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REVISED DRAFT

Remedial Action Plan
for
Site 17 – Pettibone Creek

Naval Station Great Lakes
Great Lakes, Illinois

Naval Facilities Engineering Command
Midwest

Naval Facilities Engineering Command Midwest

Contract Number N62467-04-D-0055

Contract Task Order 474

AUGUST 2011

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REVISED DRAFT REMEDIAL ACTION PLAN
FOR
SITE 17 – PETTIBONE CREEK

NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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LIST OF ACRONYMS

µg/kg	micrograms per kilogram
CERCLA	Comprehensive Environmental Response, compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CLEAN	Comprehensive Long-term Environmental Action Navy
cm	centimeters
COC	Chemical of Concern
COPC	Chemicals of Potential Concern
CTO	Contract Task Order
E&S Manual	Illinois Procedures and Standards for Urban Soil Erosion and Sediment Control
EEQ	Ecological Effects Quotients
EMAC	Environmental Multiple Award Contract
ERA	Ecological Risk Assessment
FEMA	Federal Emergency Management Administration
FS	Feasibility Study
ft	Feet
GPS	Global Positioning System
HHRA	Human Health Risk Assessment
HI	Hazard Index
IAS	Initial Assessment Study
Illinois DOT	Illinois Department of Transportation
Illinois EPA	Illinois Environmental Protection Agency
ILCR	Incremental Lifetime Cancer Risk
IR	Installation Restoration
LDPE	Low density poylethylene
MSDS	Material Safety Data Sheet
msl	mean sea level
NCP	National Oil and Hazardous Substance Pollution contingency Plan
NCRS	North Chicago Refiners and Smelters
NEPA	National Environmental Policy Act
OICC	Officer in Charge of Construction
PAH	Polynuclear Aromatic Hydrocarbon
PCB	polychlorinated biphenyl
ppm	parts per million
PRG	Preliminary Remediation Goals

QAPP	Quality Assurance Project Plan
RA	Risk Assessment
RAP	Remedial Action Plan
RBC	Risk-Based Concentration
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operating Procedure
SVOC	Senivolatile Organic Compound
TACO	Tiered Approach to Corrective Action Objectives
TOC	Total Organic Carbon
Tetra Tech	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this document is to present the Remedial Action Plan (RAP) for Site 17 – Pettibone Creek at Naval Station Great Lakes located in Great Lakes, Illinois. This RAP includes the excavation and off-site disposal of contaminated sediment located within the North Branch of Pettibone Creek. In addition, RAP activities include stream restoration. This RAP was prepared for the United States Navy, Naval Facilities Engineering Command Midwest, by Tetra Tech NUS, Inc. (Tetra Tech) under Contract Task Order (CTO) 474 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) IV Contract Number N62467-04-D-0055.

This work is being performed under the Navy's Installation Restoration (IR) Program, which includes the following five distinct phases of work:

- Phase 1 is the Preliminary Assessment [formerly known as the Initial Assessment Study (IAS)]
- Phase 2 is the Remedial Investigation / Risk Assessment (RI/RA)
- Phase 3 is the Feasibility Study (FS), Proposed Plan, and Record of Decision
- Phase 4 is the remedial design (also know as the RAP)
- Phase 5 is the RAP implementation

This RAP was prepared under Phase 4 (remedial design) and defines activities associated with corrective measures to be conducted to address contaminated sediments within Pettibone Creek upstream of the Boat Basin. Contaminated sediment in the Boat Basin will be addressed separately.

1.2 FACILITY DESCRIPTION

Naval Station Great Lakes covers 1,632 acres of Lake County, which is located in northeastern Illinois, north of the City of Chicago along the western shore of Lake Michigan. Lake County extends from the Wisconsin border south to Cook County and west to McHenry County. The Naval Station fronts 1.5 miles of Lake Michigan shoreline, and since 1911 has provided facilities and support to training activities and a variety of military commands and includes the Navy's only boot camp (Figure 1-1). A variety of land uses currently surround Naval Station Great Lakes, including urbanized and industrial areas to the north, industrial use to the west, and a mixture of public use land and residential neighborhoods to the south.

1.3 REGULATORY SUMMARY

1.3.1 Naval Station Great Lakes

During an IAS performed in 1986, the Navy identified 14 potentially contaminated areas where hazardous material may have been released in the environment at the Naval Station (Rogers, Golden, & Halpern and BCM Eastern Inc., 1996). In addition, many sampling events have been conducted since the 1970s within the industrialized (non-Navy property) areas upstream of Naval Station Great Lakes. To investigate these areas within and upstream of the Naval Station, the Navy developed a team of representatives from the Illinois Environmental Protection Agency (Illinois EPA), Naval Facilities Engineering Command Southeast and its consultant Tetra Tech, and the Naval Station Great Lakes Environmental Department. The investigations were conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and its governing regulations, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, and the National Environmental Policy Act (NEPA). This RAP is limited to the North Branch of Pettibone Creek within Site 17, located within Naval Station Great Lakes, east of Sheridan Road (Figure 1-1).

1.3.2 Site 17 – Pettibone Creek

Site 17 – Pettibone Creek has two major branches. The North Branch originates in the City of North Chicago near Commonwealth Avenue, flows south under Martin Luther King Jr. Drive and a parking area, resurfaces north of Sheridan Road, flows below Sheridan Road, resurfaces on Naval Station Great Lakes property, and flows south and east through Naval Station Great Lakes until it enters the Boat Basin and then discharges to Lake Michigan. The South Branch originates in a residential area southwest of Naval Station Great Lakes, flows northward through the Shore Acres Golf Course Country Club, and enters Naval Station Great Lakes near the intersection of G Street and 3rd Street. Flow continues northward on Naval Station Great Lakes property where it joins with flow from the North Branch. North Branch Pettibone Creek ranges between 15 and 30 feet in width and several inches to 2 feet in depth. Storm sewers collect stormwater from a large section of the City of North Chicago and from Naval Station Great Lakes and discharges it to Pettibone Creek (Illinois EPA, 1995). Because of the industrial and urban nature of this watershed, Pettibone Creek is subject to flash flooding and associated erosive forces during storm events. As a result, Pettibone Creek has severe erosion and sedimentation problems. Figure 1-2 presents Pettibone Creek within the limits of Naval Station Great Lakes property along with storm drain locations that discharge to Pettibone Creek. Photographs of sections of Pettibone Creek are included in Appendix A.

Because Site 17 is a stream that collects runoff from urban and industrialized areas both within and adjacent to Naval Station Great Lakes property, Site 17 has been receiving urban and industrial area stormwater runoff since the development of this portion of Lake County. Therefore, early investigation of Site 17 included studies of abandoned industrial facilities in the City of North Chicago located upstream of Naval Station Great Lakes. These facilities [Fansteel, North Chicago Refiners and Smelters (NCRS), and a Vacant Lot] were turn-of-the-century manufacturing facilities that produced tantalum mill products, non-ferrous metals, and zinc oxide. The United States Environmental Protection Agency (USEPA) Region 5 investigated these facilities for volatile organic compound (VOC), semivolatile organic compound (SVOC), pesticide, polychlorinated biphenyl (PCB), and metal contamination. These former industrial areas are identified on Figure 1-1. Due to the contamination found upstream of Naval Station Great Lakes and the types of industrial activities performed on Naval Station Great Lakes property, the RAP for Site 17 – Pettibone Creek and the associated activities associated with this RAP will be performed in accordance the CERCLA program. A summary of the environmental investigations performed for Pettibone Creek is provided in Section 2.0.

This RAP is consistent with Navy policy on the handling of contaminated sediments, because implementation of this RAP will occur only after the upgradient contamination areas and potential sources to the proposed remediation area have been controlled. Although it is likely that contamination will continue to be deposited in the form of sediment within the limits of Pettibone Creek, with the remediation of off-base contamination areas, the expected future contamination will be associated with urban land use only and not industrial activities and spills.

1.4 REPORT ORGANIZATION

The following information is contained in the remainder of this document:

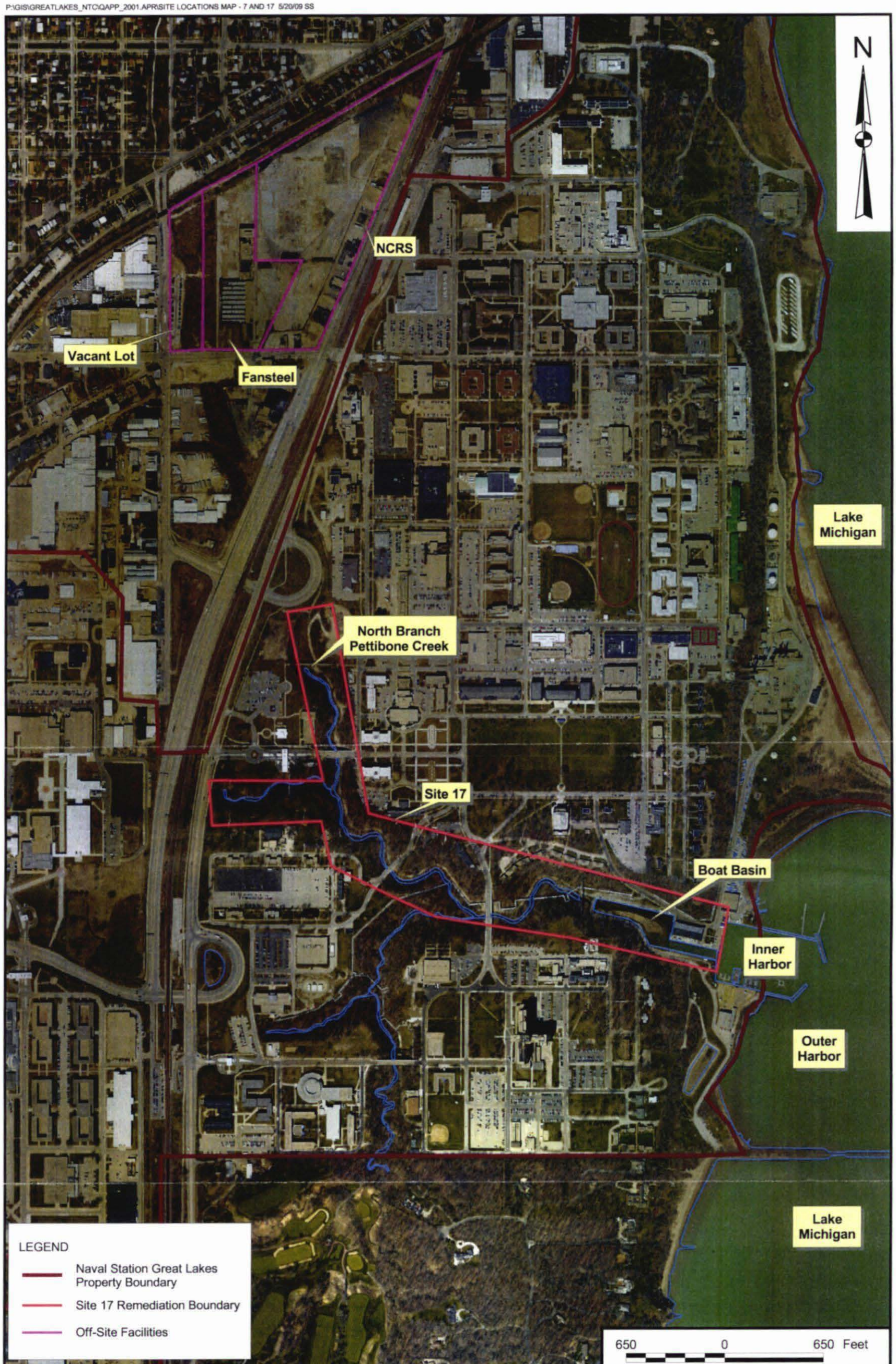
- Section 2.0 summarizes site characteristics including site description, summary of environmental investigations conducted within North Branch Pettibone Creek, and the nature and extent of contamination within North Branch Pettibone Creek.

