT is above 1.0 µg/l. The area closest to the PBG sources contains the highest concentrations of total DNT. The highest concentration of total DNT, detected during 2018, was in monitoring well PBN-8202A located immediately downgradient of the PBG Waste Pits. Total DNT concentrations near the PBG sources increased from 2017 and 2018. A rise in the groundwater table seemed to cause the increased DNT concentrations. Between April 2016 and April 2018, the groundwater table near the PBG Waste Pits rose approximately seven feet.

3.4 Scope and Role of the Proposed Action

The scope and role of the action discussed in this PP includes all the groundwater remedial actions planned for the PBG Plume. The preferred groundwater remedial action will reduce potential risks associated with exposure to contaminated groundwater in the sand and gravel aquifer. Using treatment technologies, this response will reduce the toxicity, mobility, and volume of source materials that constitute the principal threat.

Local residents have historically used groundwater outside the BAAP boundary as a drinking water source. The Army has replaced three residential wells in the PBG Plume due to VOC impacts. Two residential wells were installed in 1990 and one well in 1996. The use of groundwater for human consumption will continue in the future. When establishing the RAOs for this response action, the Army has considered the NCP's expectation to return groundwater to its beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. The Army intends to return the contaminated sand and gravel aquifer at BAAP to its potential beneficial uses, which is considered to be total DNT concentrations below the NR 140 ES, to the extent practicable. If a return to potential beneficial use is not practicable, the expectation is to prevent further migration of the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction.

3.5 Summary of Site Risks

The Army performed a risk assessment to determine and document whether groundwater contamination in the PBG Plume poses a potential current or hypothetical future risk to human health. CERCLA requires the completion of a Human Health Risk Assessment (HHRA) prior to selecting a remedial alternative. The HHRA must evaluate the potential human health risks associated with chemical exposure to environmental media (e.g., groundwater, vapor). The HHRA was conducted using standard USEPA risk assessment guidance, exposure assumptions, and toxicity factors. The USEPA risk assessment process uses conservative assumptions about exposure to chemicals and their toxicity so that risks reported are not underestimated. In all circumstances, priority was given to evaluating the potential human health risk regardless of the impact. The HHRA evaluated two potential human exposure pathways to contaminated groundwater; domestic groundwater uses and vapor intrusion.

Domestic Groundwater Risk

Groundwater located in the PBG Plume and within the BAAP boundary is not used for human consumption. BAAP land was transferred from the Army to other property owners and includes a deed restriction on the use of groundwater. This restricts the potential exposure to groundwater within the boundary of BAAP. These groundwater access restrictions state that the property owner "shall not access or use groundwater underlying the property for any purpose without the prior written approval of the Army and the WDNR."

Residential wells located outside of BAAP use groundwater for potable water and domestic purposes. The potential future use of groundwater adjacent to and downgradient of BAAP is expected to be for potable water and domestic purposes. Residential well users can be exposed to contaminated groundwater through ingestion or drinking of water, inhalation of vapor during showering or dishwashing, and dermal contact while bathing.

Hypothetical future (on-site) risks were evaluated using groundwater data from monitoring wells.

Current (off-site) risks were evaluated using groundwater data from residential wells and monitoring wells. The maximum groundwater concentration of each COPC during 2015, 2016, 2017, and 2018 were used to estimate the risks. Hypothetical future on-site risks apply if groundwater on-site (within BAAP) will be used for domestic water in the future.

The groundwater risk estimates were calculated for each COPC using the maximum groundwater concentrations and a simple scaling method described in Section 2.6.1 of the USEPA's Regional Screening Levels (RSLs) – User's Guide (November 2018). These calculations use the USEPA's RSL Resident Tapwater Generic Table (November 2018).

The results of the HHRA determined that contaminated groundwater in the PBG Plume poses an unacceptable risk to groundwater usage by humans. Domestic groundwater use poses both a current (off-site) and hypothetical future (on-site) risk to human health. Provided below is a summary of exposure risks for the PBG Plume.

PBG Plume

The risk-based contaminants of concern (COCs) identified in the PBG Plume were chloroform, CTET, ethyl ether, TCE, and 2,6-DNT.

- Chloroform had an off-site cancer risk above the risk management criteria. Based on the groundwater monitoring data from 2015 to 2018, chloroform concentrations were below the NR 140 ES. Therefore, remedial alternatives were not evaluated for chloroform.
- CTET had an off-site cancer risk above the risk management criteria. Based on the groundwater monitoring data from 2015 to 2018, CTET concentrations were above the NR 140 ES.
- Ethyl ether had an on-site non-cancer risk above the risk management criteria. Based on the groundwater monitoring data from 2015 to 2018, ethyl ether concentrations were above the NR 140 ES.
- TCE had both an off-site cancer risk and an on-site and off-site non-cancer risk above the risk management criteria. Based on the groundwater monitoring data from 2015 to 2018, TCE concentrations were above the NR 140 ES.
- 2,6-DNT had an on-site and off-site cancer risk plus an on-site non-cancer risk above the risk management criteria. Based on the groundwater monitoring data from 2015 to 2018, 2,6-DNT concentrations were above the NR 140 ES.

Based on the above information, CTET, ethyl ether, TCE, and 2,6-DNT were the COCs considered in the FS for the development of remedial alternatives in the PBG Plume. However, the Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT).

Table 3.2
Groundwater COCs & Cleanup Levels
Propellant Burning Ground Plume

Contaminant of Concern (COC) - HHRA						Groundwater Cleanup Level (1)
Cancer Risk			Non-Cancer Risk			
COC	On-Site	Off-Site	COC	On-Site	Off-Site	
Carbon Tetrachloride		X				5
Chloroform		X				6
			Ethyl Ether	X		1,000
Trichloroethene		X	Trichloroethene	X	X	5
2,6-Dinitrotoluene	X	X	2,6-Dinitrotoluene	X		0.05

Notes:
(1) The Groundwater Cleanup Level is the NR 140 Enforcement Standard (ES)
Based on analytical lab results from residential and groundwater monitoring well samples from 2015, 2016, 2017, and 2018.
All concentration values are expressed in micrograms-per-liter (µg/l)

Vapor Intrusion Risk

The vapor intrusion pathway was considered in the HHRA. An evaluation was conducted to determine whether vapors from the PBG Plume pose a current or hypothetical future risk to human health. Vapor intrusion occurs when there is a migration of vapor-forming chemicals from a subsurface source (e.g., contaminated groundwater) into an overlying building. The exposure route evaluated was the inhalation of contaminants from indoor air. The HHRA did not identify vapor intrusion risks from groundwater contamination.

3.6 Remedial Action Objectives

The following remedial action objectives (RAOs) were developed for the PBG Plume:

- Protect human health by preventing human exposure to contaminated groundwater.
- Restore the groundwater aquifer to beneficial use (i.e., for potable purposes) within a reasonable time frame wherever practicable, based upon site conditions, by reducing contaminant concentrations in groundwater to levels that comply with chemical-specific applicable or relevant and appropriate requirements (ARARs).
- Minimize the impact of contaminated groundwater on the environment.

The RAOs for the PBG Plume will be achieved when the risk-based groundwater COCs are below the groundwater cleanup levels (NR 140 ES) shown above in Table 3.2.

3.7 Summary of Remedial Alternatives

The FS identified and screened remedial technologies and associated process options that may be appropriate for satisfying the RAOs with respect to effectiveness, implementability, and cost. All remediation costs utilize 30 years of implementation (including groundwater monitoring). For alternatives taking longer than 30 years to achieve RAOs, costs would be considerably higher. The Army developed the following remedial alternatives from the retained remedial technologies carried forward after the initial screening. Remedial alternatives were based on achieving the NR 140 ES groundwater standard.

- **Alternative 1 – No Action (Groundwater LUCs)**, as required by the NCP. Alternative 1 would have no impact on the PBG Plume and would not require groundwater monitoring of residential wells or monitoring wells. There would be no contaminant removal, treatment, containment or monitoring related to this alternative. As a condition of the Army's property transfer, land use controls (LUCs) will restrict groundwater use within the property boundaries of the former BAAP boundary.

- **Alternative 2 – Monitored Natural Attenuation (MNA) and Alternate Water Supply (Groundwater LUCs and Sampling).** Alternative 2 would include MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 2 would also continue residential and monitoring well sampling.

- **Alternative 3 – Active Groundwater Remediation – Pump and Treat (Alternate Water Supply, MNA, Groundwater LUCs and Sampling).** Alternative 3 would include groundwater extraction and treatment with mobile treatment units, MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 3 would also continue residential and monitoring well sampling.

- **Alternative 4 – Active Groundwater Remediation – Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling).** Alternative 4 would include in-situ anaerobic biodegradation of groundwater contaminants, MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 4 would also continue residential and monitoring well sampling. MNA will reduce the concentrations of the following VOCs by natural processes: CTET, chloroform, ethyl ether, and TCE. Alternative 4 would target remediating the impacted groundwater with elevated DNT concentrations. The Army's groundwater remediation efforts will be inclusive of all six DNT isomers (total DNT). Alternative 4 would include in-situ bioremediation (biochemical) treatment utilizing permanent and temporary vertical injection wells to administer the biochemical product into the PBG Plume. The biochemical product would consist of a nutrient-enriched emulsified vegetable oil (EVO). The EVO would be distributed in the groundwater as an oil-in-water emulsion (mixture). The oil-in-water emulsion would be prepared using a food-grade oil, food-grade surfactants, and clean water. Once injected into the groundwater, the EVO mixture would stimulate anaerobic biodegradation of the DNT. The vertical injection locations would be located both on-site and off-site. At each injection location, the EVO mixture would be pumped into various depths within the PBG Plume. This method would treat both the horizontal and vertical extent of DNT contaminated groundwater. Alternative 4 is expected to also reduce the concentrations of VOCs that coexist within the targeted treatment areas for DNT.

- **Alternative 5 – Well Replacement – Plume Area (MNA, Groundwater LUCs and Sampling).** Alternative 5 would involve replacing shallow aquifer residential wells (meeting replacement criteria) within the PBG Plume area with deeper aquifer wells, MNA and LUCs consisting of on-site groundwater access restrictions. Alternative 5 would also continue residential and monitoring well sampling.

- **Alternative 6 – Source Area Treatment (Alternate Water Supply, MNA, Groundwater LUCs and Sampling).** Alternative 6 would involve in-situ anaerobic biodegradation of groundwater contaminants (elevated DNT concentrations) directly downgradient of the source area, MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 6 would also continue residential and monitoring well sampling.

The Army expects MNA to reduce the concentrations of the following VOCs by natural processes: CTET, chloroform, ethyl ether, and TCE. The Army developed active remedial alternatives specifically for elevated concentrations of 2,6-DNT in the PBG Plume. The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT).

3.8 Evaluation of Alternatives for PBG Plume

This section compares the remedial alternatives summarized above to each other using the nine criteria set forth in 40 CFR 300.430(e)(9)(iii) and listed in Table 3.3 below. In the remedial decision-making process, USEPA describes the relative performance of each alternative against the evaluation criteria and notes how each alternative compares to the other alternatives under consideration. The FS contains a detailed analysis of the alternatives. The nine evaluation criteria fall into three groups described as follows:

Threshold criteria are requirements that each alternative must meet to be eligible for selection.

Primary balancing criteria are used to weigh major trade-offs between alternatives.

Modifying criteria are considered after public comments are received on the PP.

Table 3.3: Evaluation Criteria for CERCLA Remedial Alternatives	
Threshold Criteria	**1. Overall Protection of Human Health and the Environment** determines whether an alternative can adequately protect human health and the environment by eliminating, reducing, or controlling exposures to hazardous substances, pollutants or contaminants to levels that do not pose an unacceptable risk.
	2. Compliance with ARARs evaluates whether the remedial alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is required and justified.
Primary Balancing Criteria	**3. Long-term Effectiveness and Permanence** considers the ability of an alternative to maintain protection of human health and the environment over time.
	4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
	5. Short-term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
	6. Implementability considers the technical and administrative feasibility of implementing an alternative, including factors such as the relative availability of goods and services.
	7. Cost includes the estimated capital and annual operation and maintenance costs, as well as present worth cost of an alternative. Present worth cost is the total cost of an alternative over time in today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent. DERP guidance (13.(a)(6)) states, "For long-term maintenance phases that are expected to continue indefinitely, cost-to-complete estimates should include a finite period of 30 years." Consequently, remedial alternatives for which the O&M term is expected to exceed 30 years, the Army must limit the O&M term to 30 years per DERP guidance.
Modifying Criteria	**8. State Agency Acceptance** considers whether the State agrees with the Army's analyses and recommendations, as described in the RI/FS and PP.
	9. Community Acceptance considers whether the local community agrees with State's analyses and preferred alternative. Comments received on the PP are an important indicator of community acceptance.

3.8.1 Overall Protection of Human Health and the Environment

The HHRA evaluated two potential human exposure pathways to contaminated groundwater; domestic groundwater uses and vapor intrusion. The HHRA did not identify risks to groundwater through vapor intrusion. The results of the HHRA indicated that domestic groundwater use poses both a current (off-site) and hypothetical future (on-site) risk to human health.

The six alternatives provide varying levels of human health protection and the environmental protection.

Alternative 1 (No Action) would not be protective of human health or the environment. This alternative would still restrict groundwater usage within the BAAP boundary. This alternative would result in the Army terminating the residential and monitoring well sampling program. Alternative 1 fails this threshold criterion.

Alternative 2 (MNA and Alternate Water Supply) would provide protection of human health and the environment due to groundwater access restrictions within the BAAP boundary and the provision of an alternate water supply condition for residential wells. The groundwater sampling program would monitor the groundwater concentrations for compliance and contaminant reduction.

Alternatives 3 (Pump and Treat), 4 (In-Situ Anaerobic Bioremediation), and 6 (Source Area Treatment) would provide protection of human health and the environment by reducing the groundwater contaminants. They would also restrict groundwater usage within the BAAP boundary. The provision of the alternate water supply condition would address concerns associated with residential well impacts. The groundwater sampling program would monitor the groundwater concentrations for compliance and contaminant reduction.

Alternative 5 (Well Replacement) would be protective of human health but not the environment. The Army would provide clean potable water to potential domestic groundwater users. There would be no route of entry through groundwater consumption, eliminating the risk of exposure through groundwater. There would be no active groundwater remediation performed. Alternative 5 fails this threshold criterion.

3.8.2 Compliance with ARARs

CERCLA and the NCP require that remedial actions at least attain legally applicable or relevant and appropriate Federal and State requirements, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law, which are collectively referred to as "ARARs," unless such ARARs can be waived. The USEPA defines three types of ARARs: action-specific, chemical-specific, and location-specific.

Alternative 1 (No Action) would not comply with ARARs and provide no groundwater monitoring.

Alternatives 2, 3, 4, 5, and 6 would comply with ARARs. The evaluation did not identify any location-specific ARARs. Listed below are the ARARs that apply.

- National Primary Drinking Water Regulations: 40 CFR Part 141 Subpart G (chemical-specific).
- Wisconsin Groundwater Standards: Chapter NR 140 Groundwater Quality (chemical-specific).
- Residential Well Construction Standards: Chapter NR 812 Well Construction and Pump Installation (action-specific). Requirements for installing water supply wells and extracting groundwater.

3.8.3 Long-term Effectiveness and Permanence

Alternative 1 (No Action) would not be effective in reducing the risk associated with contaminated groundwater and provides no controls to prevent exposure over time.

Alternative 2 (MNA and Alternate Water Supply) offers a long-term solution as groundwater concentrations are expected to decrease as the chemicals would undergo a slow natural degradation process. Alternative 2 would be the least effective alternative.

Alternative 3 (Pump and Treat) would reduce DNT concentrations through groundwater removal and treatment. Maintaining hydraulic control of groundwater must occur throughout the treatment process to be effective.

Alternatives 4 (In-Situ Anaerobic Bioremediation) and 6 (Source Area Treatment) would reduce DNT concentrations through in-situ anaerobic biodegradation. The bioremediation process permanently destroys the groundwater contaminants. Both alternatives would be an effective long-term solution. Alternative 6 would only reduce DNT concentrations near the source areas of the DBG and PBG. Alternative 4 would be the most effective long-term alternative and the most permanent for treatment of DNT contaminated groundwater.

Alternative 5 (Well Replacement) would provide receptors with long-term access to clean potable water. Groundwater concentrations are expected to decrease as the chemicals would undergo a slow natural degradation process. This alternative would be an effective long-term and permanent solution.

3.8.4 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Alternative 1 (No Action) would not reduce the toxicity, mobility, and volume of contaminants because it does not include a treatment component. This alternative does not meet the statutory preference for the use of treatment as a principal element for the reduction of toxicity, mobility, and volume of hazardous substances.

All other alternatives, except Alternative 2 (MNA and Alternate Water Supply) and Alternative 5 (Well Replacement), have the potential to be effective at reducing the toxicity, mobility, and volume of the COCs through treatment. Alternatives 2 and 5 would have limited reductions in toxicity, mobility, and volume as the contaminants would only naturally degrade.

Alternative 3 (Pump and Treat) would use groundwater extraction and treatment to decrease the toxicity and volume of impacted groundwater and decrease the mobility of groundwater impacts through hydraulic control.

Alternatives 4 (In-Situ Anaerobic Bioremediation) and 6 (Source Area Treatment) would achieve the greatest overall decrease in toxicity and volume of the DNT in groundwater through in-situ anaerobic biodegradation.

3.8.5 Short-Term Effectiveness

Alternative 1 (No Action) would have no short-term impacts and not involve site activities.

Alternative 2 (MNA and Alternate Water Supply) would have no short-term impacts and no additional work associated with implementation.

Alternative 3 (Pump and Treat) would have moderate short-term impacts to workers, residents and the environment during implementation. Construction of extraction wells, mobile treatment units, and underground discharge piping would cause the impacts. Both on-site and off-site construction would occur. Once construction was completed, short-term impacts would be limited to vehicle activity.

Alternatives 4 (In-Situ Anaerobic Bioremediation) and 6 (Source Area Treatment) would have moderate short-term impacts to workers, residents and the environment during implementation. Installation of the permanent and temporary vertical injection wells would cause the impacts. Both on-site and off-site construction would occur. Once construction was completed, short-term impacts would be limited to vehicle activity.

Alternative 5 (Well Replacement) would have moderate short-term impacts to workers, residents and the environment during implementation. Installation of new homeowner wells would cause impacts to private property.

3.8.6 Implementability

Alternative 1 (No Action) would be easy to implement as it would not involve site activities.

Alternative 2 (MNA and Alternate Water Supply) is the most implementable as it is currently being applied.

Alternatives 3 (Pump and Treat), 4 (In-Situ Anaerobic Bioremediation), and 6 (Source Area Treatment) require drilling and construction activities and would be readily implementable using standard construction equipment. The in-situ injection of the biochemical product under Alternatives 4 and 6 would be more challenging due to varying soil conditions at depth.

3.8.7 Cost

The FS developed the estimated 30-year costs for each alternative. These preliminary cost estimates should be within -30 percent to +50 percent of the actual implementation costs. Table 3.4 shows a summary of the capital costs, operation and maintenance (O&M) costs and total costs.

3.8.8 State Acceptance

Alternatives 1, 2, and 5 may not be acceptable to the WDNR because they would not perform any active groundwater remediation and would not achieve the RAOs. Alternative 6 may not be acceptable to the WDNR because it would only treat groundwater near the source areas and would not prevent potential human exposure to the groundwater contamination migrating off-site.

Alternatives 3 and 4 may be acceptable to the WDNR based on permanence, long-term protectiveness, and effectiveness. Ultimate WDNR acceptance will be determined during the remedial design phase.

3.8.9 Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends. The community's comments will be described and addressed in the Record of Decision (ROD).

Table 3.4
Cost Estimates for Alternatives
Propellant Burning Ground Plume

	Alternative	Capital Cost	Long-Term Operating Cost	Contingency	Total Cost
1	No Action (Groundwater LUCs)	$0	$0	$0	$0
2	MNA & Alternate Water Supply (Groundwater LUCs and Sampling)	$0	$4,913,113	$0	$4,913,113
3	Active GW Remediation – Pump & Treat (Alternate Water Supply, MNA, Groundwater LUCs and Sampling)	$4,541,967	$7,433,131	$726,715	$12,701,812
4	Active GW Remediation – Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling)	$4,068,412	$4,913,113	$650,946	$9,632,470
5	Well Replacement – Plume Area (MNA, Groundwater LUCs and Sampling)	$2,937,500	$4,511,746	$470,000	$7,919,246
6	Source Area Treatment – Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling)	$251,791	$4,913,113	$40,287	$5,205,190

3.9 Summary of the Preferred Alternative for PBG Plume

The Army's preferred remedial alternative is Active Groundwater Remediation – Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling) – Alternative 4. Alternative 4 will target remediating the impacted groundwater with elevated DNT concentrations. The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT). Alternative 4 will include in-situ bioremediation (biochemical) treatment utilizing permanent and temporary vertical injection wells to administer the biochemical product into the contaminant plume. The vertical injection locations would be located both on-site and off-site. Shown on Figure 11 is a conceptual plan for in-situ bioremediation treatment (Alternative 4) with the anticipated treatment lines of vertical injection wells. The locations of the vertical injection wells and the horizontal and vertical extent of in-situ treatment will be determined during the remedial design phase.

The preferred remedial action for the PBG Plume will reduce potential exposure risks associated with the contaminated groundwater. The in-situ treatment of DNT in the PBG Plume will positively affect groundwater by reducing the potential for DNT impacted groundwater to migrate downgradient towards residential properties. Groundwater monitoring and MNA will verify contaminant level reduction and provide protection to residential drinking water supplies. LUCs will restrict groundwater use within the property boundaries of the BAAP. These LUCs will continue until COC levels in groundwater allow for unrestricted use and unlimited exposure. If needed, the remedial action will also include a provision for an alternate water supply condition including bottled water or well replacement.

4.0 DETERRENT BURNING GROUND PLUME

4.1 Site Background

The seven-acre DBG area is located in the northeastern portion of BAAP (see Figure 2). The Army used the DBG area as a waste disposal site from the 1940s to 1970s. The east side of the DBG consisted of three burn pits and metal tanks within a former sand borrow pit. Open burning of the deterrent caused soil and groundwater contamination. Deterrent is a liquid organic extract from surplus propellant, composed mostly of DNT and di-n-butyl phthalate, as well as minor amounts of diphenylamine, benzene, and NC. Coal ash from the power plant, construction rubble, trash, and burned garbage were deposited in Landfill #3, located on the west side of the DBG.

In 1999 and 2000, approximately 4,260 cubic yards of impacted soil (DNT and metals) were removed from the three burn pits and incinerated off-site. During 2003, a geosynthetic clay and geomembrane barrier cap was installed over the DBG burn pits and Landfill #3. Between 2003 and 2008, an Enhanced Biodegradation System (EBS) operated beneath the DBG cap and near the former burn pits. The EBS was designed to enhance naturally occurring biodegradation of DNT in subsurface soil by maintaining soil moisture, nutrients, and soil gas oxygen beneath the cap. Water and nutrients were introduced into the soil column through a network of piping. Due to lack of evidence showing that the EBS was enhancing degradation beyond natural processes, the system was decommissioned. The Army has not conducted any active groundwater remediation in the DBG area.

Landfill #5 is located to the northeast of the DBG. Landfill #5 reportedly received solid waste, including office waste, demolition debris, laboratory waste, and coal ash from the power plant. Records indicate that no hazardous materials were disposed in Landfill #5. In 1988, a clay barrier cap was constructed over Landfill #5. The cap received regulatory approval from the WDNR on September 20, 1989.

The WDNR requires the Army to maintain and annually inspect the DBG and Landfill #5 caps. The caps are inspected for erosion, settlement, undesirable vegetation, and other deficiencies. Annual cap and cover maintenance reports are submitted to the WDNR.

4.2 Groundwater Contamination

As described above, the sources of groundwater contamination are the former burn pits at the DBG and Landfill #3. The DBG Plume is approximately 1½ miles long and 800 feet wide and extends southeast beyond the BAAP boundary. Outside of BAAP, the plume continues southeast towards Weigand’s Bay (connected to the Wisconsin River). The DBG Plume shown in Figure 12 represents the area where groundwater concentrations exceed a NR 140 ES or PAL for total DNT. All six DNT isomers (2,3-DNT, 2,4-DNT, 2,5-DNT, 2,6-DNT, 3,4-DNT, and 3,5-DNT) have been detected in the DBG Plume. Figure 12 displays the current monitoring well and residential well sampling frequencies associated with the DBG Plume. Currently, groundwater contamination is being monitored through recurring sampling as directed by the WDNR. Groundwater contamination remains in the surficial sand and gravel aquifer and has not migrated into the bedrock.

Detected concentrations from groundwater samples collected from 2015 to 2018 were compared to the Wisconsin Chapter NR 140 ES and PAL (screening levels). The RI/FS summarized the groundwater data. The following chemicals exceeded the screening levels and identified as COPCs for the DBG Plume:

Table 4.1
Groundwater COPCs
Deterrent Burning Ground Plume

Contaminants of Potential Concern (COPCs)	Maximum Concentration 2015 – 2018	Chapter NR 140 Wisconsin Groundwater Quality Standards		Well & Date of Maximum Concentration
		Preventive Action Limit (PAL)	Enforcement Standard (ES)	
2,6-Dinitrotoluene (1)	0.22	0.005	0.05	DBM-8202 (4/24/17)
Total Dinitrotoluene (2)	8.58	0.005	0.05	DBM-8202 (4/24/17)
Sulfate (3)	1,100	125	250	ELN-8203A (4/26/18)
Tetrahydrofuran	20	10	50	ELN-8203B (4/18/16)
1,1,2-Trichlorethane	0.98	0.5	5	ELN-8203B (4/26/18)
Trichloroethene (4)	4.7	0.5	5	residential well (8/29/16)

Notes:
(1) The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (Total DNT).
(2) Total DNT consists of isomers (2,3-DNT; 2,4-DNT; 2,5-DNT; 2,6-DNT; 3,4-DNT; 3,5-DNT)
(3) The Sulfate Chapter NR 140 ES and PAL are based on a taste threshold and not based on risk to human health.
(4) TCE is not found in DBG Plume monitoring wells. Residential well jet pumps are the suspected source of TCE.
All concentration values are expressed in micrograms-per-liter (µg/l)

Figure 13 is a total DNT isoconcentration map for the DBG Plume. The isoconcentration map was prepared using all groundwater data collected during 2018. The total DNT isoconcentrations shown on Figure 13 are broken into three-color designations. The green shaded areas indicate where total DNT is above the NR 140 PAL (0.005 µg/l). The blue shaded areas indicate where total DNT is above the NR 140 ES (0.05 µg/l) but below 1.0 µg/l. The red shaded area displays where total DNT is above 1.0 µg/l. The area closest to the DBG sources contains the highest concentrations of total DNT. The highest concentration of total DNT, detected during 2018, was in monitoring well DBM-8201 located immediately downgradient of the DBG. Total DNT concentrations near the DBG sources have been decreasing. Total DNT concentrations near the BAAP boundary and the leading of the DBG Plume have shown increasing trends. Groundwater monitoring has shown that Landfill #5 is not a source of DNT in the DBG Plume.

The extent of sulfate contamination shown on Figure 14 is adjacent to Landfill #5. The isoconcentration map was prepared using all groundwater data collected during 2018. The green shaded area displays where sulfate was detected above the NR 140 PAL [125 milligrams per liter (mg/l)]. The blue shaded area displays where sulfate was detected above the NR 140 ES (250 mg/l). The highest concentration of sulfate, detected during 2018, was in monitoring well ELN-8203A, which is immediately downgradient of Landfill #5. The limits of the sulfate isoconcentrations are approximately 500 by 850 feet and do not intersect with DNT migrating from the DBG. Sulfate concentrations have remained stable. Wisconsin has a "secondary" NR 140 Public Welfare Groundwater Quality Standard for sulfate. The sulfate NR 140 Groundwater Standard is based on a taste threshold and not on risk to human health.

1,1,2-Trichloroethane (1,1,2-TCA) has only exceeded the NR 140 PAL in four monitoring wells (ELN-8203A,B,C and S1134R) located directly south and downgradient of Landfill #5. 1,1,2-TCA concentrations have remained stable. Due to the limited extent of 1,1,2-TCA detections, an isoconcentration map was not prepared.

Tetrahydrofuran has only exceeded the NR 140 PAL in monitoring well ELN-8203B one time (2016). Tetrahydrofuran has been detected in other monitoring wells near Landfill #5 but always below the NR 140 PAL. Due to the limited extent of tetrahydrofuran detections, an isoconcentration map was not prepared.

TCE has been detected in three residential wells located downgradient of the DBG Plume and adjacent to Weigand’s Bay. Two of those residential wells had TCE detections above the NR 140 PAL. Historically, TCE has not been detected in monitoring wells associated with the DBG Plume. During 2020, the Army investigated TCE detections in residential wells north of Weigand’s Bay. The investigation determined that the well jet pumps were the source of TCE contamination in the shallow residential wells.

4.3 Scope and Role of the Proposed Action

The scope and role of the action discussed in this PP includes all the groundwater remedial actions planned for the DBG Plume. The preferred groundwater remedial action will reduce potential risks associated with exposure to contaminated groundwater in the sand and gravel aquifer. Using treatment technologies, this response will reduce the toxicity, mobility, and volume of source materials that constitute the principal threat.

Local residents have historically used groundwater outside the BAAP boundary as a drinking water source. The Army replaced one residential well within the DBG Plume, due to DNT impacts. The replacement well was installed in 2019. The use of groundwater for human consumption will continue in the future. When establishing the RAOs for this response action, the Army has considered the NCP’s expectation to return groundwater to its beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. The Army intends to return the contaminated sand and gravel aquifer at BAAP to its potential beneficial uses, which is considered to be total DNT concentrations below the NR 140 ES, to the extent practicable. If a return to potential beneficial use is not practicable, the expectation is to prevent further migration of the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction.

4.4 Summary of Site Risks

The Army performed a risk assessment to determine and document whether groundwater contamination in the DBG Plume poses a potential current or hypothetical future risk to human health. CERCLA requires the completion of a HHRA prior to selecting a remedial alternative. The HHRA must evaluate the potential human health risks associated with chemical exposure to environmental media (e.g., groundwater, vapor). The HHRA was conducted using standard USEPA risk assessment guidance, exposure assumptions, and toxicity factors. The USEPA risk assessment process uses conservative assumptions about exposure to chemicals and their toxicity so that risks reported are not underestimated. In all circumstances, priority was given to evaluating the potential human health risk regardless of the impact. The HHRA evaluated two potential human exposure pathways to contaminated groundwater; domestic groundwater uses and vapor intrusion.

Domestic Groundwater Risk

Groundwater located in the DBG Plume and within the BAAP boundary is not used for human consumption. The former BAAP land was transferred from the Army to other property owners and includes a deed restriction on the use of groundwater. This restricts the potential exposure to groundwater within the boundary of BAAP. These groundwater access restrictions state that the property owner "shall not access or use groundwater underlying the property for any purpose without the prior written approval of the Army and the WDNR."

Residential wells located outside of BAAP use groundwater for potable water and domestic purposes. The potential future use of groundwater adjacent to and downgradient of BAAP is expected to be for potable water and domestic purposes. Residential well users can be exposed to contaminated groundwater through ingestion or drinking of water, inhalation of vapor during showering or dishwashing, and dermal contact while bathing.

Hypothetical future (on-site) risks were evaluated using groundwater data from monitoring wells. Current (off-site) risks were evaluated using groundwater data from residential wells and monitoring wells. The maximum groundwater concentration of each COPC during 2015, 2016, 2017, and 2018 were used to estimate the risks. Hypothetical future on-site risks apply if groundwater on-site (within BAAP) will be used for domestic water in the future.

The groundwater risk estimates were calculated for each COPC using the maximum groundwater concentrations and a simple scaling method described in Section 2.6.1 of the USEPA's RSLs – User's Guide (November 2018). These calculations use the USEPA's RSL Resident Tapwater Generic Table (November 2018).

The results of the HHRA determined that contaminated groundwater in the DBG Plume poses an unacceptable risk to groundwater usage by humans. Domestic groundwater use poses both a current (off-site) and hypothetical future (on-site) risk to human health. Provided below is a summary of exposure risks for the DBG Plume.

DBG Plume

The risk-based COCs identified in the DBG Plume were chloroform, 1,1,2-TCA, TCE, and total DNT.

- Chloroform had an off-site cancer risk above the risk management criteria. Based on recent groundwater monitoring data, chloroform concentrations were below the NR 140 ES. Therefore, remedial alternatives were not evaluated for chloroform.
- 1,1,2-TCA had an on-site non-cancer risk above the risk management criteria. Based on recent groundwater monitoring data, 1,1,2-TCA concentrations were below the NR 140 ES. Therefore, remedial alternatives were not evaluated for 1,1,2-TCA.
- TCE had both an off-site cancer and non-cancer risk above the risk management criteria. There are no known sources of TCE near the DBG Plume. The monitoring wells in the DBG Plume have not detected TCE. Groundwater sampling has found TCE in residential well jet pumps. Therefore, remedial alternatives were not evaluated for TCE.
- Total DNT had an off-site cancer risk above the risk management criteria. Based on recent groundwater monitoring data, total DNT concentrations were above the NR 140 ES.

Based on the above information, total DNT (all six DNT isomers) was the only COC considered in the FS for the development of remedial alternatives in the DBG Plume.

Table 4.2
Groundwater COCs & Cleanup Levels
Deterrent Burning Ground Plume

Contaminant of Concern (COC) - HHRA						Groundwater Cleanup Level (1)
Cancer Risk			Non-Cancer Risk			
COC	On-Site	Off-Site	COC	On-Site	Off-Site	
Chloroform		X				6
			1,1,2-Trichloroethane	X		5
Trichloroethene (2)		X	Trichloroethene (2)		X	5
Total Dinitrotoluene		X				0.05

Notes:
(1) The Groundwater Cleanup Level is the NR 140 Enforcement Standard (ES)
(2) Trichloroethene has not been found in monitoring wells but in residential well jet pumps; not considered a COC.
Based on analytical lab results from residential and groundwater monitoring well samples from 2015, 2016, 2017, and 2018.
All concentration values are expressed in micrograms-per-liter (µg/l)

Vapor Intrusion Risk

The vapor intrusion pathway was considered in the HHRA. An evaluation was conducted to determine whether vapors from the DBG Plume pose a current or hypothetical future risk to human health. Vapor intrusion occurs when there is a migration of vapor-forming chemicals from a subsurface source (e.g., contaminated groundwater) into an overlying building. The exposure route evaluated was the inhalation of contaminants from indoor air. The HHRA did not identify vapor intrusion risks from groundwater contamination.

4.5 Remedial Action Objectives

The following RAOs were developed for the DBG Plume:

- Protect human health by preventing human exposure to contaminated groundwater.
- Restore the groundwater aquifer to beneficial use (i.e., for potable purposes) within a reasonable time frame wherever practicable, based upon site conditions, by reducing contaminant concentrations in groundwater to levels that comply with chemical-specific ARARs.
- Minimize the impact of contaminated groundwater on the environment.

The RAOs for the DBG Plume will be achieved when the risk-based groundwater COCs are below the groundwater cleanup levels (NR 140 ES) shown above in Table 4.2.

4.6 Summary of Remedial Alternatives

The FS identified and screened remedial technologies and associated process options that may be appropriate for satisfying the RAOs with respect to effectiveness, implementability, and cost. All remediation costs utilize 30 years of implementation (including groundwater monitoring). For alternatives taking longer than 30 years to achieve RAOs, costs would be considerably higher. The Army developed the following remedial alternatives from the retained remedial technologies carried forward after the initial screening. Remedial alternatives were based on achieving the NR 140 ES groundwater standard.

- **Alternative 1 – No Action (Groundwater LUCs)**, as required by the NCP. Alternative 1 would have no impact on the DBG Plume and would not require groundwater monitoring of residential wells or monitoring wells. There would be no contaminant removal, treatment, containment or monitoring related to this alternative. As a condition of the Army's property transfer, LUCs will restrict groundwater use within the property boundaries of the former BAAP boundary.

- **Alternative 2 – Monitored Natural Attenuation (MNA) and Alternate Water Supply (Groundwater LUCs and Sampling).** Alternative 2 would include MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 2 would also continue residential and monitoring well sampling.

- **Alternative 3 – Active Groundwater Remediation – Pump and Treat (Alternate Water Supply, MNA, Groundwater LUCs and Sampling).** Alternative 3 would include groundwater extraction and treatment with mobile treatment units, MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 3 would also continue residential and monitoring well sampling.

- **Alternative 4 – Active Groundwater Remediation – Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling).** Alternative 4 would include in-situ anaerobic biodegradation of groundwater contaminants, MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 4 would also continue residential and monitoring well sampling. Alternative 4 would target remediating the impacted groundwater with elevated DNT concentrations. The Army's groundwater remediation efforts will be inclusive of all six DNT isomers (total DNT). Alternative 4 would include in-situ bioremediation (biochemical) treatment utilizing temporary vertical injection wells to administer the biochemical product into the DBG Plume. The biochemical product would consist of a nutrient-enriched emulsified vegetable oil (EVO). The EVO would be distributed in the groundwater as an oil-in-water emulsion (mixture). The oil-in-water emulsion would be prepared using a food-grade oil, food-grade surfactants, and clean water. Once injected into the groundwater, the EVO mixture would stimulate anaerobic biodegradation of the DNT. The vertical injection locations would be located both on-site and off-site. At each injection location, the EVO mixture would be pumped into various depths within the DBG Plume. This method would treat both the horizontal and vertical extent of DNT contaminated groundwater.

- **Alternative 5 – Well Replacement – Plume Area (MNA, Groundwater LUCs and Sampling).** Alternative 5 would involve replacing shallow aquifer residential wells (meeting replacement criteria) within the DBG Plume area with deeper aquifer wells, MNA and LUCs consisting of on-site groundwater access restrictions. Alternative 5 would also continue residential and monitoring well sampling.

- **Alternative 6 – Source Area Treatment (Alternate Water Supply, MNA, Groundwater LUCs and Sampling).** Alternative 6 would involve in-situ anaerobic biodegradation of groundwater contaminants (elevated DNT concentrations) directly downgradient of the source area, MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 6 would also continue residential and monitoring well sampling.

The Army developed active remedial alternatives specifically for elevated concentrations of total DNT in the DBG Plume. The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT).

4.7 Evaluation of Alternatives for DBG Plume

This section compares the remedial alternatives summarized above to each other using the nine criteria set forth in 40 CFR 300.430(e)(9)(iii). The nine criteria were presented above in Section 3.8. In the remedial decision-making process, USEPA describes the relative performance of each alternative against the evaluation criteria and notes how each alternative compares to the other alternatives under consideration. The FS contains a detailed analysis of the alternatives.

4.7.1 Overall Protection of Human Health and the Environment

The HHRA evaluated two potential human exposure pathways to contaminated groundwater; domestic groundwater uses and vapor intrusion. The HHRA did not identify risks to groundwater through vapor intrusion. The results of the HHRA indicated that domestic groundwater use poses both a current (off-site) and hypothetical future (on-site) risk to human health.

The six alternatives provide varying levels of human health protection and the environmental protection.

Alternative 1 (No Action) would not be protective of human health or the environment. This alternative would still restrict groundwater usage within the BAAP boundary. This alternative would result in the Army terminating the residential and monitoring well sampling program. Alternative 1 fails this threshold criterion.

Alternative 2 (MNA and Alternate Water Supply) would provide protection of human health and the environment due to groundwater access restrictions within the BAAP boundary and the provision of an alternate water supply condition for residential wells. The groundwater sampling program would monitor the groundwater concentrations for compliance and contaminant reduction.

Alternatives 3 (Pump and Treat), 4 (In-Situ Anaerobic Bioremediation), and 6 (Source Area Treatment) would provide protection of human health and the environment by reducing the groundwater contaminants. They would also restrict groundwater usage within the BAAP boundary. The provision of the alternate water supply condition would address concerns associated with residential well impacts. The groundwater sampling program would monitor the groundwater concentrations for compliance and contaminant reduction.