- Section 3.0 presents the RAP for removing sediment from North Branch Pettibone Creek and for restoration of the disturbed areas of creek.

- Section 4.0 presents erosion and sediment control features proposed for the RAP described in Section 3.0.

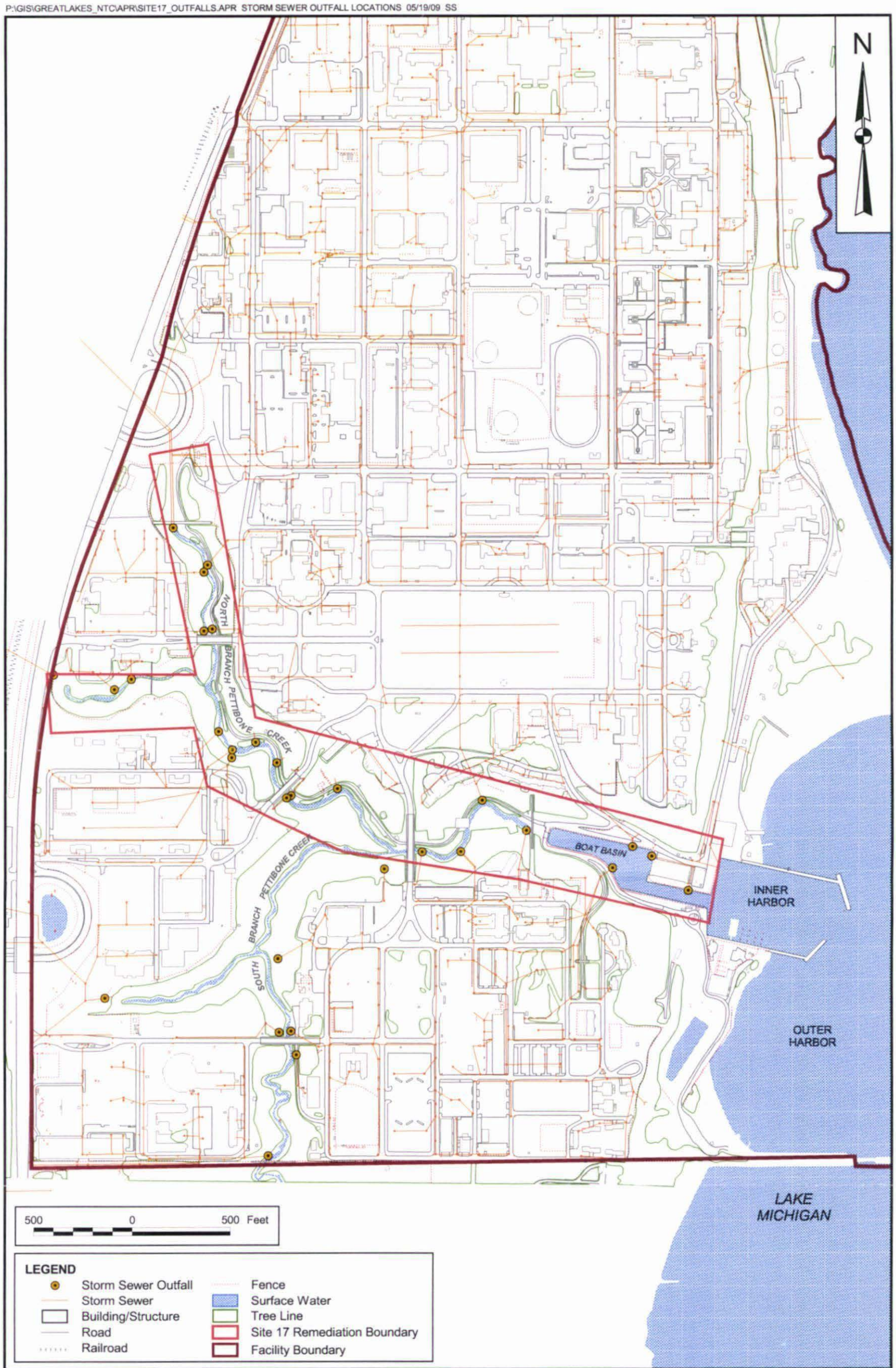
- Section 5.0 presents the verification sampling and analysis plan.

P:\GIS\GREATLAKES_NTC\QAPP_2001.APR\SITE LOCATIONS MAP - 7 AND 17 5/20/09 SS



DRAWN BY	DATE		CONTRACT NUMBER 01021	
J. BELLONE	4/5/01	SITE VICINITY MAP	APPROVED BY RFD	DATE 4/20/03
CHECKED BY T. SMITH	DATE 5/20/09	SITE 17 - PETTIBONE CREEK RAP	APPROVED BY —	DATE —
COST/SCHEDULE-AREA		NAVAL STATION GREAT LAKES	DRAWING NO. FIGURE 1-1	REV 0
SCALE AS NOTED	NAVFAC	GREAT LAKES, ILLINOIS		

P:\GIS\GREATLAKES_NTC\APR\SITE17_OUTFALLS.APR STORM SEWER OUTFALL LOCATIONS 05/19/09 SS



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K. PEILA	08/17/05		PETTIBONE CREEK AND STORM SEWER OUTFALL LOCATIONS	APPROVED BY RFD	DATE 03/20/09
CHECKED BY T. SMITH	DATE 05/19/09	NAVFAC	SITE 17 - PETTIBONE CREEK RAP	APPROVED BY —	DATE —
COST/SCHEDULE-AREA			NAVAL STATION GREAT LAKES	DRAWING NO. FIGURE 1-2	REV 0
SCALE AS NOTED			GREAT LAKES, ILLINOIS		

2.0 SITE SUMMARY

2.1 SITE SUMMARY

A general description of Site 17 Pettibone Creek is provided in Section 1.0. The following sections describe the physical conditions of Site 17 Pettibone Creek. These descriptions were excerpted from the Site 17 RI (Tetra Tech 2003) and FS (Tetra Tech, 2005). This section also presents a summary of previous investigations that have been conducted along Pettibone Creek and a comparison to the results from the December 2008 investigation. The comparison also includes the calculation of the residual risk to human health and the ecological environment if removal of contaminated brown/tan sediment was conducted and the native blue/gray native clay soil identified in the December 2008 investigation remained in the North Branch of Pettibone Creek.

2.1.1 Physiography and Topography

Most of Naval Station Great Lakes is situated on a plateau along the Lake Michigan shoreline. Site 17 is a stream valley with steeply eroded slopes. The banks of Pettibone Creek are forested with white and red oak, maple, European larch, and white and Scotch pine trees. There are also shrubs, including raspberry and blackberry bushes along the banks, and vegetative cover including wild grape vines and perennial weeds. The principle mammals in the area include groundhogs, raccoons, squirrels, opossums, rabbits, chipmunks, and deer (Tetra Tech, 2001).

The topography of Site 17 includes a moderately steep stream gradient and banks and hillsides with 30- to 60-percent slopes that form the ravine through which Pettibone Creek flows. Site 17 elevations vary from approximately 600 feet above mean sea level (msl) at the tops of the Pettibone Creek hillsides to approximately 510 feet above msl at the Boat Basin where the Pettibone Creek discharges to Lake Michigan (Tetra Tech, 2003).

2.1.2 Surface Water Hydrology

Site 17 includes Pettibone Creek, the steep banks and hillsides that are adjacent to Pettibone Creek, and the Boat Basin through which Pettibone Creek flows prior to discharging to Lake Michigan. In general, flow in Pettibone Creek is eastward, with flow from both the North and South Branches joining within the limits of Naval Station Great Lakes Property. As discussed in Section 1.0, the North Branch conveys flow from urban and industrialized areas north of Naval Station Great Lakes, and the South Branch conveys flow from residential and public use areas south of Naval Station Great Lakes.

2.1.3 Geology

The coastal geomorphology for Naval Station Great Lakes is characterized as a bluff coast, with bluffs consist of gray to brown glacial till interbedded with glacial-like sediments of clay, silt, sand, and sandy outwash. Silt and clay are the dominant bluff materials. The average grain-size distribution of the gracial till is 10 percent sand, 42 percent silt, and 48 percent clay. In general, only 10 to 15 percent of eroded bluff materials are coarse enough to provide beach sediments (Tetra Tech, 2003). Bluff heights relative to mean lake level are variable, but generally in the range of 70 to 90 feet, and bluff slopes range from 25 degrees to nearly vertical. These bluffs are incised by "V"-shaped ravines occupied by streams such as Pettibone Creek that drain the western uplands eastward to Lake Michigan (Tetra Tech, 2003).