Alternative 5 (Well Replacement) would be protective of human health but not the environment. The Army would provide clean potable water to potential domestic groundwater users. There would be no route of entry through groundwater consumption, eliminating the risk of exposure through groundwater. There would be no active groundwater remediation performed. Alternative 5 fails this threshold criterion.

4.7.2 Compliance with ARARs

CERCLA and the NCP require that remedial actions at least attain legally applicable or relevant and appropriate Federal and State requirements, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law, which are collectively referred to as "ARARs," unless such ARARs can be waived. The USEPA defines three types of ARARs: action-specific, chemical-specific, and location-specific.

Alternative 1 (No Action) would not comply with ARARs and provide no groundwater monitoring.

Alternatives 2, 3, 4, 5, and 6 would comply with ARARs. The evaluation did not identify any location-specific ARARs. Listed below are the ARARs that apply.

- National Primary Drinking Water Regulations: 40 CFR Part 141 Subpart G (chemical-specific).
- Wisconsin Groundwater Standards: Chapter NR 140 Groundwater Quality (chemical-specific).
- Residential Well Construction Standards: Chapter NR 812 Well Construction and Pump Installation (action-specific). Requirements for installing water supply wells and extracting groundwater.

4.7.3 Long-term Effectiveness and Permanence

Alternative 1 (No Action) would not be effective in reducing the risk associated with contaminated groundwater and provides no controls to prevent exposure over time.

Alternative 2 (MNA and Alternate Water Supply) offers a long-term solution as groundwater concentrations are expected to decrease as the chemicals would undergo a slow natural degradation process. Alternative 2 would be the least effective alternative.

Alternative 3 (Pump and Treat) would reduce DNT concentrations through groundwater removal and treatment. Maintaining hydraulic control of groundwater must occur throughout the treatment process to be effective.

Alternatives 4 (In-Situ Anaerobic Bioremediation) and 6 (Source Area Treatment) would reduce DNT concentrations through in-situ anaerobic biodegradation. The bioremediation process permanently destroys the groundwater contaminants. Both alternatives would be an effective long-term solution. Alternative 6 would only reduce DNT concentrations near the source areas of the DBG and PBG. Alternative 4 would be the most effective long-term alternative and the most permanent for treatment of DNT contaminated groundwater.

Alternative 5 (Well Replacement) would provide receptors with long-term access to clean potable water. Groundwater concentrations are expected to decrease as the chemicals would undergo a slow natural degradation process. This alternative would be an effective long-term and permanent solution.

4.7.4 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Alternative 1 (No Action) would not reduce the toxicity, mobility, and volume of contaminants because it does not include a treatment component. This alternative does not meet the statutory preference for the use of treatment as a principal element for the reduction of toxicity, mobility, and volume of hazardous substances.

All other alternatives, except Alternative 2 (MNA and Alternate Water Supply) and Alternative 5 (Well Replacement), have the potential to be effective at reducing the toxicity, mobility, and volume of the COCs through treatment. Alternatives 2 and 5 would have limited reductions in toxicity, mobility, and volume as the contaminants would only naturally degrade.

Alternative 3 (Pump and Treat) would use groundwater extraction and treatment to decrease the toxicity and volume of impacted groundwater and decrease the mobility of groundwater impacts through hydraulic control.

Alternatives 4 (In-Situ Anaerobic Bioremediation) and 6 (Source Area Treatment) would achieve the greatest overall decrease in toxicity and volume of the DNT in groundwater through in-situ anaerobic biodegradation.

4.7.5 Short-Term Effectiveness

Alternative 1 (No Action) would have no short-term impacts and not involve site activities.

Alternative 2 (MNA and Alternate Water Supply) would have no short-term impacts and no additional work associated with implementation.

Alternative 3 (Pump and Treat) would have moderate short-term impacts to workers, residents and the environment during implementation. Construction of extraction wells, mobile treatment units, and underground discharge piping would cause the impacts. Both on-site and off-site construction would occur. Once construction was completed, short-term impacts would be limited to vehicle activity.

Alternatives 4 (In-Situ Anaerobic Bioremediation) and 6 (Source Area Treatment) would have moderate short-term impacts to workers, residents, and the environment during implementation. Installation of the temporary vertical injection wells would cause the impacts. Both on-site and off-site construction would occur. Once construction was completed, short-term impacts would be limited to vehicle activity.

Alternative 5 (Well Replacement) would have moderate short-term impacts to workers, residents and the environment during implementation. Installation of new homeowner wells would cause impacts to private property.

4.7.6 Implementability

Alternative 1 (No Action) would be easy to implement as it would not involve site activities.

Alternative 2 (MNA and Alternate Water Supply) is the most implementable as it is currently being applied.

Alternatives 3 (Pump and Treat), 4 (In-Situ Anaerobic Bioremediation), and 6 (Source Area Treatment) require drilling and construction activities and would be readily implementable using standard construction equipment. The in-situ injection of the biochemical product under Alternatives

4 and 6 would be more challenging due to varying soil conditions at depth.

4.7.7 Cost

The FS developed the estimated 30-year costs for each alternative. These preliminary cost estimates should be within -30 percent to +50 percent of the actual implementation costs. Table 4.3 shows a summary of the capital costs, O&M costs and total costs.

4.7.8 State Acceptance

Alternatives 1, 2, and 5 may not be acceptable to the WDNR because they would not perform any active groundwater remediation and would not achieve the RAOs. Alternative 6 may not be acceptable to the WDNR because it would only treat groundwater near the source areas and would not prevent potential human exposure to the groundwater contamination migrating off-site. Alternatives 3 and 4 may be acceptable to the WDNR based on permanence, long-term protectiveness, and effectiveness. Ultimate WDNR acceptance will be determined during the remedial design phase.

4.7.9 Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends. The community's comments will be described and addressed in the ROD.

Table 4.3
Cost Estimates for Alternatives
Deterrent Burning Ground Plume

	Alternative	Capital Cost	Long-Term Operating Cost	Contingency	Total Cost
1	No Action (Groundwater LUCs)	$0	$0	$0	$0
2	MNA & Alternate Water Supply (Groundwater LUCs and Sampling)	$0	$4,240,490	$0	$4,240,490
3	Active GW Remediation - Pump & Treat (Alternate Water Supply, MNA, Groundwater LUCs and Sampling)	$3,470,038	$8,522,395	$555,206	$12,547,639
4	Active GW Remediation - Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling)	$10,134,835	$706,748	$1,621,574	$12,463,156
5	Well Replacement - Plume Area (MNA, Groundwater LUCs and Sampling)	$2,850,000	$3,839,123	$456,000	$7,145,123
6	Source Area Treatment - Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling)	$807,038	$4,240,490	$129,126	$5,176,654

4.8 Summary of the Preferred Alternative for DBG Plume

The Army's preferred remedial alternative is Active Groundwater Remediation - Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling) - Alternative 4. Alternative 4 will target remediating the impacted groundwater with elevated DNT concentrations. The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT). Alternative 4 will include in-situ bioremediation (biochemical) treatment utilizing temporary vertical injection wells to administer the biochemical product into the contaminant plume. The vertical injection locations will be located both on-site and off-site. Shown on Figure 15 is a conceptual plan for in-situ bioremediation treatment (Alternative 4) with the anticipated treatment lines of vertical injection wells. The locations of the vertical injection wells and the horizontal and vertical extent of in-situ treatment will be determined during the remedial design phase.

The preferred remedial action for the DBG Plume will reduce potential exposure risks associated with the contaminated groundwater. The in-situ treatment of DNT in the DBG Plume will positively affect groundwater by reducing the potential for DNT impacted groundwater to migrate downgradient towards residential properties. Groundwater monitoring and MNA will verify contaminant level reduction and provide protection to residential drinking water supplies. LUCs will restrict groundwater use within the property boundaries of the BAAP. These LUCs will continue until COC levels in groundwater allow for unrestricted use and unlimited exposure. If needed, the remedial action will also include a provision for an alternate water supply condition including bottled water or well replacement.

5.0 CENTRAL PLUME

5.1 Site Background

The source of DNT contaminated groundwater in the Central Plume is located in the north-central portion of BAAP (see Figure 2). The production of NG, rocket paste, and rocket propellant occurred there. These production areas were not connected to the main industrial sewer network. The production related wash waters were discharged to open ditches and may have contributed to groundwater contamination.

Soil removal activities were conducted around production buildings and along ditches and drainage pathways leading from the Nitroglycerin, Rocket Paste, and Rocket Propellant production areas. In addition, sewer removal and adjacent soil excavations were completed. The Army has not conducted any active groundwater remediation in the Central Plume.

5.2 Groundwater Contamination

As described above, the source of groundwater contamination was the discharge of production related water to open ditches and ponds. The Central Plume is approximately 3.5 miles long and extends south beyond the BAAP boundary. Outside of BAAP, the plume continues south towards Gruber's Grove Bay (connected to the Wisconsin River). Figure 16 displays the current monitoring well and residential well sampling frequencies associated with the Central Plume. Currently, groundwater contamination is being monitored through recurring sampling as directed by the WDNR.

Groundwater contamination remains in the surficial sand and gravel aquifer and has not migrated into the bedrock.

Detected concentrations from groundwater samples collected from 2015 to 2018 were compared to the Wisconsin Chapter NR 140 ES and PAL (screening levels). The RI/FS summarized the groundwater data. The following chemicals exceeded the screening levels and identified as COPCs for the Central Plume:

Table 5.1
Groundwater COPCs
Central Plume

Contaminants of Potential Concern (COPCs)	Maximum Concentration 2015 - 2018	Chapter NR 140 Wisconsin Groundwater Quality Standards		Well & Date of Maximum Concentration
		Preventive Action Limit (PAL)	Enforcement Standard (ES)	
2,6-Dinitrotoluene (1)	0.08	0.005	0.05	SEN-0503B (11/15/18)
Total Dinitrotoluene (2)	0.209	0.005	0.05	NLN-1001A (6/26/18)
Benzene (3)	10	0.5	5	SEN-0503B (6/12/17)
Chloroform	2	0.06	6	residential well (10/5/15)

Notes:

(1) The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (Total DNT).

(2) Total DNT consists of isomers (2,3-DNT; 2,4-DNT; 2,5-DNT; 2,6-DNT; 3,4-DNT; 3,5-DNT)

(3) Benzene has not been found on-site in the Central Plume. The source of benzene is not attributable to the Army.

All concentration values are expressed in micrograms-per-liter (µg/l)

Figure 17 is a total DNT isoconcentration map for the Central Plume. The isoconcentration map was prepared using all groundwater data collected during 2018. The total DNT isoconcentrations shown on Figure 17 are broken into two-color designations. The green shaded areas indicate where total DNT is above the NR 140 PAL (0.005 µg/l). The blue shaded areas indicate where total DNT is above the NR 140 ES (0.05 µg/l). The northern section of the Central Plume contains the highest concentrations of total DNT. The highest concentration of total DNT, detected during 2018, was in monitoring well NLN-1001A. Total DNT concentrations in the northern section of the Central Plume have been increasing. Total DNT concentrations near the BAAP boundary and the leading of the Central Plume have been stable.

Benzene has been detected twice in monitoring well SEN-0503B (2016 and 2017). The 2016 detection was above the NR 140 PAL and the 2017 detection was above the NR 140 ES. SEN-0503B is located south of the BAAP boundary and near the leading edge of the Central Plume. Since 2017, SEN-0503B has not had a benzene detection. Historically, benzene has not been detected in monitoring wells associated with the Central Plume. There has been no source of benzene identified in the Central Plume. The source of benzene is not attributable to the Army.

Chloroform has exceeded the NR 140 PAL in monitoring wells and residential wells south of the BAAP boundary. Upgradient monitoring wells have not seen chloroform exceedances. There has been no source of chloroform identified in the Central Plume. Chloroform concentrations have remained stable. Due to the limited extent of chloroform detections, an isoconcentration map was not prepared.

5.3 Scope and Role of the Proposed Action

The scope and role of the action discussed in this PP includes all the groundwater remedial actions planned for the Central Plume. The preferred groundwater remedial action will reduce potential risks associated with exposure to contaminated groundwater in the sand and gravel aquifer. Using treatment technologies, this response will reduce the toxicity, mobility, and volume of source materials that constitute the principal threat.

Local residents have historically used groundwater outside the BAAP boundary as a drinking water source. The Army has replaced three residential wells, due to DNT impacts, in the Central Plume. Two residential wells were installed in 2005 and one well in 2018. The use of groundwater for human consumption will continue in the future. When establishing the RAOs for this response action, the Army has considered the NCP's expectation to return groundwater to its beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. The Army intends to return the contaminated sand and gravel aquifer at BAAP to its potential beneficial uses, which is considered to be total DNT concentrations below the NR 140 ES, to the extent practicable. If a return to potential beneficial use is not practicable, the expectation is to prevent further migration of the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction.

5.4 Summary of Site Risks

The Army performed a risk assessment to determine and document whether groundwater contamination in the Central Plume poses a potential current or hypothetical future risk to human health. CERCLA requires the completion of a HHRA prior to selecting a remedial alternative. The HHRA must evaluate the potential human health risks associated with chemical exposure to environmental media (e.g., groundwater, vapor). The HHRA was conducted using standard USEPA risk assessment guidance, exposure assumptions, and toxicity factors. The USEPA risk assessment process uses conservative assumptions about exposure to chemicals and their toxicity so that risks reported are not underestimated. In all circumstances, priority was given to evaluating the potential human health risk regardless of the impact. The HHRA evaluated two potential human exposure pathways to contaminated groundwater; domestic groundwater uses and vapor intrusion.

Domestic Groundwater Risk

Groundwater located in the Central Plume and within the BAAP boundary is not used for human consumption. The former BAAP land was transferred from the Army to other property owners and includes a deed restriction on the use of groundwater. This restricts the potential exposure to groundwater within the boundary of BAAP. These groundwater access restrictions state that the property owner "shall not access or use groundwater underlying the property for any purpose without the prior written approval of the Army and the WDNR."

Residential wells located outside of BAAP use groundwater for potable water and domestic purposes. The potential future use of groundwater adjacent to and downgradient of BAAP is expected to be for potable water and domestic purposes. Residential well users can be exposed to contaminated groundwater through ingestion or drinking of water, inhalation of vapor during showering or dishwashing, and dermal contact while bathing.

Hypothetical future (on-site) risks were evaluated using groundwater data from monitoring wells. Current (off-site) risks were evaluated using groundwater data from residential wells and monitoring wells. The maximum groundwater concentration of each COPC during 2015, 2016, 2017, and 2018 were used to estimate the risks. Hypothetical future on-site risks apply if groundwater on-site (within BAAP) will be used for domestic water in the future.

The groundwater risk estimates were calculated for each COPC using the maximum groundwater concentrations and a simple scaling method described in Section 2.6.1 of the USEPA's RSLs – User's Guide (November 2018). These calculations use the USEPA's RSL Resident Tapwater Generic Table (November 2018).

The results of the HHRA determined that contaminated groundwater in the Central Plume poses an unacceptable risk to groundwater usage by humans. Domestic groundwater use poses a current (off-site) risk to human health. Provided below is a summary of exposure risks for the Central Plume.

Central Plume

The risk-based COCs identified in the Central Plume were benzene, chloroform, 1,2-dichloroethane, and 2,6-DNT.

- Benzene had an off-site cancer risk above the risk management criteria. There are no known sources of benzene near the Central Plume. The on-site (upgradient) monitoring wells have not detected benzene. The source of benzene is not attributable to the Army. Therefore, remedial alternatives were not evaluated for benzene.
- Chloroform had an off-site cancer risk above the risk management criteria. Based on recent groundwater monitoring data, chloroform concentrations were below the NR 140 ES. Therefore, remedial alternatives were not evaluated for chloroform.
- 1,2-Dichloroethane had an off-site cancer risk above the risk management criteria. Based on recent groundwater monitoring data, 1,2-dichloroethane concentrations were below the NR 140 ES. Therefore, remedial alternatives were not evaluated for 1,2-dichloroethane.
- 2,6-DNT had an off-site cancer risk above the risk management criteria. Based on recent groundwater monitoring data, 2,6-DNT concentrations were above the NR 140 ES.

Based on the above information, 2,6-DNT was the only COC considered in the FS for the development of remedial alternatives in the Central Plume. However, the Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT).

Table 5.2
Groundwater COCs & Cleanup Levels
Central Plume

Contaminant of Concern (COC) - HHRA						Groundwater Cleanup Level (1)
Cancer Risk			Non-Cancer Risk			
COC	On-Site	Off-Site	COC	On-Site	Off-Site	
Benzene (2)		X	none			5
Chloroform		X				6
1,2-Dichloroethane		X				5
2,6-Dinitrotoluene		X				0.05

Notes:
(1) The Groundwater Cleanup Level is the NR 140 Enforcement Standard (ES)
(2) The source of benzene is not attributable to the Army; not considered a COC.
Based on analytical lab results from residential and groundwater monitoring well samples from 2015, 2016, 2017, and 2018.
All concentration values are expressed in micrograms-per-liter (μg/l)

Vapor Intrusion Risk

The vapor intrusion pathway was considered in the HHRA. An evaluation was conducted to determine whether vapors from the Central Plume pose a current or hypothetical future risk to human health. Vapor intrusion occurs when there is a migration of vapor-forming chemicals from a subsurface source (e.g., contaminated groundwater) into an overlying building. The exposure route evaluated was the inhalation of contaminants from indoor air. The HHRA did not identify vapor intrusion risks from groundwater contamination.

5.5 Remedial Action Objectives

The following RAOs were developed for the Central Plume:

- Protect human health by preventing human exposure to contaminated groundwater.
- Restore the groundwater aquifer to beneficial use (i.e., for potable purposes) within a reasonable time frame wherever practicable, based upon site conditions, by reducing contaminant concentrations in groundwater to levels that comply with chemical-specific ARARs.
- Minimize the impact of contaminated groundwater on the environment.

The RAOs for the Central Plume will be achieved when the risk-based groundwater COCs are below the groundwater cleanup levels (NR 140 ES) shown in Table 5.2.

5.6 Summary of Remedial Alternatives

The FS identified and screened remedial technologies and associated process options that may be appropriate for satisfying the RAOs with respect to effectiveness, implementability, and cost. A source area alternative was not developed for the Central Plume because there are no known remaining source areas. All remediation costs utilize 30 years of implementation (including groundwater monitoring). For alternatives taking longer than 30 years to achieve RAOs, costs would be considerably higher. The Army developed the following remedial alternatives from the retained remedial technologies carried forward after the initial screening. Remedial alternatives were based on achieving the NR 140 ES groundwater standard.

- **Alternative 1 – No Action (Groundwater LUCs)**, as required by the NCP. Alternative 1 would have no impact on the Central Plume and would not require groundwater monitoring of residential wells or monitoring wells. There would be no contaminant removal, treatment, containment or monitoring related to this alternative. As a condition of the Army’s property transfer, LUCs will restrict groundwater use within the property boundaries of the former BAAP boundary.

- **Alternative 2 – Monitored Natural Attenuation (MNA) and Alternate Water Supply (Groundwater LUCs and Sampling).** Alternative 2 would include MNA, LUCs consisting of on-site groundwater access restrictions and a provision for an alternate water supply condition for residential wells. Alternative 2 would also continue residential and monitoring well sampling.

- **Alternative 3 – Active Groundwater Remediation – Pump and Treat (Alternate Water Supply, MNA, Groundwater LUCs and Sampling).** Alternative 3 would include groundwater extraction and treatment with mobile treatment units, MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 3 would also continue residential and monitoring well sampling.

- **Alternative 4 – Active Groundwater Remediation – Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling).** Alternative 4 would include in-situ anaerobic biodegradation of groundwater contaminants, MNA, LUCs consisting of on-site groundwater access restrictions, and a provision for an alternate water supply condition for residential wells. Alternative 4 would also continue residential and monitoring well sampling. Alternative 4 would target remediating the impacted groundwater with elevated DNT concentrations. The Army’s groundwater remediation efforts will be inclusive of all six DNT isomers (total DNT). Alternative 4 would include in-situ bioremediation (biochemical) treatment utilizing temporary vertical injection wells to administer the biochemical product into the Central Plume. The biochemical product would consist of a nutrient-enriched emulsified vegetable oil (EVO). The EVO would be distributed in the groundwater as an oil-in-water emulsion (mixture). The oil-in-water emulsion would be prepared using a food-grade oil, food-grade surfactants, and clean water. Once injected into the groundwater, the EVO mixture would stimulate anaerobic biodegradation of the DNT. The vertical injection locations would be located both on-site and off-site. At each injection location, the EVO mixture would be pumped into various depths within the Central Plume. This method would treat both the horizontal and vertical extent of DNT contaminated groundwater.

- **Alternative 5 – Well Replacement – Plume Area (MNA, Groundwater LUCs and Sampling).** Alternative 5 would involve replacing shallow aquifer residential wells (meeting replacement criteria) within the Central Plume area with deeper aquifer wells, MNA and LUCs consisting of on-site groundwater access restrictions. Alternative 5 would also continue residential and monitoring well sampling.

The Army developed active remedial alternatives specifically for elevated concentrations of 2,6-DNT in the Central Plume. The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT).

5.7 Evaluation of Alternatives for Central Plume

This section compares the remedial alternatives summarized above to each other using the nine criteria set forth in 40 CFR 300.430(e)(9)(iii). The nine criteria were presented above in Section 3.8. In the remedial decision-making process, USEPA describes the relative performance of each alternative against the evaluation criteria and notes how each alternative compares to the other alternatives under consideration. The FS contains a detailed analysis of the alternatives.

5.7.1 Overall Protection of Human Health and the Environment

The HHRA evaluated two potential human exposure pathways to contaminated groundwater; domestic groundwater uses and vapor intrusion. The HHRA did not identify risks to groundwater through vapor intrusion. The results of the HHRA indicated that domestic groundwater use poses a current (off-site) risk to human health.

The five alternatives provide varying levels of human health protection and the environmental protection.

Alternative 1 (No Action) would not be protective of human health or the environment. This alternative would still restrict groundwater usage within the BAAP boundary. This alternative would result in the Army terminating the residential and monitoring well sampling program. Alternative 1 fails this threshold criterion.

Alternative 2 (MNA and Alternate Water Supply) would provide protection of human health and the environment due to groundwater access restrictions within the BAAP boundary and the provision of an alternate water supply condition for residential wells. The groundwater sampling program would monitor the groundwater concentrations for compliance and contaminant reduction.

Alternatives 3 (Pump and Treat) and 4 (In-Situ Anaerobic Bioremediation would provide protection of human health and the environment by reducing the groundwater contaminants. They would also restrict groundwater usage within the BAAP boundary. The provision of the alternate water supply condition would address concerns associated with residential well impacts. The groundwater sampling program would monitor the groundwater concentrations for compliance and contaminant reduction.

Alternative 5 (Well Replacement) would be protective of human health but not the environment. The Army would provide clean potable water to potential domestic groundwater users. There would be no route of entry through groundwater consumption, eliminating the risk of exposure through groundwater. There would be no active groundwater remediation performed. Alternative 5 fails this threshold criterion.

5.7.2 Compliance with ARARs

CERCLA and the NCP require that remedial actions at least attain legally applicable or relevant and appropriate Federal and State requirements, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law, which are collectively referred to as "ARARs," unless such ARARs can be waived. The USEPA defines three types of ARARs: action-specific, chemical-specific, and location-specific.

Alternative 1 (No Action) would not comply with ARARs and provide no groundwater monitoring.

Alternatives 2, 3, 4, and 5 would comply with ARARs. The evaluation did not identify any location-specific ARARs. Listed below are the ARARs that apply.

- National Primary Drinking Water Regulations: 40 CFR Part 141 Subpart G (chemical-specific).
- Wisconsin Groundwater Standards: Chapter NR 140 Groundwater Quality (chemical-specific).
- Residential Well Construction Standards: Chapter NR 812 Well Construction and Pump Installation (action-specific). Requirements for installing water supply wells and extracting groundwater.

5.7.3 Long-term Effectiveness and Permanence

Alternative 1 (No Action) would not be effective in reducing the risk associated with contaminated groundwater and provides no controls to prevent exposure over time.

Alternative 2 (MNA and Alternate Water Supply) offers a long-term solution as groundwater concentrations are expected to decrease as the chemicals would undergo a slow natural degradation process. Alternative 2 would be the least effective alternative.

Alternative 3 (Pump and Treat) would reduce DNT concentrations through groundwater removal and treatment. Maintaining hydraulic control of groundwater must occur throughout the treatment process to be effective.

Alternative 4 (In-Situ Anaerobic Bioremediation) would reduce DNT concentrations through in-situ anaerobic biodegradation. The bioremediation process permanently destroys the groundwater contaminants. Alternative 4 would be an effective long-term solution. Alternative 4 would be the most effective long-term alternative and the most permanent for treatment of DNT contaminated groundwater.

Alternative 5 (Well Replacement) would provide receptors with long-term access to clean potable water. Groundwater concentrations are expected to decrease as the chemicals would undergo a slow natural degradation process. This alternative would be an effective long-term and permanent solution.

5.7.4 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Alternative 1 (No Action) would not reduce the toxicity, mobility, and volume of contaminants because it does not include a treatment component. This alternative does not meet the statutory preference for the use of treatment as a principal element for the reduction of toxicity, mobility, and volume of hazardous substances.

All other alternatives, except Alternative 2 (MNA and Alternate Water Supply) and Alternative 5 (Well Replacement), have the potential to be effective at reducing the toxicity, mobility, and volume of the COCs through treatment. Alternatives 2 and 5 would have limited reductions in toxicity, mobility, and volume as the contaminants would only naturally degrade.

Alternative 3 (Pump and Treat) would use groundwater extraction and treatment to decrease the toxicity and volume of impacted groundwater and decrease the mobility of groundwater impacts through hydraulic control.

Alternative 4 (In-Situ Anaerobic Bioremediation) would achieve the greatest overall decrease in toxicity and volume of the DNT in groundwater through in-situ anaerobic biodegradation.

5.7.5 Short-Term Effectiveness

Alternative 1 (No Action) would have no short-term impacts and not involve site activities.

Alternative 2 (MNA and Alternate Water Supply) would have no short-term impacts and no additional work associated with implementation.

Alternative 3 (Pump and Treat) would have moderate short-term impacts to workers, residents and the environment during implementation. Construction of extraction wells, mobile treatment units, and underground discharge piping would cause the impacts. Both on-site and off-site construction would occur. Once construction was completed, short-term impacts would be limited to vehicle activity.

Alternative 4 (In-Situ Anaerobic Bioremediation) would have moderate short-term impacts to workers, residents, and the environment during implementation. Installation of the temporary vertical injection wells would cause the impacts. Both on-site and off-site construction would occur. Once construction was completed, short-term impacts would be limited to vehicle activity.

Alternative 5 (Well Replacement) would have moderate short-term impacts to workers, residents and the environment during implementation. Installation of new homeowner wells would cause impacts to private property.

5.7.6 Implementability

Alternative 1 (No Action) would be easy to implement as it would not involve site activities.

Alternative 2 (MNA and Alternate Water Supply) is the most implementable as it is currently being applied.

Alternatives 3 (Pump and Treat), 4 (In-Situ Anaerobic Bioremediation), and 6 (Source Area Treatment) require drilling and construction activities and would be readily implementable using standard construction equipment. The in-situ injection of the biochemical product under Alternative 4 would be more challenging due to varying soil conditions at depth.

5.7.7 Cost

The FS developed the estimated 30-year costs for each alternative. These preliminary cost estimates should be within -30 percent to +50 percent of the actual implementation costs. Table 5.3 shows a summary of the capital costs, O&M costs and total costs.

5.7.8 State Acceptance

Alternatives 1, 2, and 5 may not be acceptable to the WDNR because they would not perform any active groundwater remediation and would not achieve the RAOs. Alternatives 3 and 4 may be acceptable to the WDNR based on permanence, long-term protectiveness, and effectiveness. Ultimate WDNR acceptance will be determined during the remedial design phase.

5.7.9 Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends. The community's comments will be described and addressed in the ROD.

Table 5.3
Cost Estimates for Alternatives
Central Plume

	Alternative	Capital Cost	Long-Term Operating Cost	Contingency	Total Cost
1	No Action (Groundwater LUCs)	$0	$0	$0	$0
2	MNA & Alternate Water Supply (Groundwater LUCs and Sampling)	$0	$2,398,538	$0	$2,398,538
3	Active GW Remediation - Pump & Treat (Alternate Water Supply, MNA, Groundwater LUCs and Sampling)	$8,674,059	$7,953,709	$1,387,849	$18,015,617
4	Active GW Remediation - Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling)	$20,103,428	$399,756	$3,216,548	$23,719,733
5	Well Replacement - Plume Area (MNA, Groundwater LUCs and Sampling)	$1,150,000	$1,997,172	$184,000	$3,331,172

5.8 Summary of the Preferred Alternative for Central Plume

The Army's preferred remedial alternative is Active Groundwater Remediation - Anaerobic Bioremediation (Alternate Water Supply, MNA, Groundwater LUCs and Sampling) - Alternative 4. Alternative 4 will target remediating the impacted groundwater with elevated DNT concentrations. The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT). Alternative 4 will include in-situ bioremediation (biochemical) treatment utilizing temporary vertical injection wells to administer the biochemical product into the contaminant plume. The vertical injection locations will be located both on-site and off-site. Shown on Figure 18 is a conceptual plan for in-situ bioremediation treatment (Alternative 4) with the anticipated treatment lines of vertical injection wells. The locations of the vertical injection wells and the horizontal and vertical extent of in-situ treatment will be determined during the remedial design phase.

The preferred remedial action for the Central Plume will reduce potential exposure risks associated with the contaminated groundwater. The in-situ treatment of DNT in the Central Plume will positively affect groundwater by reducing the potential for DNT impacted groundwater to migrate downgradient towards residential properties. Groundwater monitoring and MNA will verify contaminant level reduction and provide protection to residential drinking water supplies. LUCs will restrict groundwater use within the property boundaries of the BAAP. These LUCs will continue until COC levels in groundwater allow for unrestricted use and unlimited exposure. If needed, the remedial action will also include a provision for an alternate water supply condition including bottled water or well replacement.

6.0 NITROCELLULOSE PRODUCTION AREA PLUME

6.1 Site Background

The northwest portion of BAAP is the source of DNT contaminated groundwater in the Nitrocellulose Production Area (NC Area) Plume (see Figure 2). The production of smokeless gunpowder and NC occurred in this area. DNT was a component of the manufacturing process. These production areas were connected to the main industrial sewer network. The production related wastewater may have leaked into the soil beneath the piping network or beneath the production buildings.

Soil investigation and subsequent contaminated soil excavation activities were conducted around and beneath production buildings. The former DNT Screen House (located in the middle of the NC Area Plume) was identified as a specific source of DNT contamination. Containers of solid DNT were brought to the DNT Screen House. The solid DNT was ground up and screened to remove foreign material. The screened DNT was then distributed to mixing operations within the NC Production Area. DNT contaminated soil was excavated from around a sewer sump, around and beneath the DNT Screen House. Beneath some building basements, DNT contaminated soil was identified and then excavated. In addition, the industrial sewers were removed and the surrounding soil excavated. The Army has not conducted any active groundwater remediation in the NC Area Plume.

6.2 Groundwater Contamination

As described above, the source of groundwater contamination was the discharge of production related wastewater and production activities. Figure 19 displays the current monitoring well sampling frequency associated with the NC Area Plume. The NC Area Plume is approximately ¾ mile long and ¼ mile wide. The extent of the NC Area Plume remains within the BAAP boundary. In the future, the NC Area Plume could comingle with the PBG Plume. There are no residential wells located within 2 miles downgradient (south) of the NC Area Plume. Currently, groundwater contamination is being monitored through recurring sampling as directed by the WDNR. Groundwater contamination remains in the surficial sand and gravel aquifer and has not migrated into the bedrock.

Detected concentrations from groundwater samples collected from 2015 to 2018 were compared to the Wisconsin Chapter NR 140 ES and PAL (screening levels). The RI/FS summarized the groundwater data. The following chemicals exceeded the screening levels and identified as COPCs for the NC Area Plume:

Table 6.1
Groundwater COPCs
Nitrocellulose Production Area Plume

Contaminants of Potential Concern (COPCs)	Maximum Concentration 2015 - 2018	Chapter NR 140 Wisconsin Groundwater Quality Standards		Well & Date of Maximum Concentration
		Preventive Action Limit (PAL)	Enforcement Standard (ES)	
2,6-Dinitrotoluene (1)	0.22	0.005	0.05	RIM-1002 (9/26/18)
Total Dinitrotoluene (2)	0.22	0.005	0.05	RIM-1002 (9/26/18)

Notes:
(1) The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (Total DNT).
(2) Total DNT consists of isomers (2,3-DNT; 2,4-DNT; 2,5-DNT; 2,6-DNT; 3,4-DNT; 3,5-DNT)
All concentration values are expressed in micrograms-per-liter (µg/l)

Figure 20 is a total DNT isoconcentration map for the NC Area Plume. The isoconcentration map was prepared using all groundwater data collected during 2018. The total DNT isoconcentrations shown on Figure 20 are broken into two-color designations. The green shaded areas indicate where total DNT is above the NR 140 PAL (0.005 µg/l). The blue shaded areas indicate where total DNT is above the NR 140 ES (0.05 µg/l). The highest concentration of total DNT, detected during 2018, was in monitoring well RIM-1002. RIM-1002 is located in the northern portion of the NC Area Plume. Total DNT concentrations in the NC Area Plume have been stable.

6.3 Scope and Role of the Proposed Action

The scope and role of the action discussed in this PP includes all the groundwater remedial actions planned for the NC Area Plume. The preferred groundwater remedial action will reduce potential risks associated with exposure to contaminated groundwater in the sand and gravel aquifer.

Local residents have historically used groundwater outside the BAAP boundary as a drinking water source. The NC Area Plume is expected to remain within the BAAP boundary and not impact off-site drinking water. When establishing the RAOs for this response action, the Army has considered the NCP’s expectation to return groundwater to its beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. The Army intends to return the contaminated sand and gravel aquifer at BAAP to its potential beneficial uses, which is considered to be total DNT concentrations below the NR 140 ES, to the extent practicable.

6.4 Summary of Site Risks

The Army performed a risk assessment to determine and document whether groundwater contamination in the NC Area Plume poses a potential current or hypothetical future risk to human health. CERCLA requires the completion of a HHRA prior to selecting a remedial alternative. The HHRA must evaluate the potential human health risks associated with chemical exposure to environmental media (e.g., groundwater, vapor). The HHRA was conducted using standard USEPA risk assessment guidance, exposure assumptions, and toxicity factors. The USEPA risk assessment process uses conservative assumptions about exposure to chemicals and their toxicity so that risks reported are not underestimated. In all circumstances, priority was given to evaluating the potential human health risk regardless of the impact.

The HHRA evaluated two potential human exposure pathways to contaminated groundwater; domestic groundwater uses and vapor intrusion.

Domestic Groundwater Risk

Groundwater located in the NC Area Plume is not used for human consumption. The former BAAP land was transferred from the Army to other property owners and includes a deed restriction on the use of groundwater. This restricts the potential exposure to groundwater within the boundary of BAAP. These groundwater access restrictions state that the property owner "shall not access or use groundwater underlying the property for any purpose without the prior written approval of the Army and the WDNR". There are no residential wells located within 2 miles downgradient (south) of the NC Area Plume. In addition, there are no off-site monitoring wells associated with the NC Area Plume.

Hypothetical future (on-site) risks were evaluated using groundwater data from monitoring wells. The maximum groundwater concentration of each COPC during 2015, 2016, 2017, and 2018 were used to estimate the risks. Hypothetical future on-site risks apply if groundwater on-site (within BAAP) will be used for domestic water in the future.

The groundwater risk estimates were calculated for each COPC using the maximum groundwater concentrations and a simple scaling method described in Section 2.6.1 of the USEPA's RSLs – User's Guide (November 2018). These calculations use the USEPA's RSL Resident Tapwater Generic Table (November 2018).

Both the cancer and non-cancer risk calculations were below the risk management criteria. Based on the maximum risk scenario, the NC Area Plume represents an area where cumulative risk estimates are below the risk management criteria, and so no COCs were identified. The HHRA determined that contaminated groundwater in the NC Area Plume does not pose a hypothetical future risk to groundwater usage by humans.

Table 6.2
Groundwater COCs & Cleanup Levels
Nitrocellulose Production Area Plume

Contaminant of Concern (COC) - HHRA						Groundwater Cleanup Level (1)
Cancer Risk			Non-Cancer Risk			
COC	On-Site	Off-Site	COC	On-Site	Off-Site	
2,6-Dinitrotoluene	none		none			0.05

Notes:
(1) The Groundwater Cleanup Level is the NR 140 Enforcement Standard (ES)
Based on analytical lab results from residential and groundwater monitoring well samples from 2015, 2016, 2017, and 2018.
All concentration values are expressed in micrograms-per-liter (µg/l)

Vapor Intrusion Risk

The vapor intrusion pathway was considered in the HHRA. An evaluation was conducted to determine whether vapors from the NC Area Plume pose a current or hypothetical future risk to human health. Vapor intrusion occurs when there is a migration of vapor-forming chemicals from a subsurface source (e.g., contaminated groundwater) into an overlying building. There are no on-site buildings located over the NC Area Plume. The HHRA did not identify vapor intrusion risks from groundwater contamination.

6.5 Remedial Alternative Selection

The HHRA did not identify any unacceptable risk to human health or the environment for the NC Area Plume; therefore, the FS did not develop remedial alternatives. Under CERCLA, remedial decisions must be based on risk. If the risk assessment determines there is no risk, then a no-action decision can be made.

Groundwater monitoring will verify contaminant level reduction within the NC Area Plume. The Army will continue to perform groundwater monitoring until the WDNR deems it unnecessary. LUCs will restrict groundwater use within the property boundaries of the BAAP. These LUCs will continue until COPC levels in groundwater allow for unrestricted use and unlimited exposure.

7.0 COMMUNITY PARTICIPATION

The Army will provide information about the BAAP groundwater remediation through public meetings, the Administrative Record File, fact sheets, and announcements in the local newspapers: Baraboo News Republic, Sauk Prairie Eagle, and Star News. Site documents are available for public review in the Administrative Record File and Information Repository at the Ruth Culver Community Library, 540 Water Street, Prairie du Sac, Wisconsin, and the George Culver Community Library, 615 Phillips Blvd, Sauk City, Wisconsin. The Information Repository includes the various documents containing findings and recommendations pertaining to the remedy, in addition to what are identified in this PP.

The Army routinely holds RAB meetings to inform the public about environmental cleanup activities performed at BAAP. The Army presented information on the RI/FS at the December 5, 2019 RAB meeting. The public meeting about the PP may coincide with an upcoming RAB meeting.

The Army will review all comments submitted during the comment period. Once reviewed, the Army will make a final decision on a remedial alternative. The public comment period begins on ________, 2023 and ends on ________, 2023. Comments must be postmarked or emailed no later than ________, 2023, to be considered.

The Army, in consultation with the WDNR, will make a final decision on the remedy for BAAP groundwater remediation after the public has had an opportunity to comment. Public comment may lead the Army to modify the proposed remedy. Therefore, the public is encouraged to gain a more comprehensive understanding of the site and comment on this PP, the rationale for the preference for the preferred remedial alternative, and all other remedial alternatives presented during the public comment period. All written comments received during the public comment period will be considered in making a final decision.

The Army will respond to comments received during the public comment period. These responses will be documented in the Responsiveness Summary section of the Record of Decision (ROD). The responses will become part of the site's Administrative Record, in accordance with Section 300.825(a)(2) of the NCP, after the ROD is signed.

HOW TO SUBMIT COMMENTS

There are several ways to comment during the public comment period that runs from __ to __, 2023:

Mail comment to:
U.S. Army Environmental Command
ATTN: ___________________
2455 Reynolds Road Mailstop 112
JBSA Fort Sam Houston, TX 78234-7588

Email comment to:
_________________@army.mil
Please add "BAAP Groundwater Proposed Plan" to the subject line of emails.