2.1.4 Hydrogeology

The Pettibone Creek watershed, one of five Lake Michigan watersheds in Lake County, Illinois, drains an area of 4.2 square miles, and the creek consists of North and South Branches, each with minor tributary branches. The hydrology of the watershed is well established, and the creek flows through well-defined ravines within Naval Station Great Lakes. The creek is characterized by moderately steep stream bed gradients and banks with 30 to 60 percent slopes (Tetra Tech 2003).

There is very little floodplain area along Pettibone Creek because of the steeply sloped banks. The North branch of the creek has a short time of concentration (i.e., time it takes a unit of water to run the water course) because the source of water is primarily from an urban area that has low infiltration rates and fast runoff rates during storms. As a result, Pettibone Creek is susceptible to flash floods characterized by high channel velocities and great erosive potential. The Illinois State Water Survey calculated the average flow rate of Pettibone Creek to be less than 10 cubic feet per second (cfs), which greatly increases during periods of precipitation (Tetra Tech, 2003).

2.2 PREVIOUS INVESTIGATIONS

This section provides a brief summary of the historical upstream non-Naval Station and Naval Station contaminant releases that have potentially impacted Pettibone Creek as reported in the FS (Tetra Tech, 2005). This section also summarizes the investigations conducted within Pettibone Creek. Additional details regarding the source areas and releases are provided in Section 2.2 of the Site 17 RI/RA (Tetra Tech, 2003).

Industries located along the North Branch Pettibone Creek upstream of Naval Station Great Lakes include the NCRS (also known as R. Lavin) facility and Fansteel (see Figure 1-1). Discharges from these industries in combination with discharges from several storm sewers collecting water/runoff from a large

section of the City of North Chicago have contributed to elevated concentrations of contaminants in Pettibone Creek and Boat Basin sediments according to the Illinois EPA (Illinois EPA, 1995) and USEPA (USEPA, 2002a, 2002b, and 2002c). In addition, the Navy identified potential areas where hazardous materials may have been released to the environment at Naval Station Great Lakes in the IAS (Rogers, Golden, & Halpern and BCM Eastern Inc., 1996). The IAS identified 14 potentially contaminated sites along with potential sources such as surface runoff or fallout from engine exhaust from nearby roadways, historical pesticide usage and VOCs detected in groundwater samples from monitoring wells. The following table provides a brief overview of environmental studies conducted within Pettibone Creek and the Boat Basin from 1970 to 2001.

Date	Conducted by	Comments
1970 - 1971	Illinois EPA	PCBs and pesticides found in samples
1975	USEPA	Inner Harbor sediment samples polluted with toxic metals
May 1980	USEPA Contractor	Contaminated sediment samples
April 1988	STS Consultants Ltd. for the Navy	USEPA did not approve open water disposal of sediments
July 1988	Jacobs Engineering	Copper and lead had elevated concentrations in the sediment samples
April 1989	STS Consultants Ltd. for the Navy	Highest concentrations at the Boat Basin bend to join a channel to the Inner Harbor
June 1990	Illinois EPA	Elevated concentrations of zinc, copper, and lead in sediments downstream of the NCRS facility
1991	Illinois EPA	Surface water samples were contaminated with VOCs and SVOCs
Nov. 1991	Illinois EPA	Metals and SVOCs were present at concentrations three times greater than background concentrations
Aug. 1992	Halliburton NUS for the Navy	Contaminants present in Pettibone Creek and Boat Basin sediments
Sept. 1992	Illinois EPA	Elevated concentrations of inorganics, chlorinated solvents, polynuclear aromatic hydrocarbons (PAHs), pesticides, and PCBs were detected in soil and sediment samples
April 1994	Illinois EPA	VOCs, SVOCs, pesticides, and metals detected in sediment samples
1995	Illinois EPA	Significant metals contamination in sediment samples. Illinois EPA identified many potential sources that were part of upstream facilities.
1997	Ecology and Environment, Inc. for USEPA	Contaminants detected in soil samples from the Vacant Lot site and sediment samples. Off-site active industrial discharge and stormwater drainage into Pettibone Creek represent potential sources of contamination.
2000	Contractor for Fansteel Inc.	Contaminants detected in sediment samples
October 2000	TN & Associates for USEPA Region 5	Results of downstream sampling suggested that contaminants are migrating downstream from the NCRS/City of North Chicago discharge into Pettibone Creek
September 2001	Tetra Tech	PAHs, pesticides, PCBs, and metals detected in sediment samples; VOCs and metals detected in surface water samples

The most recent field investigation, that is discussed in the Site 17 FS, was the RI/RA performed in September 2001. Activities consisted of surface water and sediment sampling within Pettibone Creek, including the collection and analysis of six surface water samples and 38 sediment samples. The sediment samples were collected from depth ranges of 0 to 4 centimeters (cm) and from 14 of the 38 locations sediment was collected at a depth of 1 foot. These samples were analyzed for PAHs, pesticides, PCBs, and metals due to the detections of PAHs, pesticides, PCBs, and metals in off-site, upstream samples, collected during previous environmental investigations of Pettibone Creek. A select number of these samples were also analyzed for VOCs and SVOCs.

In addition, sediment samples were collected from 12 locations in the Boat Basin. At each location, four samples were collected from the following depth intervals: 0 to 4 cm, 4 cm to 3 feet, 3 to 6 feet, and 6 to 10 feet. The general trend within the Boat Basin was that the sediment at the surface is "cleaner" than the sediment at depth (i.e., concentrations of pesticides, PCBs, and metals in deeper sediment samples were greater than surface sediment samples). The difference in concentration with depth may reflect decreases in contaminant loading over time; sediments have accumulated, undisturbed in the Boat Basin over an extended period (approximately 30 years since the last dredging). Concentrations of most pesticides, PCBs, and metals in at-depth samples from the Boat Basin also exceed concentrations for surface and at-depth sediments collected within Pettibone Creek. The following section summarizes the findings of this investigation.

2.3 EXTENT OF CONTAMINATION

This section summarizes the nature and extent of contamination, the human health risk assessment (HHRA), and the ecological risk assessment (ERA) within Site 17 as identified in the RI/RA and FS. Because this RAP is limited to the North Branch of Pettibone Creek, the following discussion is limited to the portion of Pettibone Creek located upstream of the Boat Basin along the North Branch to the culverts where Pettibone Creek surfaces on Naval Station Great Lakes property (see Figure 1-1). More detailed information is available in Section 4.0 of the RI/RA report (Tetra Tech, 2003).

2.3.1 Nature and Extent

VOCs were not significant site-related contaminants at Site 17. Maximum concentrations of chlorinated solvents and toluene were detected in the sample collected at the upstream boundary of Site 17.

PAHs were the predominant SVOCs detected in sediment samples collected at Site 17. In general, concentrations of PAHs were greatest in surface sediment samples and typically decreased with depth. Average concentrations detected in samples from North Branch of Pettibone Creek and the Boat Basin

[typically less than 5,000 micrograms per kilogram (µg/kg)] generally exceeded average concentrations in the South Branch Pettibone Creek (typically less than 1,000 µg/kg). PAHs were not detected in Site 17 surface water samples. PAH concentrations in sediment samples have increased compared to historical data, and this is believed to be caused by the widespread use of petroleum products in our modern industrialized society.

Pesticides, PCBs, and metals exhibit a different extent profile than PAHs in sediment. In general, concentrations of pesticides, PCBs, and metals were lower in surface sediment samples and increased with depth. Pesticides were detected in sediment samples collected at Site 17 at concentrations that reflect the widespread and historical use of chemicals for pesticide control.

PCBs were detected in less than 50 percent of the sediment samples analyzed. Average concentrations of Aroclor-1248, -1254, and -1260 in at-depth samples in the Boat Basin (240 µg/kg, 1400 µg/kg, and 300 µg/kg, respectively) were greater than those reported for the surface sediment samples and sediment samples from Pettibone Creek by a factor of two or more. Previous PCB data suggest that significant possible upstream sources may have contributed to the sediment contamination. In addition, PCB contamination of sediments may have occurred due to storage by Naval Station Great Lakes of out-of-service transformers (some filled with PCB-containing oil) at various locations within the Naval Station. Past investigations at these storage locations indicated limited soil contamination exceeding federal and state cleanup guidelines. However, there is no cleanup documentation available for the PCB-contaminated soil.

Copper, lead, and zinc were identified as significant environmental contaminants in sediment samples collected upstream of Site 17 during past environmental investigations. Concentrations detected in off-site upstream samples were often two to three times greater than concentrations in Site 17 sediment samples. Although overland runoff and stormwater discharges may contribute pollutants to the watershed, the analytical results available for the Site 17 area do not suggest that a significant point source(s) from Naval Station Great Lakes is impacting the surface water/sediment quality of Pettibone Creek or the Boat Basin. Several metals (e.g., copper, lead, mercury, selenium, silver, and zinc) were detected in sediments in Boat Basin and the North Branch Pettibone Creek at average concentrations an order of magnitude greater than background sediment concentrations reported in Tiered Approach to Corrective Action Objectives (TACO) (Illinois EPA, 2000). In contrast, most analytical results reported for the South Branch Pettibone Creek are similar to background sediment concentrations reported in TACO. The analytical data suggest that the primary source of contamination is historical discharge and stormwater discharge within the Pettibone Creek watershed, particularly because contaminant concentrations in deeper sediment samples from the Boat Basin were greater than concentrations in surface sediment samples. These differences in concentration with depth may reflect decreases in

contaminant loading over time (i.e., sediments have accumulated over the past 30 years since the last dredging; however, the most recent sediments deposited into the Boat Basin are generally "cleaner").

The potential sources of background sediment contamination still remain in the stormwater sewer systems and surface water runoff from industrial facilities into Pettibone Creek. However, these industrial facilities (R. Lavin & Sons and Fansteel) that have contributed to historical contamination in Pettibone Creek have filed petitions for bankruptcy and have ceased operations. Pettibone Creek may continue to receive a variety of wastes from upstream industries, road runoff, storm sewers, and runoff/discharges from local residential properties. Several of the potential sources (industrial sites) have been cleaned up, and it is expected that additional releases to the creek should not be as significant as they were in the past. Nevertheless, there will continue to be runoff from the surrounding unban area into Pettibone Creek and the upstream outfalls are still permitted under the state National Pollutant Discharge Elimination System program.

Lastly, as discussed above, because the source of PAHs in sediment includes runoff from roads and parking lots, the sediment may become recontaminated with PAHs. Therefore, the potential for recontamination of the sediment with PAHs and/or other chemicals from runoff and/or residual contamination at the upstream sites is likely.

The available analytical data from investigations performed prior to the 2001 RI/RA are presented in the RI/RA and FS. The 2001 RI/RA sample locations are identified on Figure 2-1. The results from the 2001 RI used to delineate the extent of excavation for this RAP are presented in Appendix A.

2.3.2 Human Health Risk Assessment

A HHRA was conducted to determine whether contamination in surface water, contaminated sediment, and fish in Pettibone Creek and the Boat Basin poses potential health risks to potential receptors (adolescent and adult recreational users) under current and/or foreseeable future site conditions. The results of the HHRA are presented in Section 6.0 of the RI/RA Report (Tetra Tech, 2003) and summarized in this section.

Chemicals of potential concern (COPCs) were identified by comparing maximum concentrations of constituents detected in Site 17 samples to USEPA Region 9 risk-based Preliminary Remediation Goals (PRGs), Illinois EPA remediation objectives for residential land use, and USEPA Region 3 Risk-Based Concentrations (RBCs) for fish ingestion. Risks to construction workers and under industrial land use scenarios were acceptable. Under current/future land use, quantitative estimates of non-carcinogenic and carcinogenic risks [Hazard Indices (HIs) and Incremental Lifetime Cancer Risks (ILCRs), respectively] were developed for adult and adolescent recreational users hypothetically exposed to COPCs in surface water,

surface sediment, and fish tissue (estimated from chemical concentrations in sediment). The results of the risk assessment are discussed below and presented in Table 2-1.

Risks from Exposure to Contaminated Sediment: HIs for adult and adolescent recreational users in Pettibone Creek (2E-03 and 3E-02, respectively) and the Boat Basin (3E-02 and 3E-02, respectively) were less than the regulatory goal of unity (1.0). The ILCR for the adolescent recreational user exposed to sediment in the South Branch Pettibone Creek was less than 1E-06. The ILCR for the adult recreational user exposed to sediment in the South Branch Pettibone Creek (E-06) was within the USEPA risk management range of 1E-06 to 1E-04. ILCRs for adult and adolescent recreational users for exposure to surface sediment in the North Branch Pettibone Creek (7E-06 and 3E-06, respectively) and the Boat Basin (8E-06 and 3E-06, respectively) were within the USEPA risk management range. ILCRs greater than 1E-06 were mainly the result of exposure to PAHs.

Risks from Exposure to Surface Water: HIs for adult (7E-02) and adolescent (7E-02) recreational users from exposure to COPCs in Pettibone Creek and the Boat Basin were less than unity. The ILCR for adult (2E-06) recreational users exposed to surface water was within the USEPA risk management range, and the ILCR for adolescent (1E-06) recreational users exposed to surface water was less than 1E-06.

Risks from Exposure to Fish Ingestion: The ILCR associated with ingestion of fish caught by the recreational fisherman (2E-04) exceeded 1E-04, and the total HI (6.6) was greater than unity (1.0). PCBs (mainly Aroclor-1254) accounted for 66 percent of the total cancer risk for fish ingestion, and pesticides accounted for the remainder of the cancer risk. A number of significant uncertainties were associated with the fish ingestion risks, including the fact that the fish tissue concentrations used in the HHRA were merely estimates (modeled) from sediment concentrations and sediment bioaccumulation factors. However, the results of the risk assessment were generally consistent with fish advisories currently in effect for Lake Michigan.

Summary of Human Health Risks: No significant potential health hazards are associated with exposure to COPCs in surface water and surface sediment under the recreational land use scenarios. The quantitative risk evaluation indicated that non-carcinogenic HIs were less than unity (1.0) for adult and adolescent recreational users. Carcinogenic risks were less than or within USEPA's risk management range of 1E-06 to 1E-04.

The HIs and ILCRs estimated for recreational fisherman consuming fish contaminated with PCBs and pesticides exceeded USEPA benchmarks. Potential health hazards are associated with the ingestion of fish based on estimated (modeled) fish tissue concentrations, sediment concentrations, and

bioaccumulation factors. This risk to recreational fisherman was consistent with the Illinois EPA fish advisories for Lake Michigan.

2.3.3 Ecological Risk Assessment

An ERA was also performed as part of the RI/RA at Site 17. The goal of the ERA for Site 17 was to determine whether adverse ecological impacts are possible as a result of exposure to chemicals. The screening-level ERA relied on environmental chemistry data; biological sampling or testing was not conducted for the RI/RA. The screening-level ERA methodology used at Naval Station Great Lakes followed the guidance presented in the Final Guidelines for Ecological Risk Assessment (USEPA, 1998), Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA, 1997), and Navy Policy for Conducting Ecological Risk Assessments [U.S. Navy, 1999], and Quality Assurance Project Plan (Tetra Tech, 2001) prepared for this project. The results of the ERA, as summarized below, were excerpted from Section 7.0 of the RI/RA report (Tetra Tech, 2003).

Several chemicals detected in surface water and/or sediment were initially retained as ecological COPCs because their concentrations exceeded screening levels or because they were bioaccumulative chemicals with Ecological Effects Quotients (EEQs) greater than 1 based on conservative exposure scenarios. These chemicals were then re-evaluated in Step 3a of the ERA to determine which chemicals had the greatest potential for causing risks to ecological receptors and therefore should be retained as chemicals of concern (COCs) for further discussion/evaluation. The two primary ecological endpoints evaluated were aquatic organisms (i.e., fish and invertebrates) and mammals and birds that consume invertebrates and/or fish, and different lists of chemicals were retained as COCs for these different endpoints. Also, different lists of COCs were retained for each of the areas (i.e., the North Branch Pettibone Creek, the South Branch Pettibone Creek, and the Boat Basin).

Table 2-2 lists the chemicals retained as ecological COCs for each of the endpoints in each of the areas. No chemicals detected in surface water were retained as COCs for risks to aquatic organisms. A few of the chemicals detected in surface water were included in the food-chain model; however, exposure via drinking water was insignificant because chemical concentrations in surface water were much lower than concentrations in sediment. Consequently, no chemicals in surface water were retained as COCs for either of the primary endpoints. Therefore, although some of the pesticides (4,4'-DDE and 4,4'-DDT) and metals were retained as COCs for the food-chain model, it was because of concentrations in sediment not surface water. However, because Pettibone Creek and the Boat Basin do not support large fish populations, the piscivorous exposure route is not expected to be significant. Additionally, exposure of terrestrial wildlife to contaminants in sediment (and surface water) via dermal contact is unlikely to

represent a major exposure pathway because fur, feathers, and chitinous exoskeletons are expected to minimize transfer of contaminants across dermal tissue.

No chemicals were retained as COCs for sediment in the South Branch Pettibone Creek for aquatic receptors or mammals/birds. With the exception of a few sporadic elevated detections, chemical concentrations in the South Branch are relatively low and may represent a good background/reference location.

PAHs, several pesticides, and several metals in sediment samples were retained as COCs for risks to aquatic receptors in the North Branch Pettibone Creek because they were detected in several samples at concentrations that exceeded alternate benchmarks. The alternate benchmarks are literature-based upper-effects levels used in the Step 3a refinement of the COPC list. The alternate benchmarks are less conservative than the screening benchmarks used in the initial COPC selection and were used to determine the ecological risk-drivers at Site 17. Also, two pesticides (4,4'-DDE and 4,4'-DDT) were retained as COCs because they may cause risks to piscivorous birds; however, as discussed above, Pettibone Creek and the Boat Basin do not support large fish populations, and the piscivorous exposure route is not expected to be significant. Most of the elevated concentrations of these chemicals were detected in the most upstream sample, which indicates that the predominant source of these chemicals appears to be outside of Naval Station Great Lakes. In addition, the concentrations of pesticides are indicative of those associated with typical applications of these pesticides. Therefore, although these chemicals were retained as COCs, the fact that they may not be site related was factored into the risk management decisions.

PAHs, several pesticides and PCBs, and several metals were retained as COCs for risks to aquatic receptors in the Boat Basin because they were detected in several sediment samples at concentrations that exceeded alternate benchmarks. Also, one pesticide (4,4'-DDE) was retained as a COC because it may cause risks to piscivorous birds. In addition, the concentrations of pesticide are indicative of those associated with typical applications of the pesticide. Therefore, although these chemicals were retained as COCs, the fact that they may not be site-related was factored into the risk management decisions.

In summary, several chemicals were retained as COCs in the North Branch Pettibone Creek and the Boat Basin because they were detected in several samples at concentrations that exceeded alternate benchmarks, indicating that there may be potential risks to aquatic receptors from these chemicals. However, because these potential risks are based on literature values, there is uncertainty in the conclusions. Also, because of the large amount of soil eroding into the creek, physical stressors as well as chemical stressors may be adding to the risks to aquatic organisms.

Finally, pesticides were selected as COCs in the North Branch Pettibone Creek and Boat Basin because they may cause a risk to piscivorous birds that consume fish from the area. The risks are based on predicted fish tissue concentrations estimated from sediment concentrations that incorporate the assumed percent lipids of the fish and site-specific total organic carbon (TOC) concentration of the sediment. The sediment in Pettibone Creek and the Boat Basin is very sandy with little TOC; therefore, the predicted fish tissue concentrations of pesticides are much greater than the pesticide concentrations in sediment samples. The literature values used to make these predictions may not be representative of actual site conditions. In addition, although the elevated pesticide detections are located in several samples along the creek and Boat Basin, the samples were biased toward depositional areas that are expected to have greater chemical concentrations than other areas of the creek. Also, based on the evaluation in Section 8 of the RI/RA (Fish Tissue Uncertainty Analysis Evaluation with Historical Data), it appears that risks to piscivorous birds and mammals are overestimated, although the amount of overestimation cannot be quantified with the existing data. Additionally, Pettibone Creek and the Boat Basin do not support large fish populations and the piscivorous exposure route is not expected to be significant because it is not expected that significant numbers of piscivorous birds are feeding in Pettibone Creek and Boat Basin. For these reasons, there is considerable uncertainty in concluding that there are potential risks to piscivorous birds from contaminated sediment.