The public meeting will be held on ____, 2023 at 6:00 PM Central Standard Time via video conference using Microsoft Teams. Virtual public meeting information will be provided to all RAB members and all community members on the mailing list, as well as any who call or email and request the information. Please call Kay Toye at (520) 903-4363 or email at kay.toye@envrg.com to request access to the public meeting. You will not need to download any software to attend the public meeting; you can use your computer browser or a call-in number will be provided for those without internet access. For questions call _______ between 7:30 a.m. and 4:00 p.m. Central Standard Time.

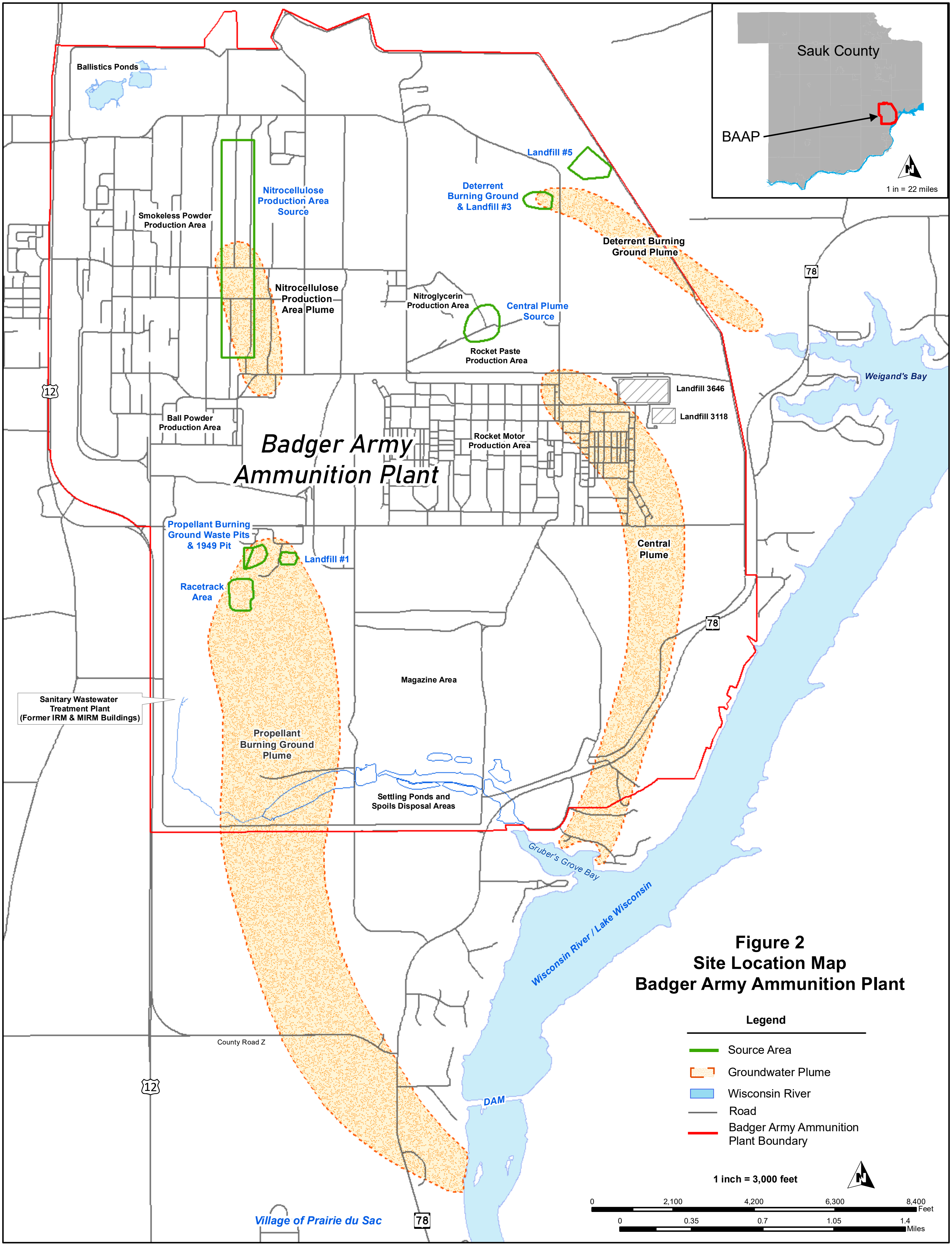
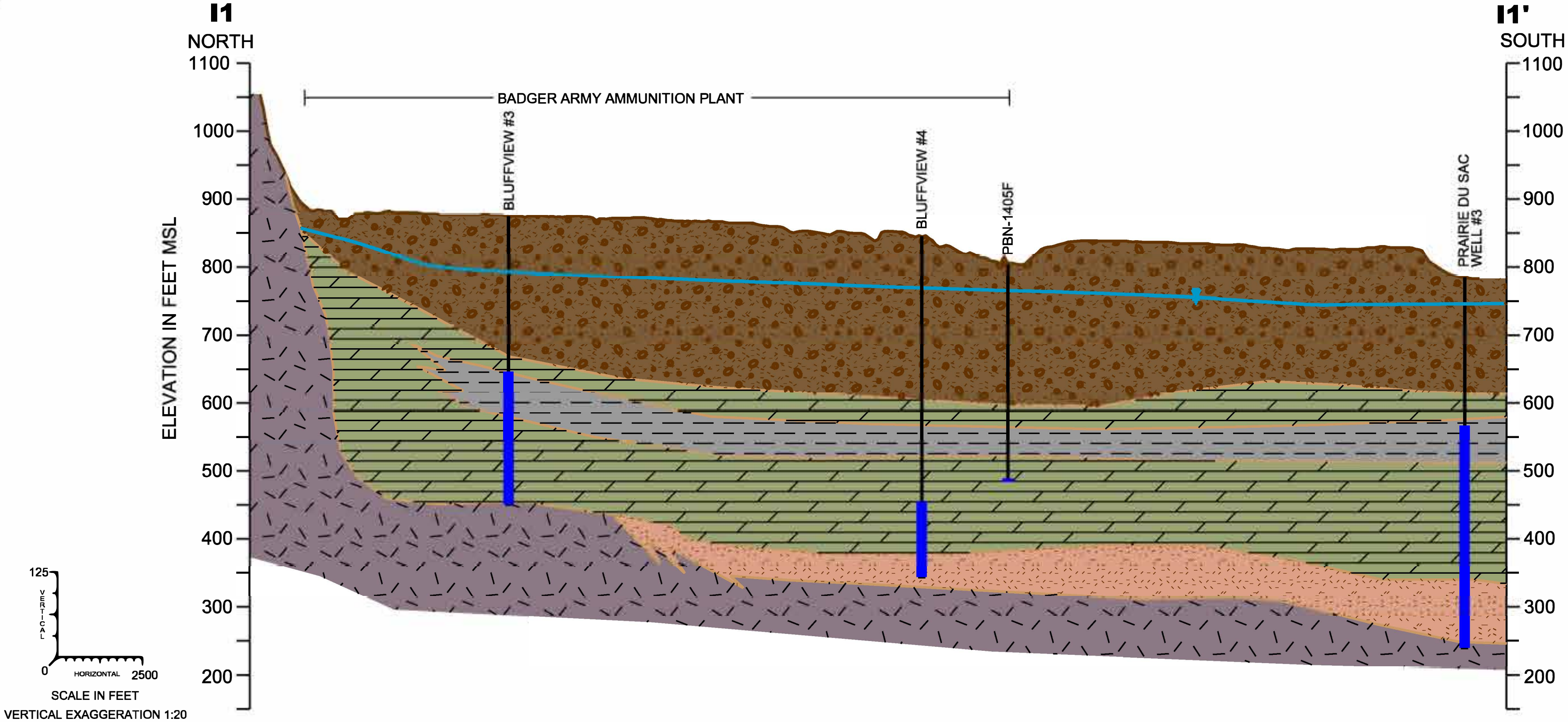


Figure 2
Site Location Map
Badger Army Ammunition Plant



LEGEND

WELL DESIGNATION; SUFFIXES REFER TO WATER TABLE WELL (A) AND PIEZOMETER (B,C,D,E & F)

WELL

GROUND SURFACE

WATER TABLE ELEVATION

WELL SCREEN

BOTTOM OF EXPLORATION

GEOLOGIC DESCRIPTIONS:

SAND AND GRAVEL, AQUIFER

EAU CLAIRE FORMATION, AQUITARD/AQUIFER (SHALE, DOLOMITE, SILTSTONE, SANDSTONE)

EAU CLAIRE FORMATION, AQUITARD (SHALE)

MT. SIMON FORMATION, AQUIFER (SANDSTONE)

BARABOO FORMATION, AQUITARD (QUARTZITE)

NOTES:
ADAPTED FROM GOTKOWITZ AND OTHERS (2005), HYDROGEOLOGY AND SIMULATION OF GROUNDWATER FLOW IN SAUK COUNTY, WISCONSIN

CROSS SECTION LOCATION

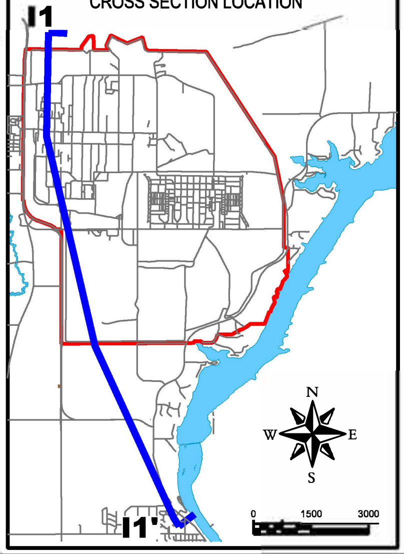


FIGURE 3

GENERALIZED GEOLOGIC CROSS SECTION NORTH-SOUTH BADGER ARMY AMMUNITION PLANT

SPS
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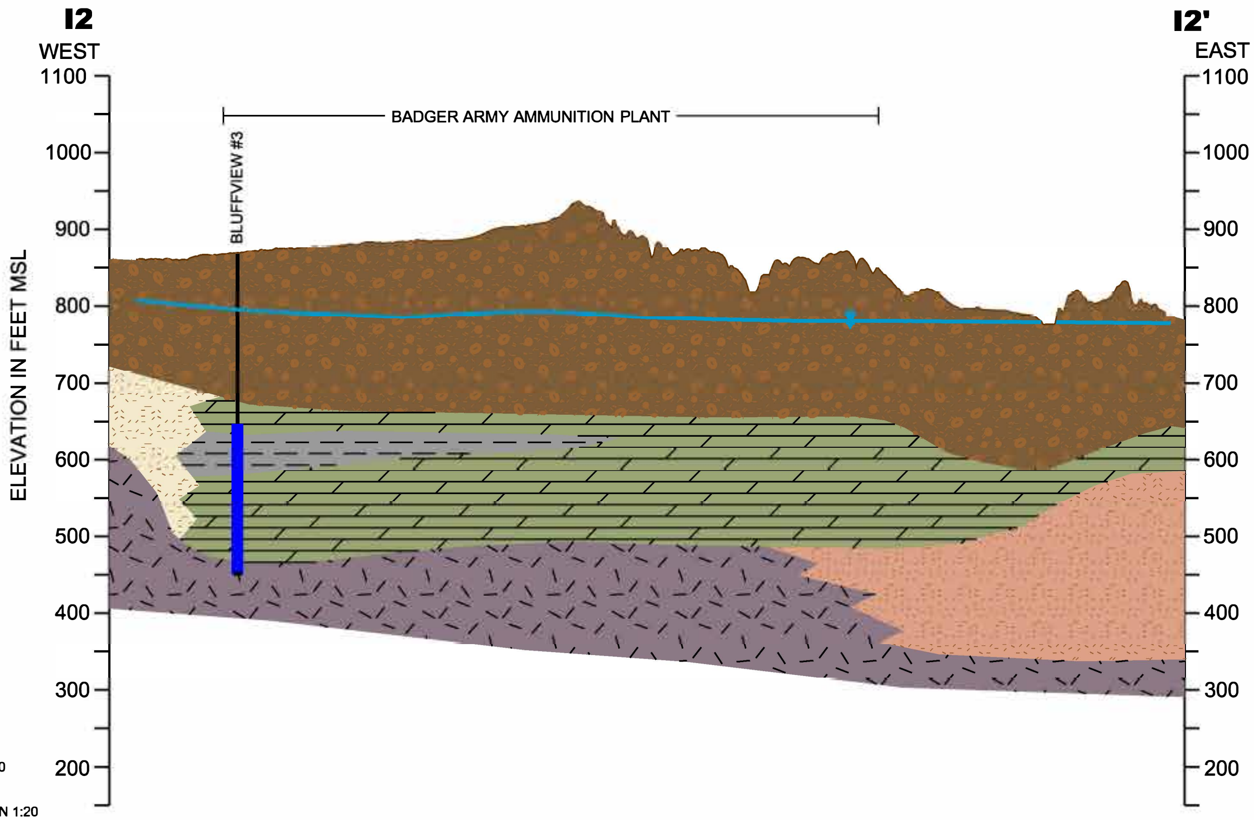
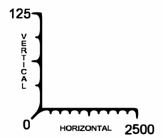
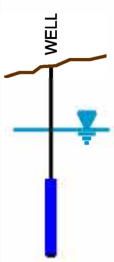




SCALE IN FEET
VERTICAL EXAGGERATION 1:20

LEGEND



WELL DESIGNATION; SUFFIXES REFER TO WATER TABLE WELL (A) AND PIEZOMETER (B,C,D,E & F)

GROUND SURFACE

WATER TABLE ELEVATION

WELL SCREEN

BOTTOM OF EXPLORATION

GEOLOGIC DESCRIPTIONS:

- SAND AND GRAVEL, AQUIFER
- WONEWOC FORMATION, AQUIFER (SANDSTONE)
- EAU CLAIRE FORMATION, AQUITARD/AQUIFER (SHALE, DOLOMITE, SILTSTONE, SANDSTONE)
- EAU CLAIRE FORMATION, AQUITARD (SHALE)
- MT. SIMON FORMATION, AQUIFER (SANDSTONE)
- BARABOO FORMATION, AQUITARD (QUARTZITE)

NOTES:
ADAPTED FROM GOTKOWITZ AND OTHERS (2005), HYDROGEOLOGY AND SIMULATION OF GROUNDWATER FLOW IN SAUK COUNTY, WISCONSIN

CROSS SECTION LOCATION

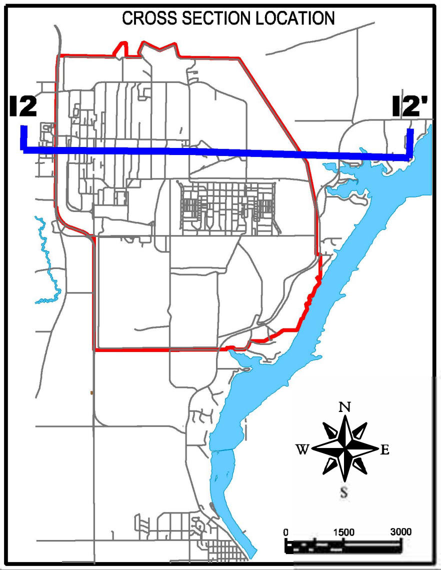


FIGURE 4

GENERALIZED GEOLOGIC CROSS SECTION WEST-EAST BADGER ARMY AMMUNITION PLANT

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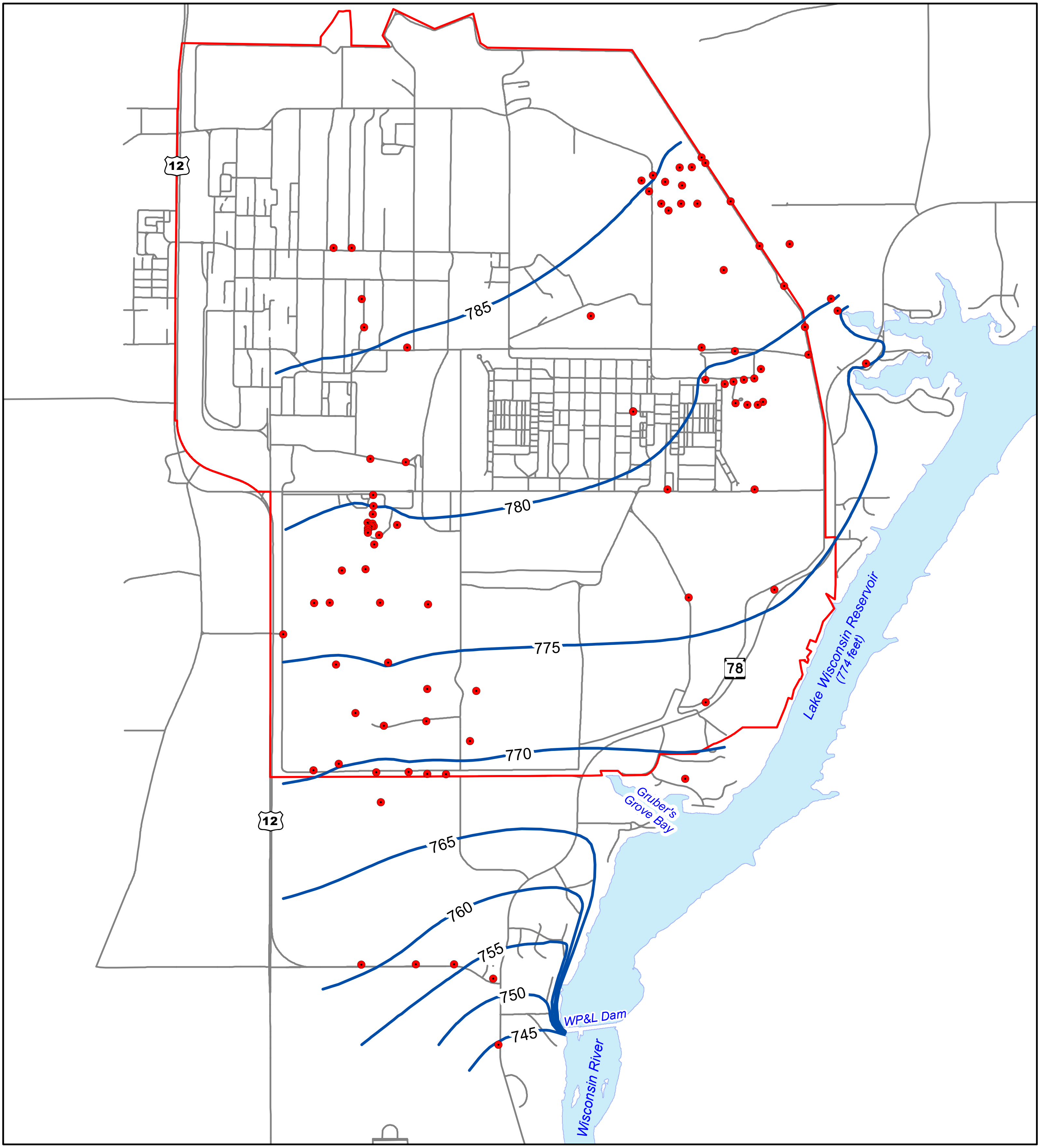

Legend

- Badger Army Ammunition Plant Boundary
- Monitoring Well (used to draw contours)
- Wisconsin River
- Road
- Groundwater Contour (2017)

Contour Interval = 5 feet

Figure 5

Groundwater Contours
Badger Army Ammunition Plant

1 inch = 3,475 feet

0 5,300 10,600 Feet

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N

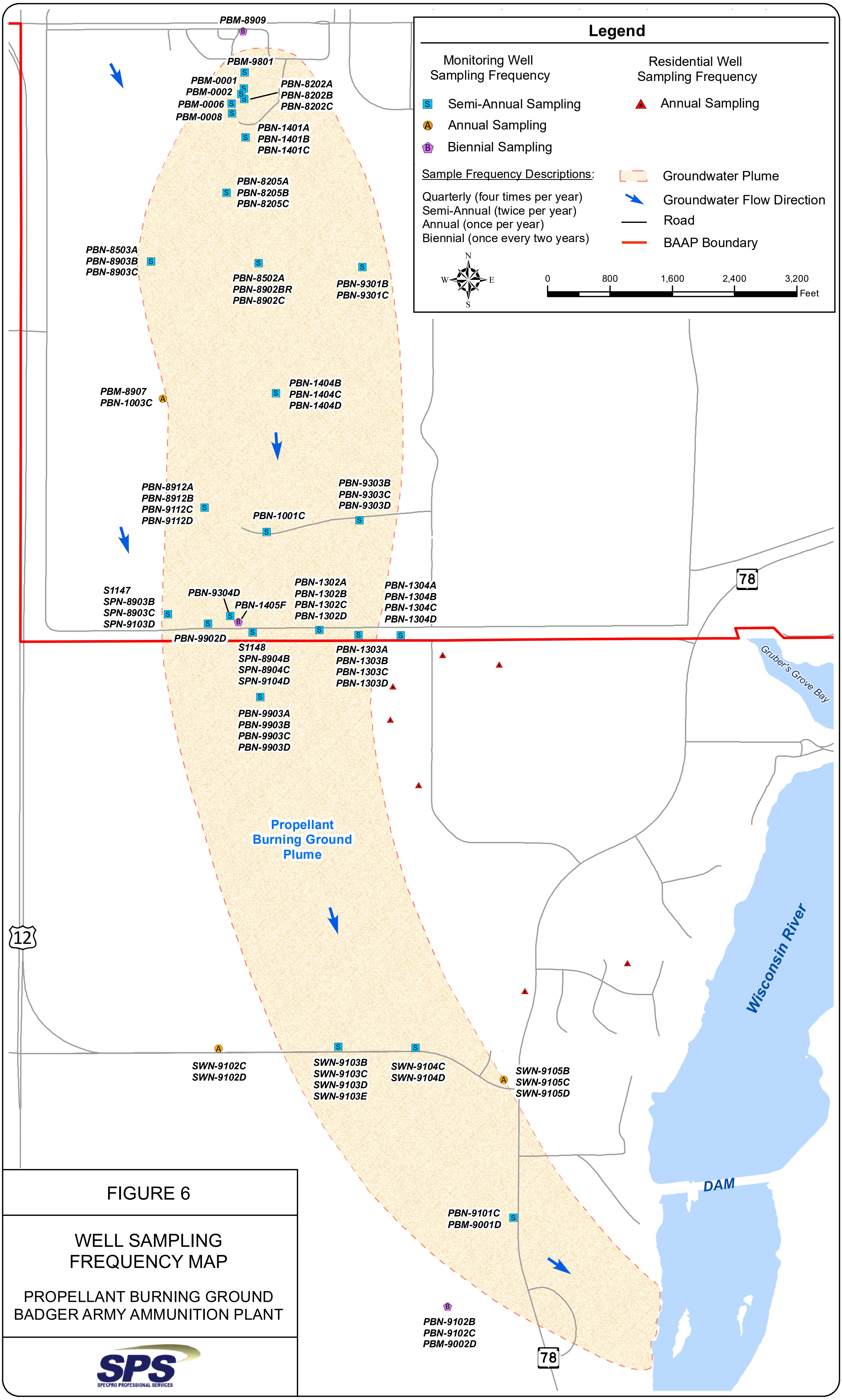


FIGURE 6

WELL SAMPLING FREQUENCY MAP

PROPELLANT BURNING GROUND
BADGER ARMY AMMUNITION PLANT

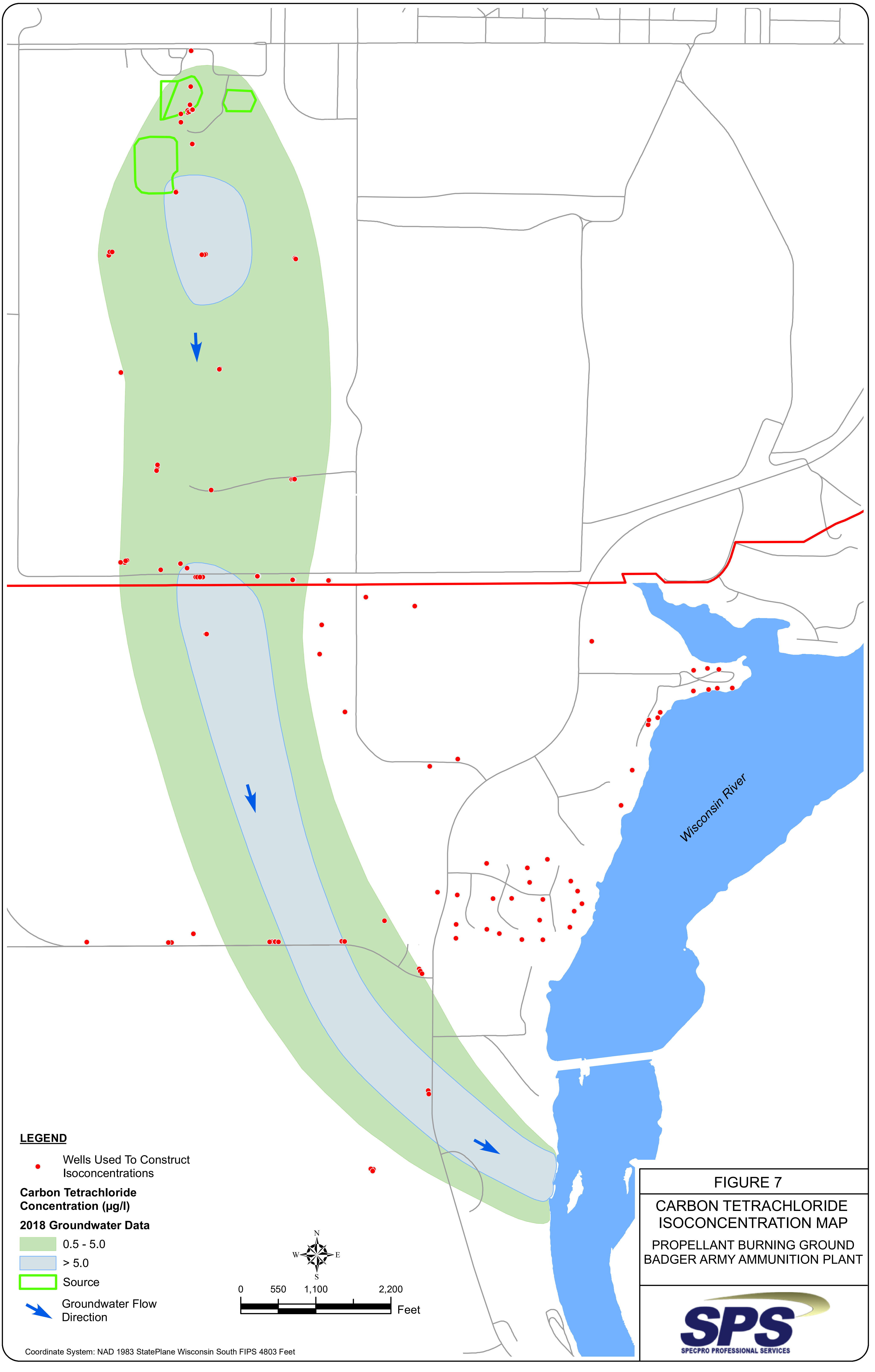
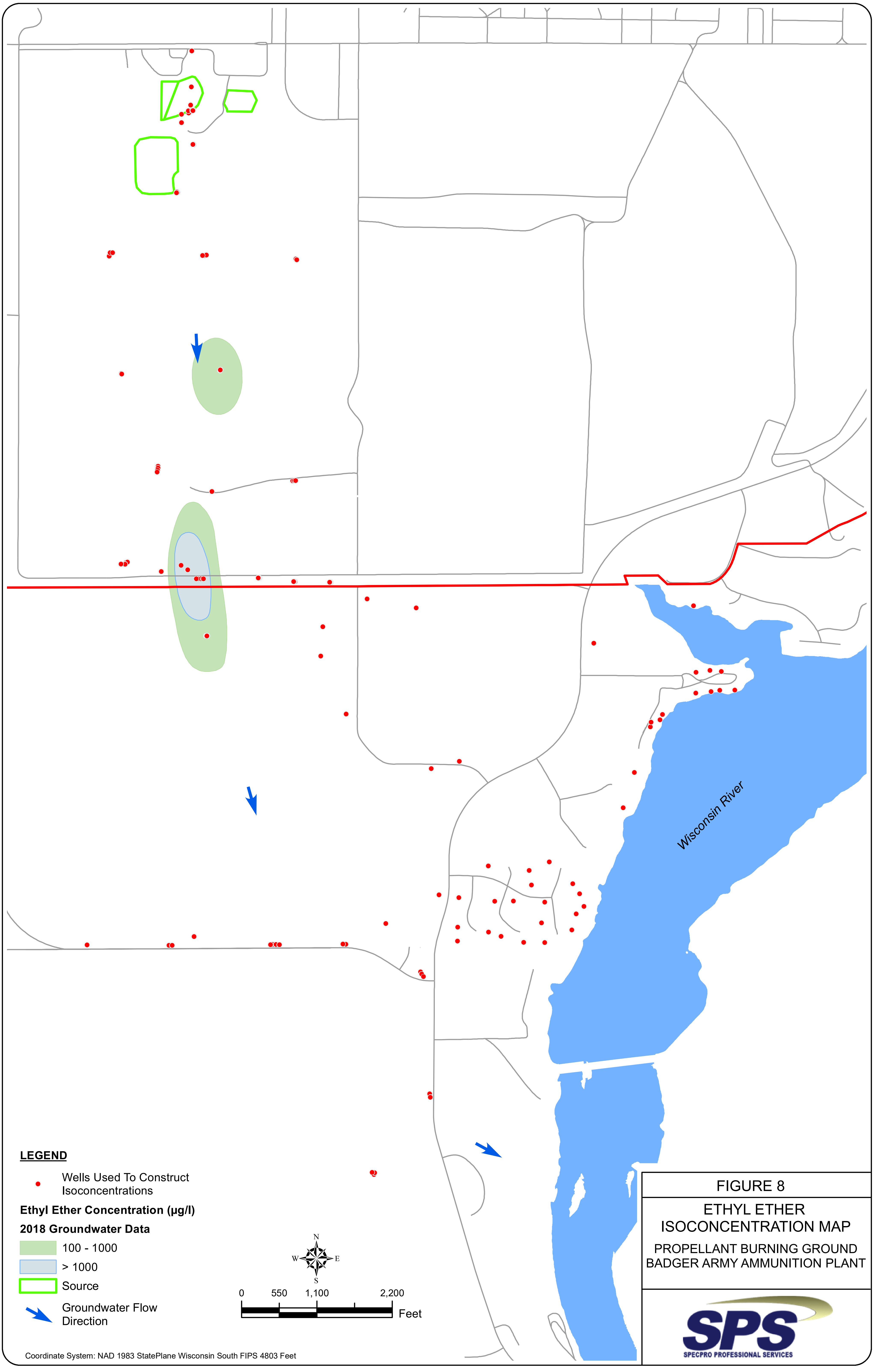


FIGURE 7

CARBON TETRACHLORIDE ISOCONCENTRATION MAP

PROPELLANT BURNING GROUND
BADGER ARMY AMMUNITION PLANT


Wisconsin River
LEGEND
Wells Used To Construct Isoconcentrations
Ethyl Ether Concentration (µg/l)
2018 Groundwater Data
100 - 1000
> 1000
Source
Groundwater Flow Direction
N
W
E
S
0
550
1,100
2,200
Feet
Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
FIGURE 8
ETHYL ETHER ISOCONCENTRATION MAP
PROPELLANT BURNING GROUND
BADGER ARMY AMMUNITION PLANT
SPS
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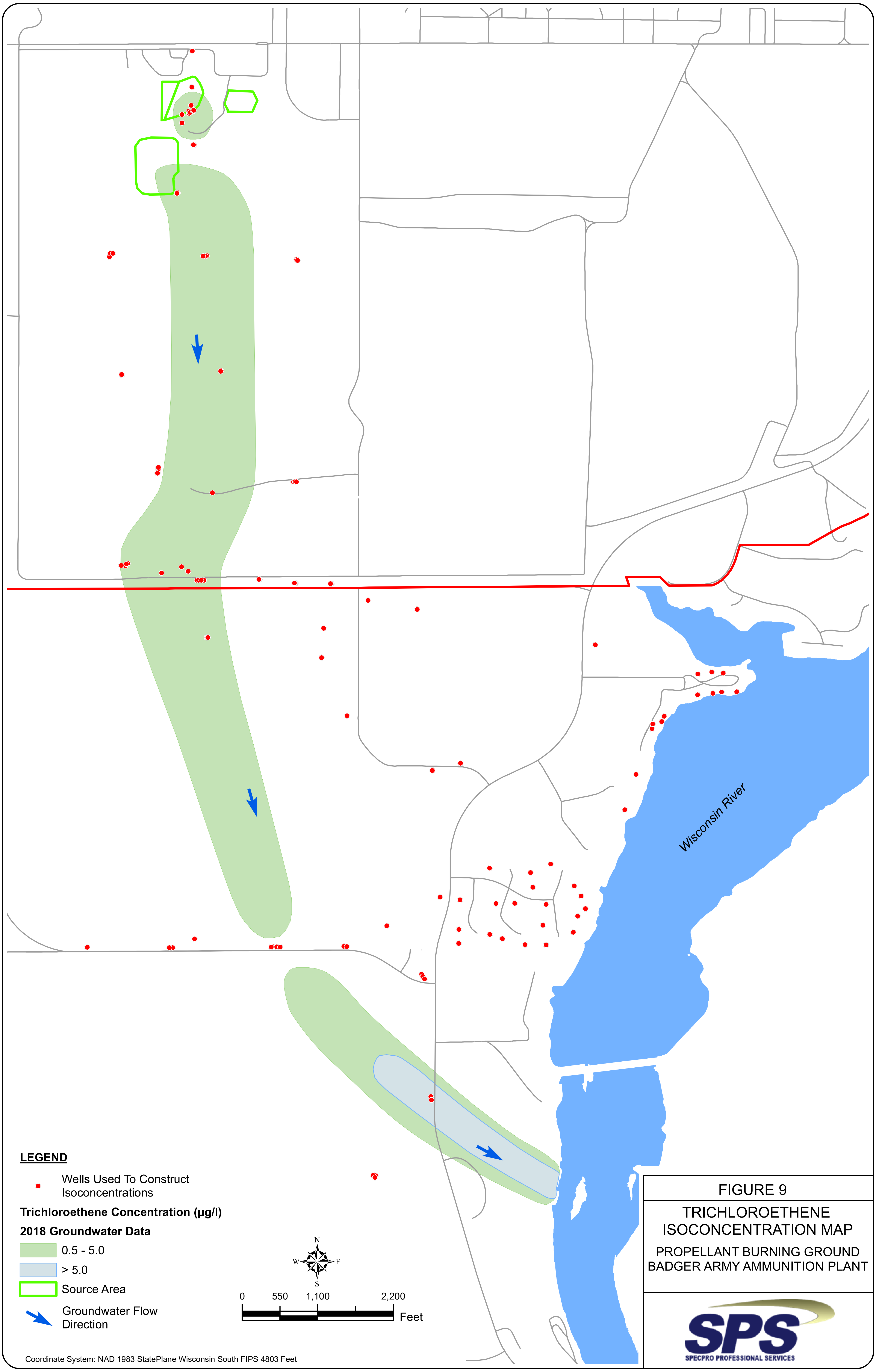


FIGURE 9

TRICHLOROETHENE ISOCONCENTRATION MAP

PROPELLANT BURNING GROUND
BADGER ARMY AMMUNITION PLANT

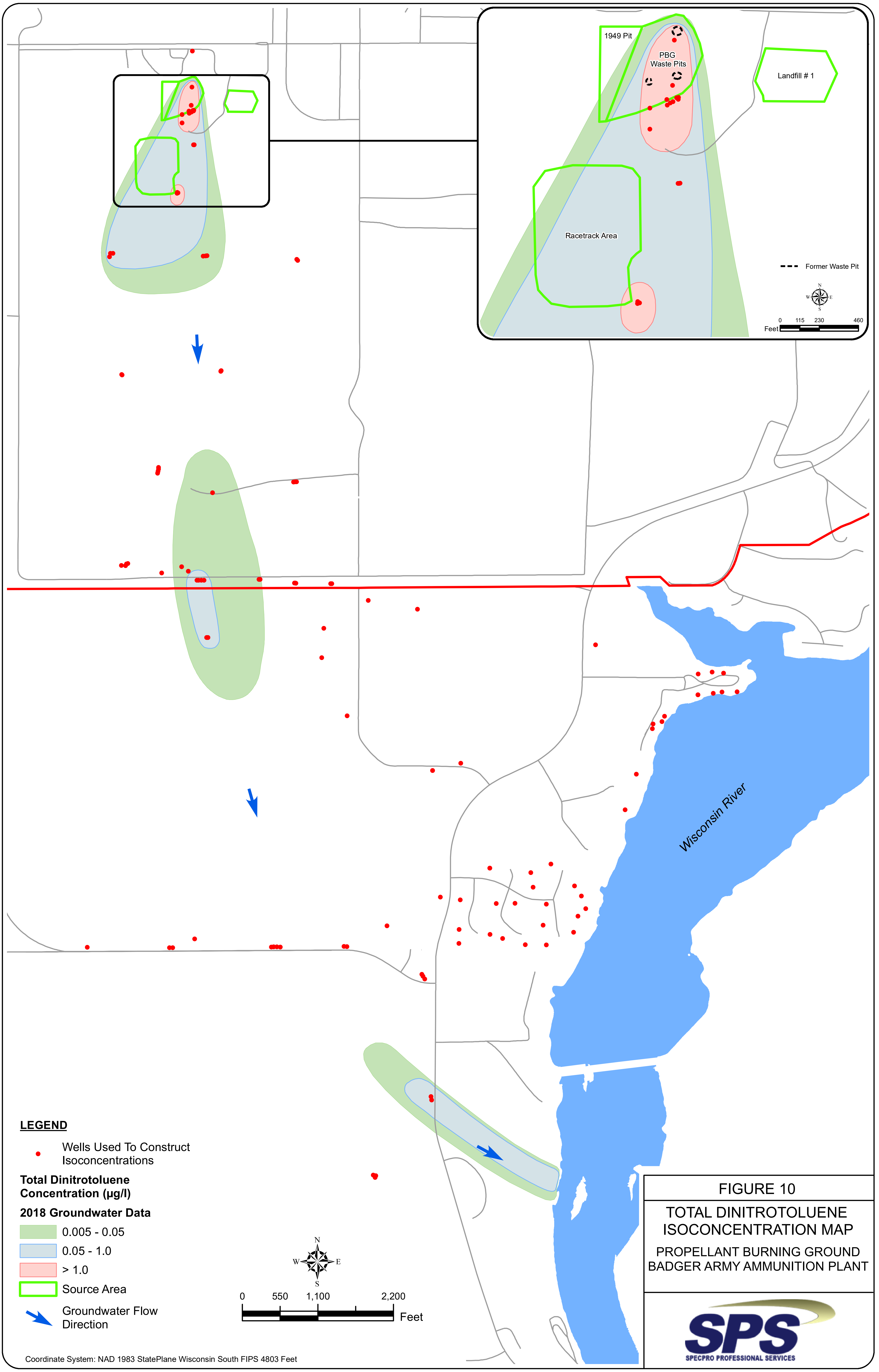
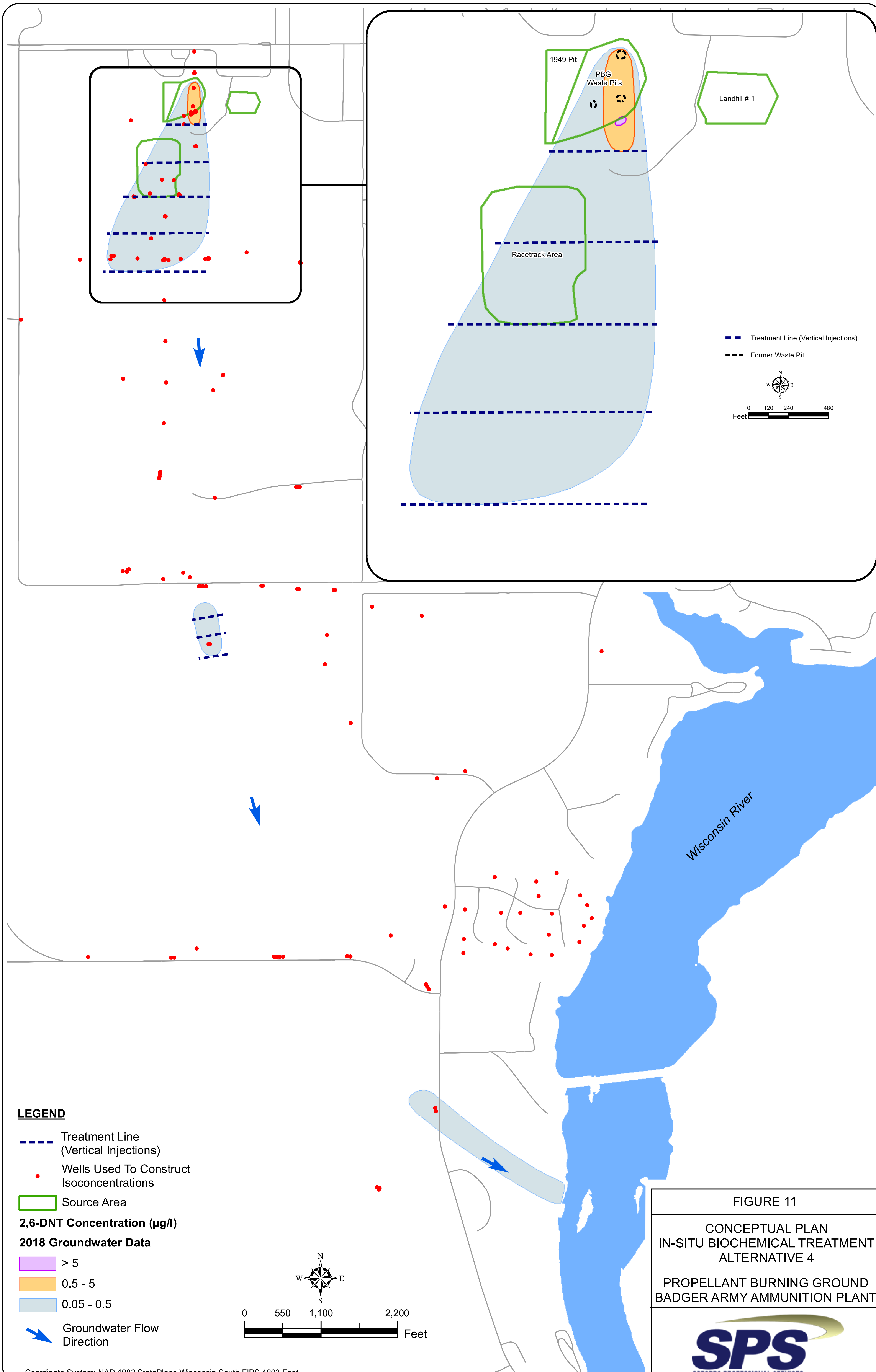