In conclusion, PAH, PCB, and metal data indicate potential risks to aquatic organisms and piscivorous birds exposed to the contaminated sediment in the North Branch Pettibone Creek and Boat Basin. The potential risks are based on literature data.

2.4 COPCS AND PRGS BASED ON THE RESULTS OF PREVIOUS INVESTIGATIONS

COPCs and PRGs based on the results of previous investigations and the HHRA and ERA, have been developed for Site 17 - Pettibone Creek. These COPCs and PRGs are presented in Table 2-5 (the results of the December 2008 investigation were not used to refine the PRGs). Compounds shaded in black are the chemicals retained as COPCs based on a comparison to the PRG screening criteria. The chemicals retained as COPCs are as follows:

- PAHs (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, ideno(1,2,3-cd)pyrene
- Pesticides/PCBs (4,4-DDT, Aroclor 1254)
- Inorganics (arsenic, cadmium, chromium, copper, mercury, thallium)

For additional discussion on the development of the PRGs refer to the Site 17 Feasibility Study (Tetra Tech, 2005). Figure 2-3 presents the 2001 and 2008 sediment sampling locations along North Branch Pettibone Creek, and indicates locations where sediment concentrations exceed PRGs and identifies the extent of contamination within the North Branch Pettibone Creek.

2.5 DECEMBER 2008 INVESTIGATION

The purpose of the December 2008 investigation within the North Branch Pettibone Creek was to determine whether the contamination detected in sediment extends to underlying native stream bed soil and to determine the sediment layer thickness at each sampling location. The results of this investigation were not used to update the HHRA and ERA presented in the RI/RA and FS rather the results were used to further delineate the vertical extent of contamination within North Branch Pettibone Creek. Using the data from this investigation, a HHRA and ERA was conducted to determine the residual risk related to the samples of native stream bed soil using the same parameters in the RI/RA. The results of the HHRA and ERA are presented in Section 2.6.

2.5.1 Investigation Summary

Additional field activities for Site 17 - Pettibone Creek were performed from December 8 to December 9, 2008. The activities consisted of collecting native stream bed soil samples located beneath the accumulated Pettibone Creek sediments. The sampling event was conducted to meet the following objectives:

- Characterize the nature and extent of contamination within the native Pettibone Creek stream bed soil.
- Further (vertically) delineate contaminated sediment in Pettibone Creek.
- Develop a physical description of the native stream bed soil.

During the investigation, 10 native stream bed soil samples were collected from locations near historical sample locations. The locations of these samples were located in the field using coordinates and a global positioning system (GPS) unit. After sample locations were identified the sample team collected samples with a hang auger. Samples were collected below the non-native loose sediment deposit (between 0.25 to 2 feet bgs) in the native stream bed soil. Native soil is typically gray clay and silt in contrast to the overlying sediment, which is typically brown fine- to course-grained sand with some silt that is prone to movement during storm events. December 2008 sample locations and results are presented on Figure 2-2. Collected samples were packaged and shipped in coolers via air courier (i.e., Federal Express) to Empirical Laboratories in Nashville, Tennessee. Each collected sample was analyzed for specific metals (copper, lead, mercury, and zinc), PAHs, pesticides, and PCBs. Table 2-3 presents a summary of the December 2008 analytical results in the form of a frequency of detection table. A full data printout (Table B-1) and a summary of detected concentrations with screening criteria (Table B-2) are provided in Appendix B. A Tetra Tech geologist collected the samples and developed the field logs, and a Tetra Tech licensed Professional Geologist reviewed the field logs and sampling documentation. The

documentation associated with the December 2008 investigation (field notes, sample logs, chain-of-custodies, and data validation letters) is provided in Appendix B.

2.5.2 December 2008 Investigation Results and Conclusions

Analytical Results - As indicated in Table 2-3, several constituents were detected in stream bed soil at concentrations greater than one or more screening values. These parameters included benzo(a)pyrene, pyrene, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, total DDT POS, copper, lead, mercury, and zinc. The concentrations of these parameters are presented in Appendix B on Table B-2 and in Table 2-3. As summarized in Table 2-4 concentrations of contaminants in non-native sediment deposits are much higher than concentrations in native stream bed soil. This evaluation indicates that the removal of sediment will reduce risks to human health and ecological receptors.

Sediment Thickness Results - At each of the 10 sampling locations, non-native sediment deposit thickness above the native stream bed soil was measured. This measurement is reported in the form of the underlying soil sample depth interval in Tables B-1 and B-2. These sample depths indicate the depth below the surface of the non-native sediment deposit, at the time of the sampling event, to the top of the underlying soil (e.g., an underlying sample depth interval of 1.0 to 1.5 feet indicates that the top of the underlying soil is 1.0 foot below the sediment surface, so the thickness of the non-native sediment deposit is recorded as 1.0 foot). The transition from the overlying non-native sediment deposit to the underlying native stream bed soil was evident by the change in soil color and type. The following table presents the sediment thickness at each sample location.

Sediment Depth Measurements

Sample	Depth (ft)	Sample	Depth (ft)
NTC17PCSD40	1.0	NTC17PCSD45	0.25
NTC17PCSD41	0.5	NTC17PCSD46	1.0
NTC17PCSD42	0.25	NTC17PCSD47	2.0
NTC17PCSD43	1.0	NTC17PCSD48	2.5
NTC17PCSD44	0.25	NTC17PCSD49	0.75

The results of the sediment depth evaluation indicate that, on average, there is approximately 1 foot of non-native sediment deposit above the underlying native stream bed soil. However, it should be noted that sediment thicknesses vary significantly along North Branch of Pettibone Creek within the Naval Station boundary, and thicknesses may change with each runoff-producing storm event. Site visits indicate that depositional areas in the creek can accumulate up to 3 to 4 feet of sediment above the native stream bed soil. Conversely, where steam velocities are high, little to no sediment is found above the native stream bed soil.

2.6 RESIDUAL RISK FROM NATIVE SEDIMENT INVESTIGATION COMPARED TO PREVIOUS RISK ASSESMENT

2.6.1 Residual Human Health Risks after Remedial Action

Using the data from the December 2008 investigation, Tetra Tech conducted a HHRA for Site 17 – North Branch Pettibone Creek to determine the residual risks from the native sediment assuming a removal action would be completed removing the contaminated brown/tan sediment. Table 2-6 shows the COPCs and PRGs based on this native sediment investigation. Similar to Table 2-5, chemicals shaded in black are the COPCs that were retained based on a comparison to the PRG screening criteria. For consistency, the same PRGs that were utilized in the original HHRA (Tetra Tech, 2003) were also used in this risk evaluation for the COPC selection process. The number of COPCs retained (i.e., exceed PRGs) in the native sediment investigation is significantly lower than the number of COPCs identified in the original contaminated sediment HHRA. In comparison to the COPCs retained in contaminated sediment investigations listed above in Section 2.5, the only chemical retained as a COPC in the native sediment investigation is the following:

- PAH benzo(a)pyrene

Total cancer risk calculations were performed for North Branch Pettibone Creek based on these native sediment results, to compare to the results discussed above that were conducted on the contaminated sediment in the original HHRA. A non-cancer hazard quotient was not calculated during this risk evaluation because of the lack of a RfD for benzo(a)pyrene. No adverse non-carcinogenic health effects are anticipated for these receptors at North Branch Pettibone Creek from the exposure to native sediment. For consistency purposes, the same receptors (adult recreational users and adolescent recreational users), risk assumptions, and parameters were evaluated in this risk calculation as were evaluated in the original HHRA. Tables 6.7 and 6.8 in the original HHRA and Tables 4.1 and 4.2 in Appendix G of this report list these receptors and parameters (Tetra Tech, 2003).

The Navy and Marine Corp Public Health Center also conducted a similar study to compare the post-action residual risk (represented by chemical concentrations in native sediment) to current levels of risk (represented by chemical concentrations in surface sediment) to determine the efficacy of the proposed remediation actions (see Appendix G, NAVFAC, 2011). The purpose of this study was to complete a human health risk evaluation to determine the level of risk reduction expected to be achieved by completing the removal action for Site 17.

In order to keep the results of this evaluation comparable to the original HHRA presented within the RI/RA (Tetra Tech, 2003), most of the assumptions made in the original RI/RA were also used in this evaluation. One exception was that updated screening levels were utilized, in addition to updated information in the assessment of chemicals that are assumed to be carcinogenic via a mutagenic mode of action, and the derivation of exposure point concentrations (EPCs).

The study conducted by the Navy and Marine Corp Public Health Center found that the ILCRs would decrease to 1E-07 in both adult and adolescent recreational users (from the original ILCRs of 8E-06 and 3E-06, respectively). The complete results of this study are included in Tables 7.1 and 7.2 in Attachment 1 of the evaluation (Appendix G).

Similar to the comparative study done by Tetra Tech discussed above, the Navy and Marine Corp Public Health Center concluded that the estimated residual risks associated with exposure to the chemicals of potential concern (COPCs) in native sediment from Pettibone Creek for both the adult and adolescent recreational users were less than or within USEPA target levels and were less than the risks calculated in the original RI/RA conducted by Tetra Tech (Tetra Tech, 2003). Therefore, the Navy also concluded that the proposed action will sufficiently accomplish risk reduction.

Reasonable Maximum Exposure (RME) Cancer Risks from Exposure to Native Sediment: RME ILCRs for adult and adolescent recreational users for exposure to native sediment in the North Branch Pettibone Creek (2.7E-07 and 9.3E-08, respectively) were below the USEPA risk management range of 1E-04 to 1E-06 and below the Illinois EPA risk goal of 1E-06.

Central Tendency Exposure (CTE) Cancer Risks from Exposure to Native Sediment: CTE ILCRs for adult and adolescent recreational users for exposure to native sediment in the North Branch Pettibone Creek (7.7E-09 and 1.3E-08, respectively) were below the USEPA risk management range of 1E-04 to 1E-06 and below the Illinois EPA risk goal of 1E-06.

Comparison of Native Sediment Total Cancer Risks to Non-Native Sediment Total Cancer Risks: Table 2-7 shows a comparison to native and non-native total cancel risks. Native sediment total cancer risks are lower than contaminated (i.e., non-native) sediment total cancer risks.

Summary of Human Health Risks: No significant potential health hazards are associated with exposure to COPCs in native sediment under the recreational land use scenarios. Carcinogenic risks were all less than USEPA's risk management range of 1E-06 to 1E-04 and the Illinois EPA risk goal of 1E-06.

2.6.2 Residual Ecological Risks after Remedial Action

Similar to the evaluation of residual risk for human health, this section presents a summary of the ecological risk evaluation to determine the level of risk reduction expected to be achieved by completing the proposed removal action for Site 17. The proposed remedy will address the following site-specific remedial action objective (RAO): reduce ecological risk associated with: (1) benthic invertebrate exposure to contaminated sediments, (2) exposure of piscivorous birds to contaminated sediment via ingestion of fish and aquatic organisms.

In order to evaluate risk reduction for benthic invertebrates and to make accurate comparison to the 2003 RI/RA, the post remediation EEQs were calculated using the screening criteria selected in Table 7-2 of the RI report and the maximum concentrations from the 2008 native sediment data. The potential reduction in risk for the benthic invertebrate endpoint resulting from completion of the proposed removal action action is presented in Table 2-8. Additionally, concentrations of COCs from the 2008 native sediment data were compared to the PRGs developed and approved for use by representatives of the Navy and Illinois EPA in the Feasibility Study (FS) (TtNUS, 2005). This comparison is presented in Table 2-9. There were very few PRG exceedances in the native sediment which indicates that there is low potential risk to the populations of benthic invertebrates in Pettibone Creek.

To evaluate risks to piscivorous birds, food-web modeling was conducted to calculate chronic daily intake using the native sediment data, which was then used to calculate EEQ using both the no observed adverse effects level and lowest observed adverse effects level. Two pesticide (DDE and DDT) presents an EEQ greater than 1 associated with exposure to native sediment from the North Branch of Pettibone Creek (see Table 2-8). Additionally, mean concentrations of COCs for the piscivorous bird endpoint from the 2008 native sediment data were compared to the PRGs developed and approved for use by representatives of the Navy and Illinois EPA in the FS (TTNUS, 2005) (see Table 2-10). The means for both DDE and DDT from the 2008 native sediment data did not exceed the PRGs. This indicates that there is no potential risk to the piscivorous bird endpoint from exposure to native sediment in Pettibone Creek.

In summary, the proposed removal action of surface sediment in the North Branch will result in a significant risk reduction for benthic invertebrates and piscivorous birds. Furthermore, stream restoration efforts following the removal action will result in habitat improvement over time, allowing accretion of sediment over existing native sediment.

TABLE 2-1

SUMMARY OF HUMAN HEALTH RISKS
POTENTIAL CURRENT AND FUTURE LAND USE SCENARIOS
SITE 17 – PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Receptor	Medium of Concern	Exposure Route	Total ILCR	
			RME	CTE
North Branch Pettibone Creek				
Adolescent Recreational User	Sediment	Incidental Ingestion and Dermal Contact	2.6E-06	4.1E-07
Adult Recreational User	Sediment	Incidental Ingestion and Dermal Contact	6.9E-06	2.2E-07
South Branch Pettibone Creek				
Adolescent Recreational User	Sediment	Incidental Ingestion and Dermal Contact	5.4E-07	7.9E-08
Adult Recreational User	Sediment	Incidental Ingestion and Dermal Contact	1.6E-06	4.5E-08
Boat Basin				
Adolescent Recreational User	Surface Water	Dermal Contact	9.7E-07	2.3E-07
	Sediment	Incidental Ingestion and Dermal Contact	3.0E-06	4.7E-07
Adult Recreational User	Surface Water	Dermal Contact	1.8E-06	1.3E-07
	Sediment	Incidental Ingestion and Dermal Contact	8.1E-06	2.6E-07
	Fish Tissue	Ingestion	1.8E-04	2.1E-05

Receptor	Medium of Concern	Exposure Route	Total HI	
			RME	CTE
North Branch Pettibone Creek				
Adolescent Recreational User	Sediment	Incidental Ingestion and Dermal Contact	3.0E-02	6.0E-03
Adult Recreational User	Sediment	Incidental Ingestion and Dermal Contact	2.7E-02	4.1E-03
South Branch Pettibone Creek				
Adolescent Recreational User	Sediment	Incidental Ingestion and Dermal Contact (1)	4.4E-03	1.1E-03
Adult Recreational User	Sediment	Incidental Ingestion and Dermal Contact	2.7E-03	6.6E-04
Boat Basin				
Adolescent Recreational User	Surface Water	Dermal Contact	6.9E-02	1.6E-02
	Sediment	Incidental Ingestion and Dermal Contact	3.2E-02	5.9E-03
Adult Recreational User	Surface Water	Dermal Contact	6.9E-02	1.6E-02
	Sediment	Incidental Ingestion and Dermal Contact	3.1E-02	4.2E-03
	Fish Tissue	Ingestion	6.6E+00	2.6E+00

TABLE 2-1

SUMMARY OF HUMAN HEALTH RISKS
POTENTIAL CURRENT AND FUTURE LAND USE SCENARIOS
SITE 17 – PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

1 Not evaluated for dermal contact because thallium was the only non-carcinogen selected as a COPC, see Section 6.2.4.1 of Site 17 RI/RA (TtNUS, 2003).

Details of the HHRA assumptions and computations are provided in Section 6 of the Site 17 RI/RA (TtNUS, 2003).

CTE - Central Tendency Exposure.
ILCR - Incremental Lifetime Cancer Risk.
RME - Reasonable Maximum Exposure.
HI - Hazard Index.

TABLE 2-2

SUMMARY OF ECOLOGICAL RISKS
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Receptor[1]	Exposure Route[2]	Chemical of Concern	EEQ[3]
North Branch Pettibone Creek			
Benthic Invertebrates and Fish	Direct contact, Ingestion of sediment, Ingestion of prey	PAHs	2.3 to 1,364
		4,4'-DDT	1,800
		4,4'-DDE	105
		4,4'-DDD	85
		Endosulfan II	80
		Copper	30
		Lead	10
		Mercury	24
		Zinc	18.0
Piscivorous Birds	Direct contact, Ingestion of sediment, Ingestion of prey	4,4'-DDT	43
		4,4'-DDE	94
Boat Basin			
Benthic Invertebrates and Fish	Direct contact, Ingestion of sediment, Ingestion of prey	PAHs	3.5 to 62
		4,4'-DDT	120
		4,4'-DDE	115
		4,4'-DDD	155
		Endosulfan I	58
		Endosulfan II	80
		Aroclor-1254	11
		Aroclor-1260	54
		Copper	18
		Lead	9.3
		Zinc	17
Piscivorous Birds	Direct contact, Ingestion of sediment, Ingestion of prey	4,4'-DDE	60

1- Risks to carnivorous mammals were also evaluated; however, no COCs were retained for this receptor.
2- COCs were detected in sediment. Surface water was also evaluated as a medium of concern; however, no chemicals were retained as COCs.
3- The LOAEL EEQ using the average concentration and average exposure assumptions is shown for piscivorous birds because this EEQ was used in the final risk determination.
EEQ = Ecological Effect Quotient.
PAHs = Polynuclear Aromatic Hydrocarbons.
COCs = Chemicals of Concern.
LOAEL = Lowest Observable Adverse Effect Level.