FIGURE 10

TOTAL DINITROTOLUENE ISOCONCENTRATION MAP

PROPELLANT BURNING GROUND
BADGER ARMY AMMUNITION PLANT


1949 Pit
PBG
Waste Pits
Landfill # 1
Racetrack Area
Treatment Line (Vertical Injections)
Former Waste Pit
0 120 240 480
Feet
Wisconsin River
LEGEND
Treatment Line
(Vertical Injections)
Wells Used To Construct
Isoconcentrations
Source Area
2,6-DNT Concentration (µg/l)
2018 Groundwater Data
> 5
0.5 - 5
0.05 - 0.5
Groundwater Flow
Direction
0 550 1,100 2,200
Feet
Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
FIGURE 11
CONCEPTUAL PLAN
IN-SITU BIOCHEMICAL TREATMENT
ALTERNATIVE 4
PROPELLANT BURNING GROUND
BADGER ARMY AMMUNITION PLANT
SPECPRO PROFESSIONAL SERVICES

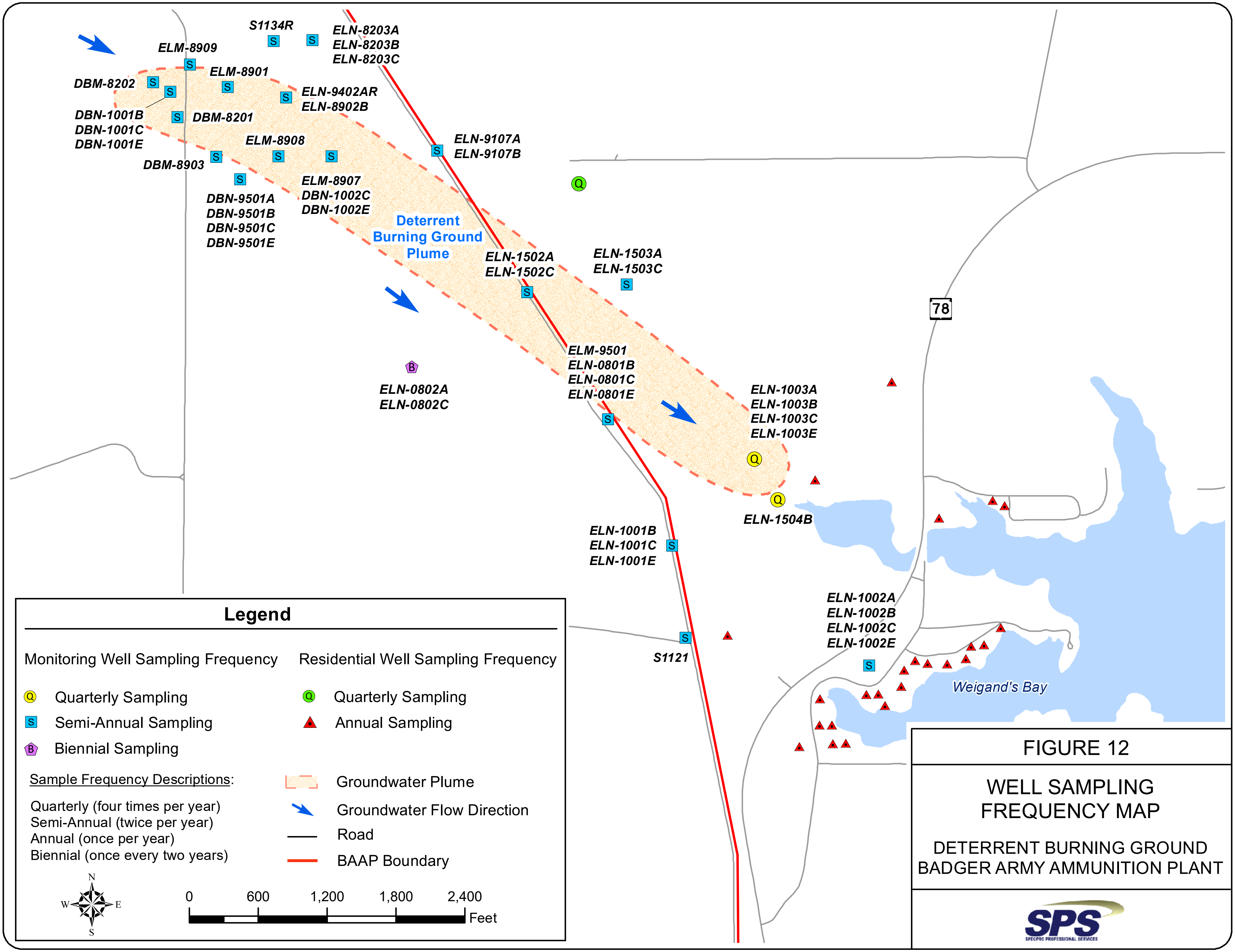


FIGURE 12

WELL SAMPLING FREQUENCY MAP

DETERRENT BURNING GROUND
BADGER ARMY AMMUNITION PLANT

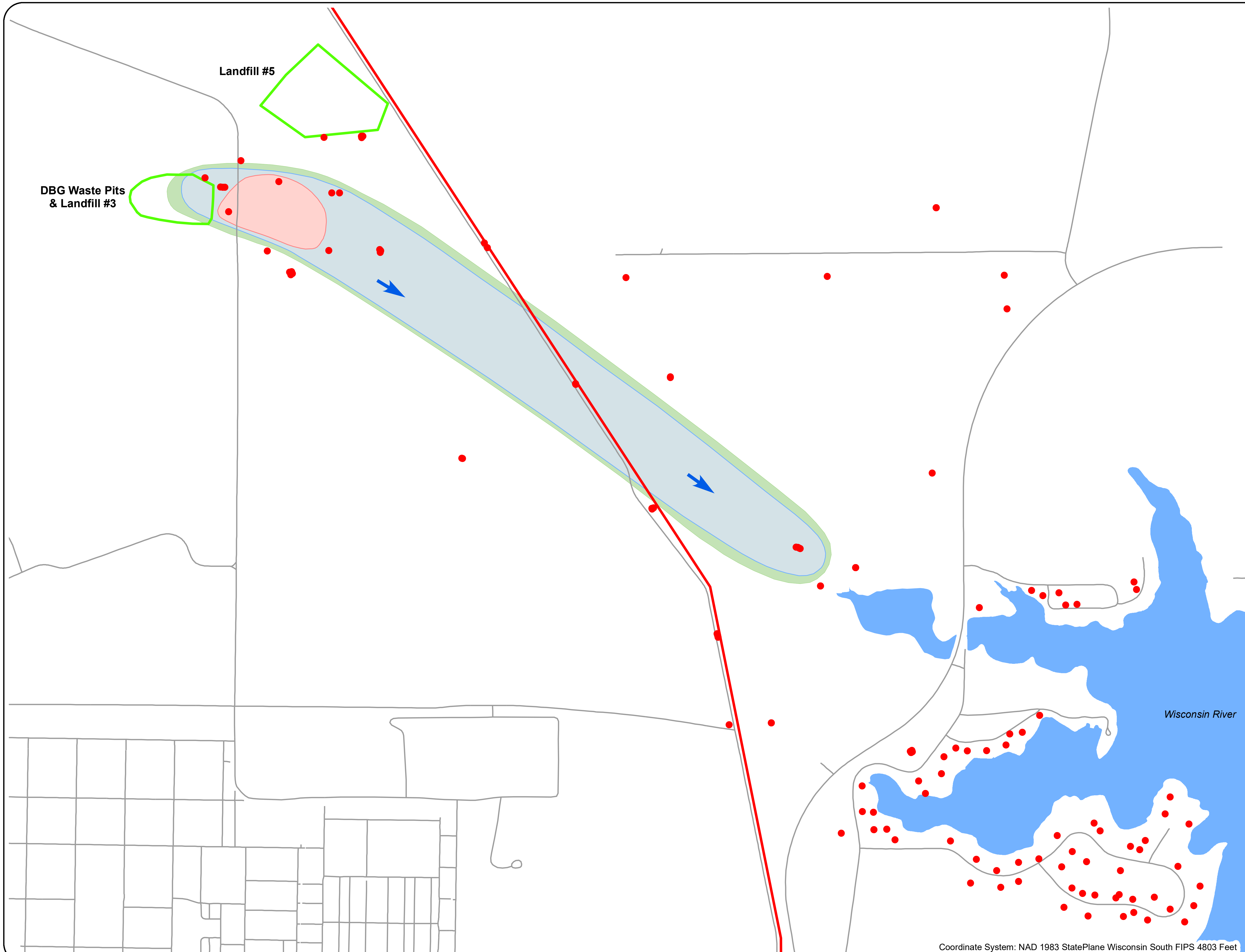


FIGURE 13

TOTAL DINITROTOLUENE ISOCONCENTRATION MAP

DETERRENT BURNING GROUND
BADGER ARMY AMMUNITION PLANT

SPS
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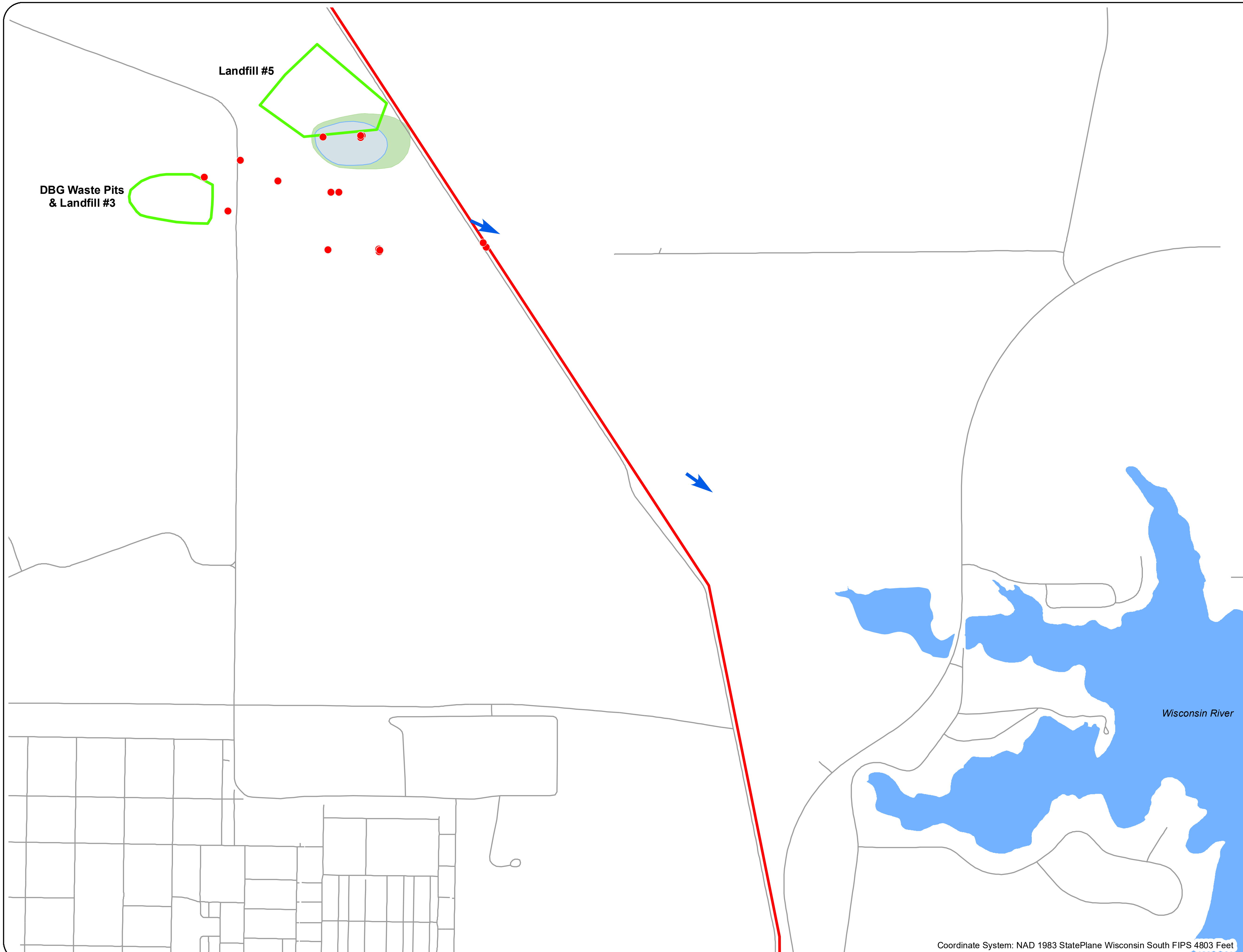

FIGURE 14

SULFATE ISOCONCENTRATION MAP

DETERRENT BURNING GROUND & LANDFILL #5
BADGER ARMY AMMUNITION PLANT

SPS
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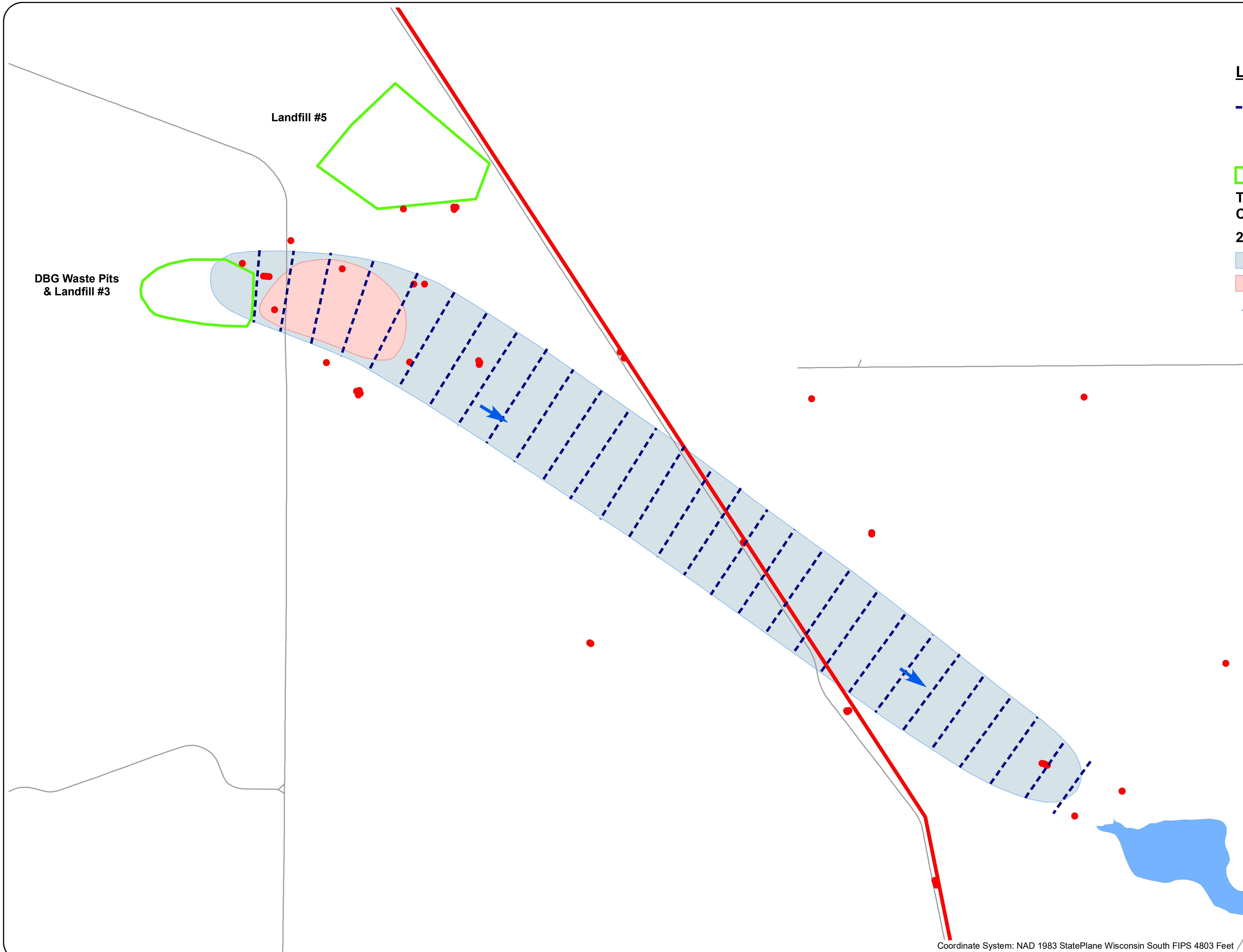