TABLE 2-3

DECEMBER 2008 INVESTIGATION DATA SUMMARY TABLE
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Parameter	Frequency of Detection	Minimum Result	Maximum Result	Location / Sample Number of Maximum Detect	Minimum Non-Detect	Maximum Non-Detect	TACO BACKGROUND SOIL WITHIN METROPOLITAN	ILLINOIS EPA UNSIEVED STREAM SEDIMENT BACKGROUND	ILLINOIS TACO ROUTE SPECIFIC VALUES FOR SOIL INGESTION	REGION 9 RESIDENTIAL SOIL PRG	REGION 9 INDUSTRIAL SOIL PRG	ECOLOGICAL SEDIMENT	MINIMUM CRITERION
							Value / Exceeds	Value / Exceeds	Value / Exceeds	Value / Exceeds	Value / Exceeds	Value / Exceeds	Value / Exceeds
Polynuclear Aromatic Hydrocarbons (ug/kg)													
2-METHYLNAPHTHALENE	9/10	2.3 J	20	NTC17PCSD47	4	4	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	368 / 0	368 / 0
ACENAPHTHENE	5/10	1.9 J	11	NTC17PCSD42 NTC17PCSD44	3.8	4	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	186 / 0	186 / 0
ANTHRACENE	6/10	3 J	71	NTC17PCSD42	3.8	4	NC / 0	NC / 0	23000000 / 0	22000000 / 0	100000000 / 0	85 / 0	85 / 0
BENZO(A)ANTHRACENE	5/10	33	260	NTC17PCSD44	3.8	4	NC / 0	NC / 0	900 / 0	620 / 0	2900 /0	287 / 0	287 / 0
BENZO(A)PYRENE	5/10	24	200	NTC17PCSD42	3.8	4	NC / 0	NC / 0	90 / 2	62 / 2	290 / 0	73 / 2	62 / 2
BENZO(B)FLUORANTHENE	5/10	20	240	NTC17PCSD42	3.8	4	NC / 0	NC / 0	900 / 0	620 / 0	2900 / 0	886 / 0	620 / 0
BENZO(G,H,I)PERYLENE	10/10	1.8 J	120	NTC17PCSD42			NC / 0	NC / 0	3100000 / 0	56000 / 0	54000000 / 0	170 / 0	170 / 0
BENZO(K)FLUORANTHENE	5/10	6.4	64	NTC17PCSD42	3.8	4	NC / 0	NC / 0	9000 / 0	6200 / 0	29000 / 0	8860 / 0	6200 / 0
CHRYSENE	5/10	29	200 J	NTC17PCSD44	3.8	4	NC / 0	NC / 0	88000 / 0	62000 / 0	290000 / 0	400 / 0	400 / 0
DIBENZO(A,H)ANTHRACENE	4/10	4.2 J	27 J	NTC17PCSD42	3.8	4	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	60 / 0	60 / 0
FLUORANTHENE	9/10	3.1 J	620 J	NTC17PCSD44	3.8	3.8	NC / 0	NC / 0	3100000 / 0	2300000 / 0	30000000 / 0	2790 / 0	2790 / 0
FLUORENE	6/10	2.8 J	19	NTC17PCSD44	3.8	4	NC / 0	NC / 0	3100000 / 0	2600000 / 0	33000000 / 0	35 / 0	35 / 0
HIGH MOLECULAR WEIGHT PAHS	10/10	4.4	2192	NTC17PCSD44			NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	1700 / 2	1700 / 2
INDENO(1,2,3-CD)PYRENE	4/10	17	100	NTC17PCSD42	3.8	4	NC / 0	NC / 0	900 / 0	620 / 0	2900 / 0	2500 / 0	620 / 0
LOW MOLECULAR WEIGHT PAHS	10/10	3.9	425.8	NTC17PCSD44			NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	552 / 0	552 / 0
NAPHTHALENE	3/10	4.8	6.5	NTC17PCSD42	3.8	4.4	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	340 / 0	340 / 0
PHENANTHRENE	10/10	3.9 J	320 J	NTC17PCSD44			NC / 0	NC / 0	3100000 / 0	56000 / 0	54000000 / 0	810 / 0	810 / 0
PYRENE	7/10	4.4	460 J	NTC17PCSD44	3.8	4	NC / 0	NC / 0	2300000 / 0	2300000 / 0	54000000 / 0	350 / 2	350 / 2
BAP EQUIVALENT-HALFND	5/10	31.593	283.81	NTC17PCSD42	3.8	4	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0
BAP EQUIVALENT-POS	5/10	29.393	283.81	NTC17PCSD42	3.8	4	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0
TOTAL PAHS	10/10	13.2	2617.8	NTC17PCSD44			NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	4000 / 0	4000 / 0
Pesticides/PCBs (ug/kg)													
4,4'-DDD	6/10	2.1 J	19 J	NTC17PCSD49	0.76	0.83	NC / 0	NC / 0	3000 / 0	2400 / 0	17000 / 0	2 / 6	2 / 6
4,4'-DDE	6/10	0.92 J	68 J	NTC17PCSD49	0.76	0.83	NC / 0	NC / 0	2000 / 0	1700 / 0	12000 / 0	2 / 4	2 / 4
4,4'-DDT	5/10	1.4 J	19 J	NTC17PCSD49	0.76	0.83	NC / 0	NC / 0	2000 / 0	1700 / 0	12000 / 0	1 / 5	1 / 5
AROCLOR-1260	1/10	7.2 J	7.2 J	NTC17PCSD48	19	22	NC / 0	NC / 0	1000 / 0	220 / 0	1000 / 0	5 / 1	5 / 1
ENDRIN	2/10	1.5 J	2 J	NTC17PCSD49	0.76	0.84	NC / 0	NC / 0	23000 / 0	18000 / 0	260000 / 0	19 / 0	19 / 0
GAMMA-BHC (LINDANE)	1/10	0.25 J	0.25 J	NTC17PCSD44	0.38	0.44	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	0.39 / 0	0.39 / 0
TOTAL AROCLOR	1/10	7.2	7.2	NTC17PCSD48	19	22	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	50 / 0	50 / 0
TOTAL DDT POS	6/10	6.4	106	NTC17PCSD49	0	0.78	NC / 0	NC / 0	NC / 0	NC / 0	NC / 0	7 / 5	7 / 5
Inorganics (mg/kg)													
COPPER	10/10	16.3	167	NTC17PCSD48			19.6 / 7	38 / 2	2900 / 0	2900 / 0	76000 / 0	16 / 10	16 / 10
LEAD	10/10	8.9	103	NTC17PCSD48			36 / 2	28 / 3	400 / 0	400 / 0	750 / 0	31 / 3	28 / 3
MERCURY	5/10	0.018	0.061	NTC17PCSD42	0.014	0.017	0.06 / 1	0.07 / 0	23 / 0	23 / 0	610 / 0	0.2 / 0	0.06 / 1
ZINC	10/10	43.2	1070	NTC17PCSD48			95 / 4	80 / 5	23000 / 0	23000 / 0	100000 / 0	120 / 2	80 / 5

Notes:
The location identification is identical to the sample number.
The column labled "Value / Exceeds" indicates the screening value for the identified criteria and the number of exceedances of that screening level.
Black shading indicates that screening value has been exceeded.

Associated Samples:

NTC17PCSD40	NTC17PCSD45
NTC17PCSD41	NTC17PCSD46
NTC17PCSD42	NTC17PCSD47
NTC17PCSD43	NTC17PCSD48
NTC17PCSD44	NTC17PCSD49

TABLE 2-4

COMPARISON OF 2001 AND 2008 SAMPLE RESULTS
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Number Sample Date Sediment/Soil description Sample Interval (in ft bgs)	Minimum Screening Value (See Table 2-3)	NTC17PCSD01 9/24/2001 Sediment - Dk Brown F-M SAND 0-0.13	NTC17PCSD01 9/24/2001 Sediment - Brown F-C SAND 1-1	NTC17PCSD49 12/9/2008 Native Soil - Brown CLAY with silt/sand 0.75-1.25	NTC17PCSD03 9/24/2001 Sediment - Ol. Gray F-SAND and SILT 0-0.13	NTC17PCSD48 12/9/2008 Native Soil - Gray CLAY little silt/sand 2.5-3.0	NTC17PCSD08 9/24/2001 Sediment - Ol. Gray F - SAND and SILT 0-0.13	NTC17PCSD08 9/24/2001 Sediment - Ol. Gray F - SAND and SILT 1-1	NTC17PCSD47 12/9/2008 Native Soil - Gray Silty CLAY 2.0-2.5
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	368	ND	ND	3.3 J	ND	7.6	ND	ND	20
ACENAPHTHENE	186	ND	ND	1.9 J	ND	4.8	ND	ND	3.8 U
ANTHRACENE	85	4000	1600	7.8	410	20	73 J	800	3.8 U
BENZALDEHYDE	NVP	ND	ND	NA	ND	NA	ND	ND	NA
BENZO(A)ANTHRACENE	287	11000	4100	37	1400	33	430	2800	3.8 U
BENZO(A)PYRENE	62	11000	4000	37	1500	24	470	2900	3.8 U
BENZO(B)FLUORANTHENE	620	12000	4100	34	1500	20	510	3200	3.8 U
BENZO(G,H,I)PERYLENE	170	7500 J	2600	21	1200	12	420	2300	3.2 J
BENZO(K)FLUORANTHENE	6200	ND	ND	10	ND	6.4	ND	ND	3.8 U
CAPROLACTAM	NVP	ND	ND	NA	ND	NA	ND	ND	NA
CARBAZOLE	NVP	ND	ND	NA	ND	NA	ND	ND	NA
CHRYSENE	400	12000	4200	39	1500	29	470	3000	3.8 U
DIBENZO(A,H)ANTHRACENE	60	ND	ND	4.2 J	ND	4 U	ND	ND	3.8 U
FLUORANTHENE	2790	33000	13000	82	4600	69	1100	8200	5.7
FLUORENE	35	2400 J	840	2.8 J	320 J	9.7	74 J	450	3.8 U
INDENO(1,2,3-CD)PYRENE	620	5800 J	1600	17	680	4 U	370	1600	3.8 U
NAPHTHALENE	340	ND	ND	4.4 U	ND	4 U	ND	ND	6.2
PHENANTHRENE	810	24000	8500	52	2600	78	630	4600	24
PYRENE	350	27000	9700	68	3400	59	940	6100	3.8 U
TOTAL PAHS	4000	156000	56670	417	20009	372.5	5757	37970	59.1
Pesticides/PCBs (ug/kg)									
4,4'-DDD	2	25 J	3.8	19 J	63	3.8 J	4.7	14	0.76 UJ
4,4'-DDE	2	36 J	8.5	68 J	110	1.2 J	11	22	0.76 UJ
4,4'-DDT	1	32 J	9.5	19 J	190	1.4 J	7.5	15	0.76 UJ
TOTAL DDT	7	93	21.8	106	363	6.4	23.2	51	0.76 U
AROCLOR-1254	NVP	300 J	92	22 UJ	200	20 UJ	40 U	45 U	19 UJ
AROCLOR-1260	5	39 UR	36 U	22 UJ	150	7.2 J	40 U	45 U	19 UJ
ENDRIN	16	ND	ND	2 J	ND	0.8 UJ	ND	ND	0.76 UJ
GAMMA-BHC (LINDANE)	0.39	ND	ND	0.44 UJ	ND	0.4 UJ	ND	ND	0.38 UJ
TOTAL PCBS	NVP	300	92	NC	350	NC	40	45	NC
ENDOSULFAN I	NVP	2 U	1.8 U	0.44 UJ	21 U	0.4 UJ	2 U	2.3 U	0.38 UJ
ENDOSULFAN II	NVP	12 J	2.8	0.89 UJ	4.1 J	0.8 UJ	0.55 J	0.9 J	0.76 UJ
TOTAL AROCLOR (Detected)	50	300 J	92	NC	350	7.2	ND	ND	19 U
Inorganics (mg/kg)									
COPPER	16	368	370	31.4	222	167	43.1	55.8	22.6
LEAD	28	322 J	187	36.6	213	103	73.0	71.9	11.2
MERCURY	0.06	0.94 J	0.31	0.017 U	0.25	0.018	0.05	0.12	0.015 U
ZINC	80	1140 J	2620	97.3	774	1070	192	171	51

TABLE 2-4

COMPARISON OF 2001 AND 2008 SAMPLE RESULTS
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Number Sample Date Sediment/Soil description Sample Interval (in ft bgs)	Minimum Screening Value (See Table 2-3)	NTC17PCSD11 9/23/2001 Sediment - Brown F-M SAND 0-0.13	NTC17PCSD11 9/23/2001 Sediment - Brown F-M SAND 1-1	NTC17PCSD46 12/9/2008 Native Soil - Gray CLAY little silt, sand, gravel 1.0-1.5	NTC17PCSD13 9/23/2001 Sediment - Brown F-M SAND 0-0.13	NTC17PCSD45 12/9/2008 Native Soil - Gray CLAY little silt 0.25-0.75	NTC17PCSD14 9/23/2001 Sediment - Brown F-M SAND 0-0.13	NTC17PCSD14 9/23/2001 Sediment - Brown/Gray M-C SAND with gravel/clay 1-1	NTC17PCSD44 12/9/2008 Native Soil - Brown SAND/SILT/CLAY 0.25-0.75
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	368	ND	ND	5.1	ND	7.5	ND	ND	5
ACENAPHTHENE	186	ND	ND	3.8 U	ND	3.9 U	ND	Nd	11
ANTHRACENE	85	1100	310	3.8 U	600	3.9 U	110 J	290	66
BENZALDEHYDE	NVP	ND	ND	NA	ND	NA	370 U	ND	NA
BENZO(A)ANTHRACENE	287	2900	950	3.8 U	2000	3.9 U	440	500	260
BENZO(A)PYRENE	62	2700	1200	3.8 U	1900	3.9 U	410	410	180
BENZO(B)FLUORANTHENE	620	2800	1000	3.8 U	1900	3.9 U	440	380	200 J
BENZO(G,H,I)PERYLENE	170	1500	1100	4.4	1300	3.8 J	260	230	100
BENZO(K)FLUORANTHENE	6200	ND	ND	3.8 U	ND	3.9 U	ND	ND	58
CAPROLACTAM	NVP	ND	ND	NA	ND	NA	370 U	ND	NA
CARBAZOLE	NVP	ND	ND	NA	ND	NA	720	ND	NA
CHRYSENE	400	2900	950	3.8 U	1900	3.9 U	430	430	200 J
DIBENZO(A,H)ANTHRACENE	60	ND	ND	3.8 U	ND	3.9 U	ND	ND	26
FLUORANTHENE	2790	8400	2700	3.8 U	5200	7.6	1200	1300	620 J
FLUORENE	35	850	160	3.8 U	280 J	3.9 U	80 J	150 J	19
INDENO(1,2,3-CD)PYRENE	620	1500	590	3.8 U	920	3.9 U	170	140 J	88
NAPHTHALENE	340	ND	ND	3.8 U	ND	3.9 U	ND	ND	4.8
PHENANTHRENE	810	6400	1800	16	3100	18	720	1000	320 J
PYRENE	350	6600	2100	3.8 U	4200	7.7	930	1000	460 J
TOTAL PAHS	4000	39250	13420	25.5	24400	44.6	5466	6060	2617.8
Pesticides/PCBs (ug/kg)									
4,4'-DDD	2	58	76	0.76 UJ	100	0.78 UJ	100	180	2.1 J
4,4'-DDE	2	110	160	0.76 UJ	110	0.78 UJ	150	200	14 J
4,4'-DDT	1	170	190	0.76 UJ	150	0.78 UJ	190	190	13 J
TOTAL DDT	7	338	426	0.76 U	360	0.78 U	440	570	29.1
AROCLOR-1254	NVP	37 U	790	19 UJ	140	20 UJ	200	40 U	21 UJ
AROCLOR-1260	5	46	40 U	19 UJ	41	20 UJ	43	40 U	21 UJ
ENDRIN	16	ND	ND	0.76 UJ	ND	0.78 UJ	ND	ND	1.5 J
GAMMA-BHC (LINDANE)	0.39	ND	ND	0.38 UJ	ND	0.39 UJ	ND	ND	0.25 J
TOTAL PCBS	NVP	46	790	NC	181	NC	243	40	NC
ENDOSULFAN I	NVP	19 U	41 U	0.38 UJ	18 U	0.39 UJ	38 U	41 U	0.42 UJ
ENDOSULFAN II	NVP	19 U	41 U	0.76 UJ	18 U	0.78 UJ	38 U	41 U	0.27 U
TOTAL AROCLOR (Detected)	50	46	ND	19 U	181	20 U	243	ND	21 U
Inorganics (mg/kg)									
COPPER	16	123	182	19.4	197	53.5	123	268	32.1
LEAD	28	120	154	9.6	155	24	108	177	20.6
MERCURY	0.06	0.45	0.14	0.014 U	0.22	0.015 U	4.7	0.1	0.038
ZINC	80	570	1260	43.9	856	230	810	2180	81.3 J

TABLE 2-4

COMPARISON OF 2001 AND 2008 SAMPLE RESULTS
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Number Sample Date Sediment/Soil description Sample Interval (in ft bgs)	Minimum Screening Value (See Table 2-3)	NTC17PCSD17 9/22/2001 Sediment - Brown M-C SAND/GRAVEL 0-0.13	NTC17PCSD17 9/22/2001 Sediment - Brown F-Gravelly SAND 1-1	NTC17PCSD43 12/9/2008 Native Soil - Gray CLAY little silt 1.0-1.5	NTC17PCSD19 9/22/2001 Sediment - Ol. Gray SILT and F-SAND 0-0.13	NTC17PCSD42 12/9/2008 Native Soil - Brown SAND/SILT/CLAY 0.25-0.75	NTC17PCSD21 9/22/2001 Sediment - Brown F-C SAND 0-0.13	NTC17PCSD41 12/8/2008 Native Soil - Gray SILT little clay/sand 0.5-1.0
Semivolatile Organics (ug/kg)								
2-METHYLNAPHTHALENE	368	ND	ND	4.2	ND	7.2	ND	2.3 J
ACENAPHTHENE	186	ND	ND	3.5 J	ND	11	ND	4 U
ANTHRACENE	85	160	87	12	290	71	120	3 J
BENZALDEHYDE	NVP	ND	ND	NA	ND	NA	360 U	NA
BENZO(A)ANTHRACENE	287	530	340	67	760	220	380	4 U
BENZO(A)PYRENE	62	500	300	62	790	200	330	4 U
BENZO(B)FLUORANTHENE	620	510	310	74	790	240	340	4 U
BENZO(G,H,I)PERYLENE	170	320	200	38	540 J	120	230	5.5
BENZO(K)FLUORANTHENE	6200	ND	ND	20	ND	64	ND	4 U
CAPROLACTAM	NVP	ND	ND	NA	ND	NA	360 U	NA
CARBAZOLE	NVP	ND	ND	NA	ND	NA	75 J	NA
CHRYSENE	400	490	330	56	740	170	350	4 U
DIBENZO(A,H)ANTHRACENE	60	ND	ND	8.1	ND	27 J	ND	4 U
FLUORANTHENE	2790	1300	900	150	2000 J	550	940	9.3
FLUORENE	35	40 J	73 J	6.3	120 J	18	77	2.9 J
INDENO(1,2,3-CD)PYRENE	620	180	130	30	320 J	100	140	4 U
NAPHTHALENE	340	ND	ND	4.1 U	ND	6.5	ND	4 U
PHENANTHRENE	810	590	610	110	1300	310	500	18
PYRENE	350	980	720	130	1500	440	720	4 U
TOTAL PAHS	4000	5920	4180	771.1	9590	2554.7	4345	41
Pesticides/PCBs (ug/kg)								
4,4'-DDD	2	30	59	0.83 UJ	170	2.4 J	51	13 J
4,4'-DDE	2	46	150	0.83 UJ	210	8.4 J	42	7.4 J
4,4'-DDT	1	110	160	0.83 UJ	230	5 J	62	3.9 J
TOTAL DDT	7	186	369	0 U	610	15.8	155	24.3
AROCLOR-1254	NVP	69	37 U	21 UJ	440	21 UJ	56	20 UJ
AROCLOR-1260	5	36 U	51	21 UJ	110	21 UJ	36 U	20 UJ
ENDRIN	16	ND	ND	0.83 UJ	ND	0.84 UJ	ND	0.8 UJ
GAMMA-BHC (LINDANE)	0.39	ND	ND	0.41 UJ	ND	0.42 UJ	ND	0.4 UJ
TOTAL PCBS	NVP	69	51	NC	550	NC	56	NC
ENDOSULFAN I	NVP	9.3 U	38 U	0.41 UJ	42 U	0.42 UJ	9.2 U	0.4 UJ
ENDOSULFAN II	NVP	1.8 J	38 U	0.83 UJ	42 U	0.84 UJ	1.1 J	0.8 UJ
TOTAL AROCLOR (Detected)	50	69	51	21 U	550	21 U	56	20 U
Inorganics (mg/kg)								
COPPER	16	206	138	22	118	18.1	79.6	23.9
LEAD	28	135	77.1	9.9	109	33.6	45.5	11.4
MERCURY	0.06	0.08	0.1	0.023	0.61	0.061	0.06	0.028
ZINC	80	1210	799	44.3 J	377 J	99.3 J	362	45.3

TABLE 2-4

COMPARISON OF 2001 AND 2008 SAMPLE RESULTS
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Number Sample Date Sediment/Soil description Sample Interval (in ft bgs)	Minimum Screening Value (See Table 2-3)	NTC17PCSD23 9/22/2001 Sediment - Brown F - SAND 0-0.13	NTC17PCSD23 9/22/2001 Sediment - Brown F-Gravelly SAND 1-1	NTC17PCSD40 12/8/2008 Native Soil - Gray SILT little clay/sand 1.0-1.5
Semivolatile Organics (ug/kg)				
2-METHYLNAPHTHALENE	368	ND	ND	4 U
ACENAPHTHENE	186	ND	ND	4 U
ANTHRACENE	85	150	390	4 U
BENZALDEHYDE	NVP	420 U	ND	NA
BENZO(A)ANTHRACENE	287	470	790	4 U
BENZO(A)PYRENE	62	470	770	4 U
BENZO(B)FLUORANTHENE	620	450	730	4 U
BENZO(G,H,I)PERYLENE	170	85 U