FIGURE 15

CONCEPTUAL PLAN
IN-SITU BIOCHEMICAL TREATMENT
ALTERNATIVE 4

DETERRENT BURNING GROUND
BADGER ARMY AMMUNITION PLANT

SPECPRO PROFESSIONAL SERVICES

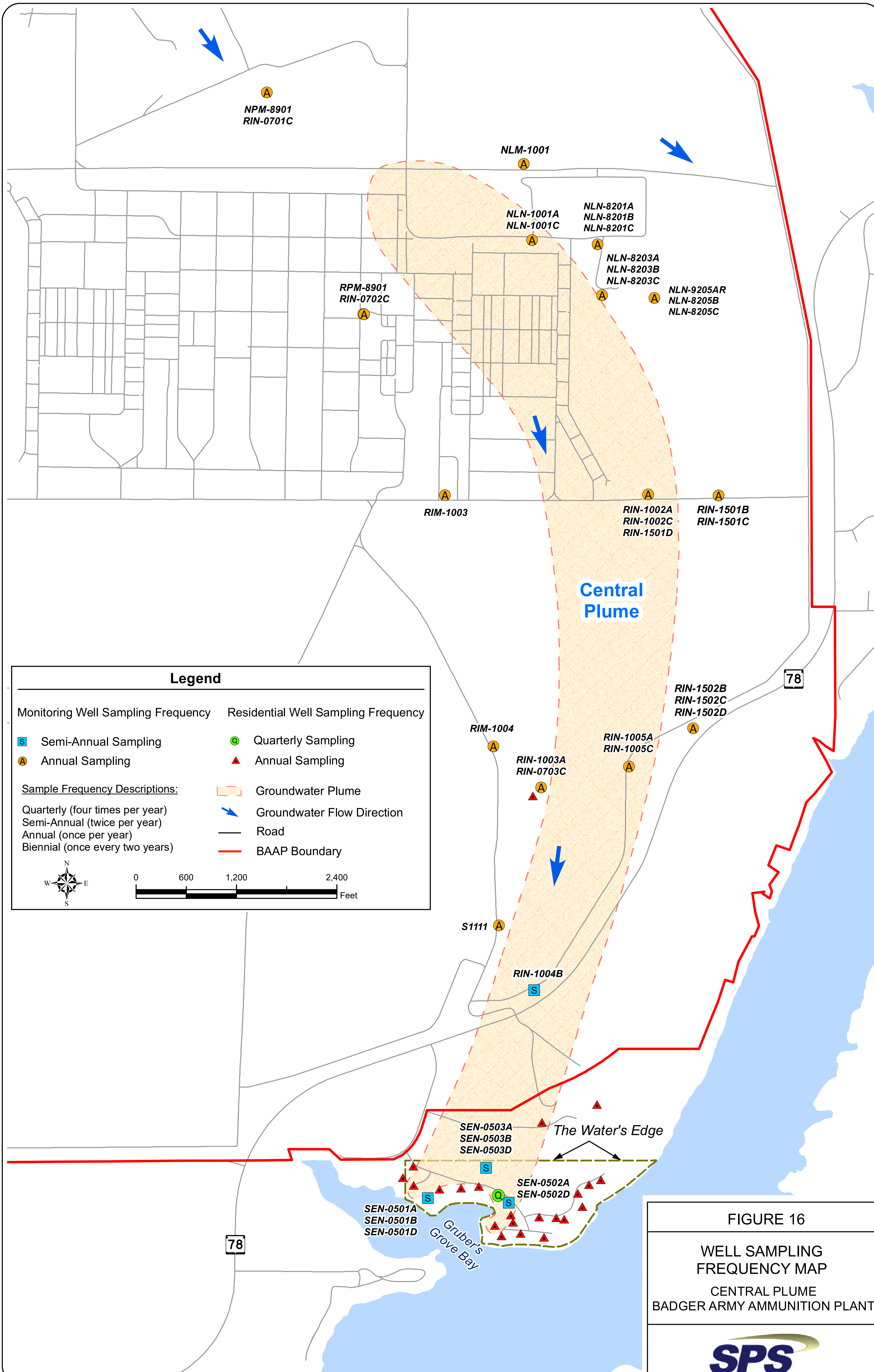


FIGURE 16

WELL SAMPLING FREQUENCY MAP

CENTRAL PLUME
BADGER ARMY AMMUNITION PLANT

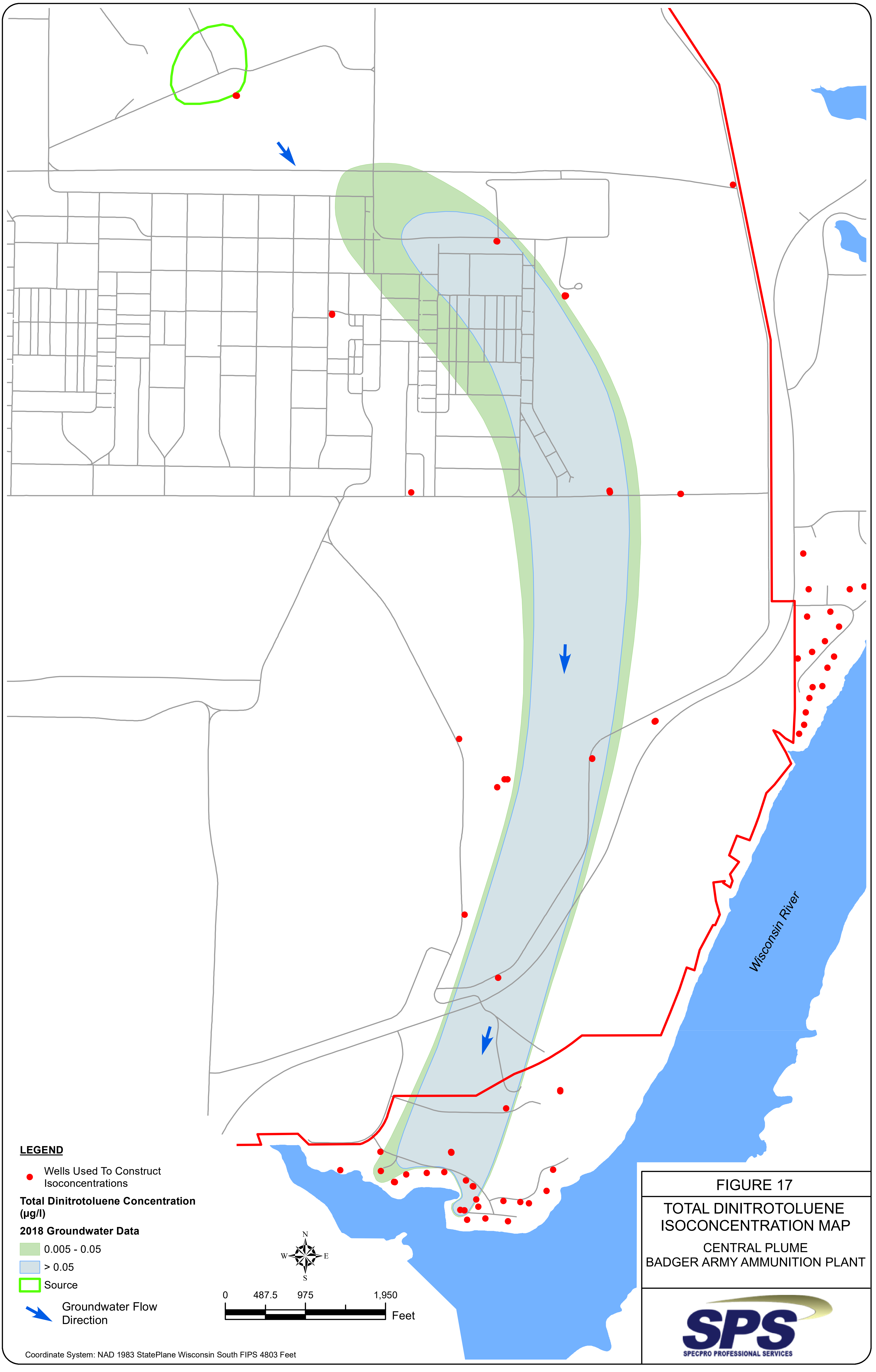


FIGURE 17

TOTAL DINITROTOLUENE ISOCONCENTRATION MAP

CENTRAL PLUME
BADGER ARMY AMMUNITION PLANT

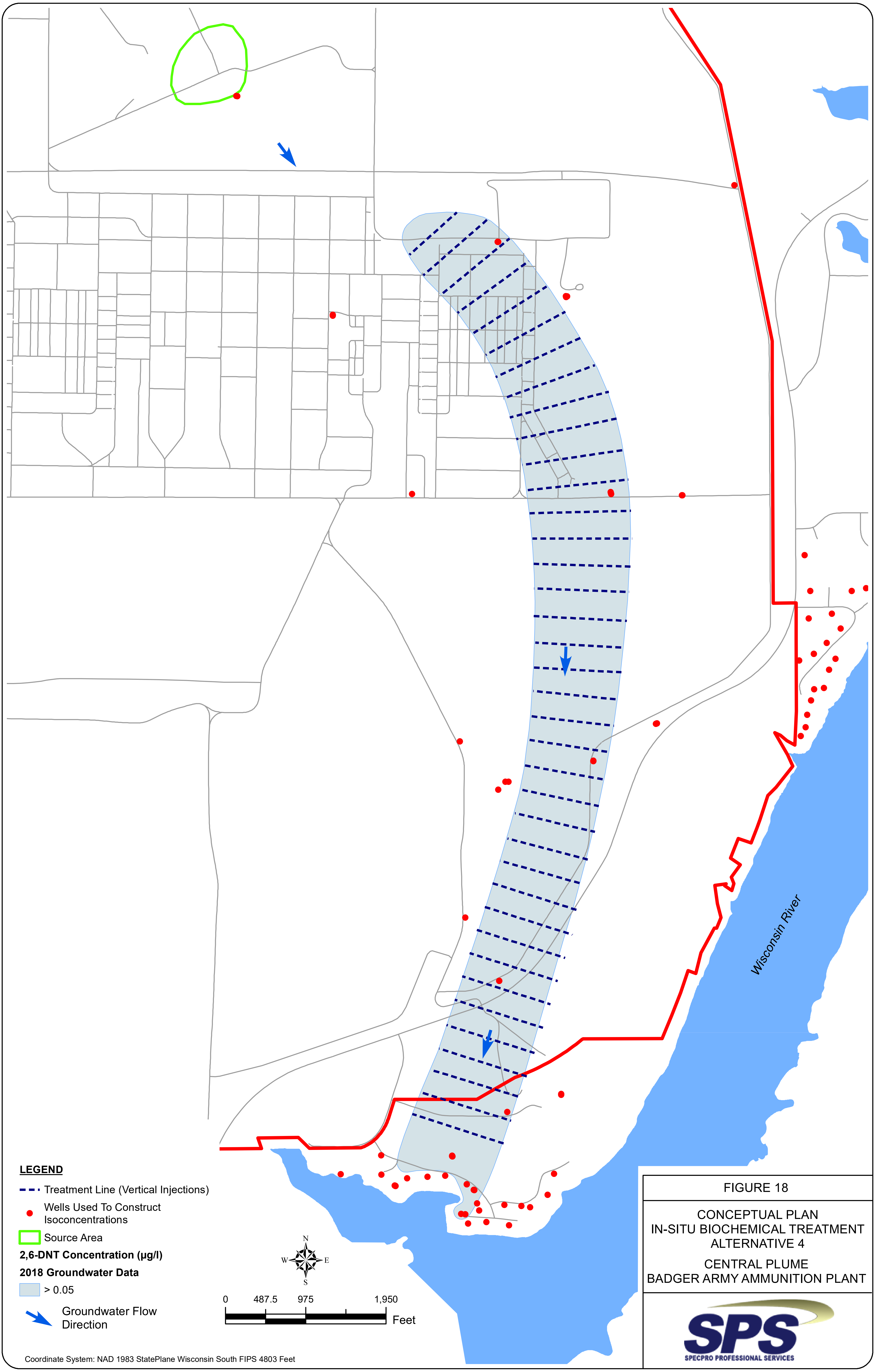
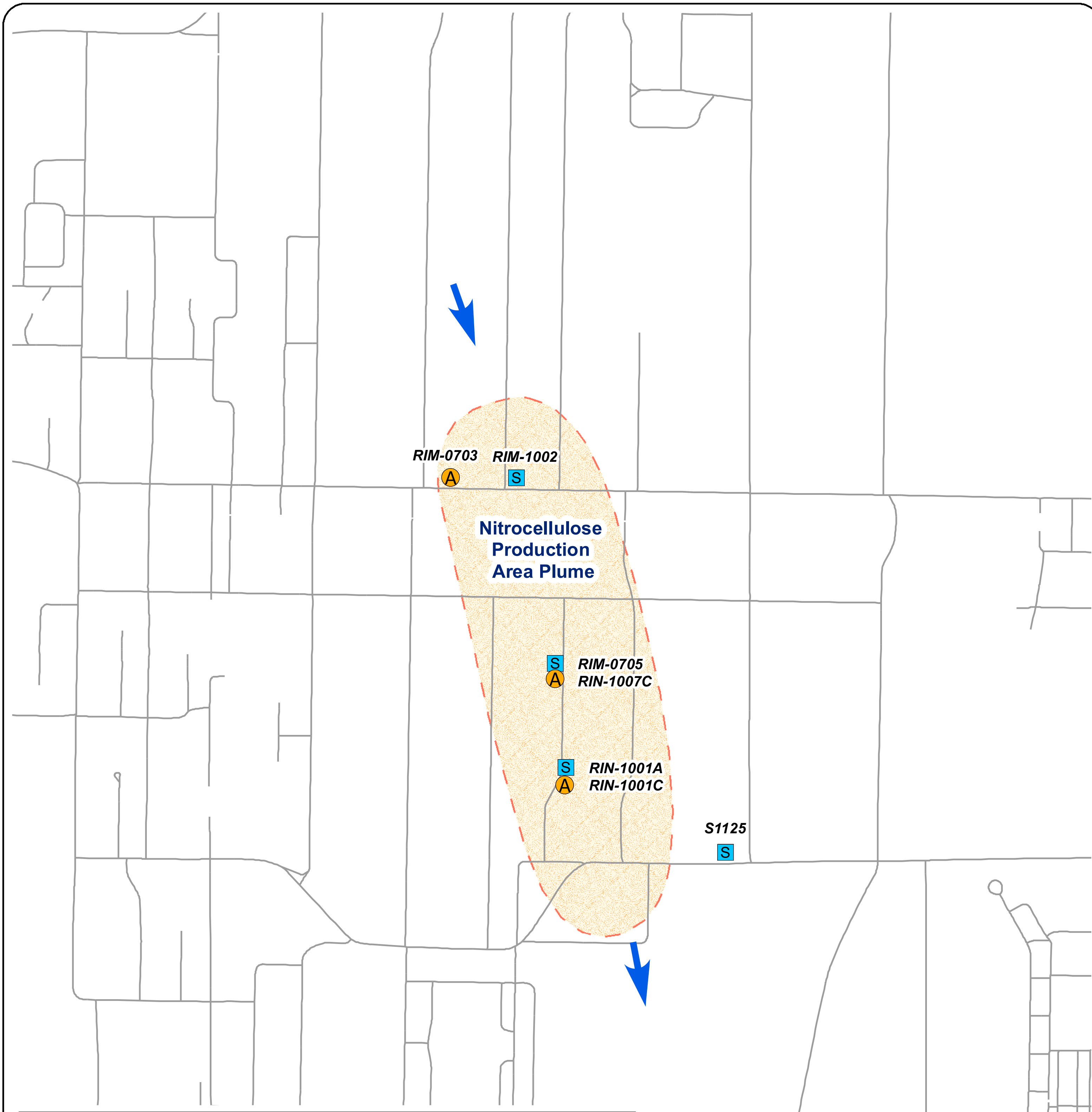


FIGURE 18

CONCEPTUAL PLAN
IN-SITU BIOCHEMICAL TREATMENT
ALTERNATIVE 4

CENTRAL PLUME
BADGER ARMY AMMUNITION PLANT



Legend

Monitoring Well Sampling Frequency

S Semi-Annual Sampling

A Annual Sampling

Groundwater Plume

Groundwater Flow Direction

Road

BAAP Boundary

Sample Frequency Descriptions:

Semi-Annual (twice per year)
Annual (once per year)

N W E S

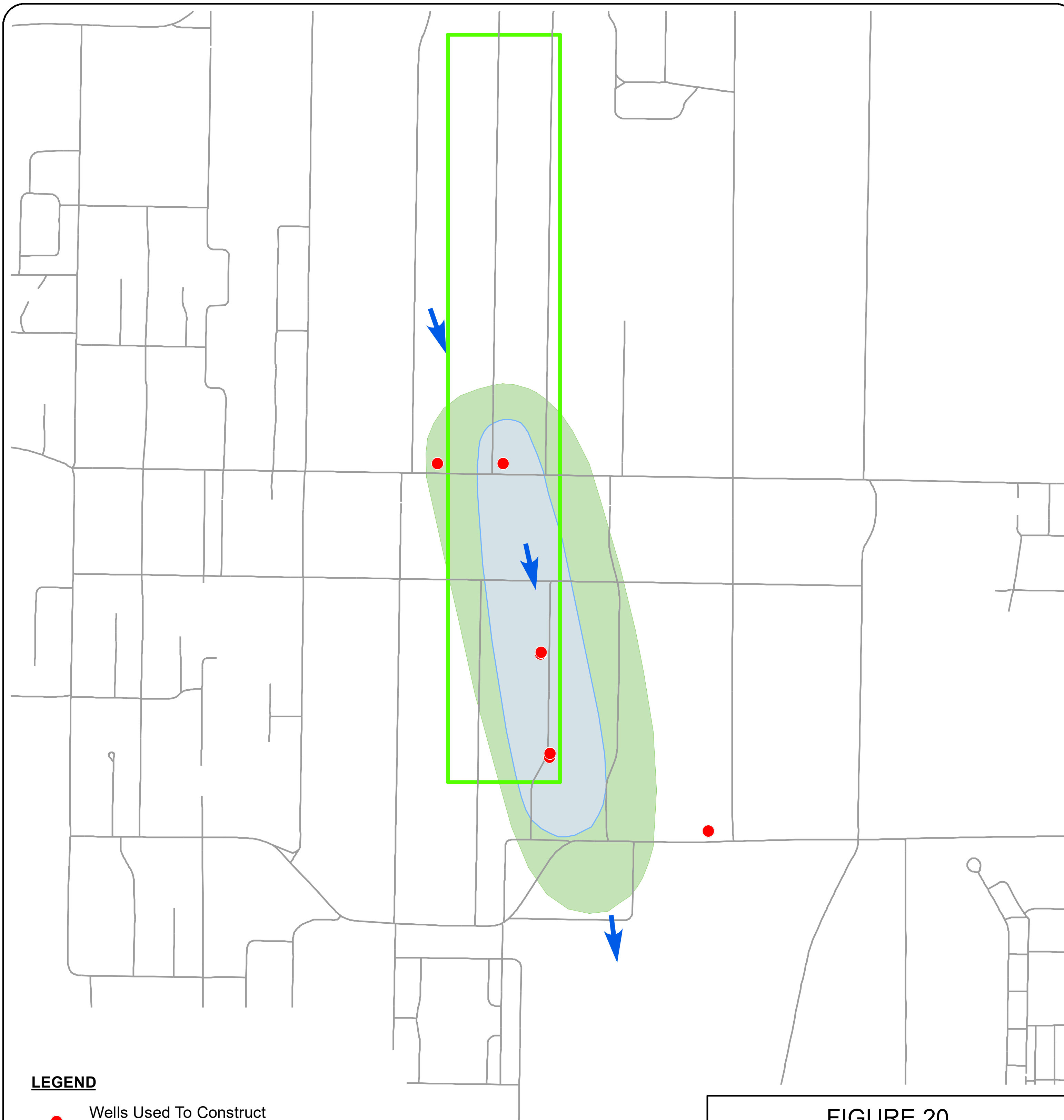
0 700 1,400 2,800 Feet

FIGURE 19

WELL SAMPLING FREQUENCY MAP

NITROCELLULOSE PRODUCTION AREA
BADGER ARMY AMMUNITION PLANT

SPS
SPECPRO PROFESSIONAL SERVICES



LEGEND

● Wells Used To Construct Isoconcentrations

Total Dinitrotoluene Concentration (µg/l)

2018 Groundwater Data

0.005 - 0.05

> 0.05

Source Area

Groundwater Flow Direction

FIGURE 20

TOTAL DINITROTOLUENE ISOCONCENTRATION MAP

NITROCELLULOSE PRODUCTION AREA
BADGER ARMY AMMUNITION PLANT

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Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet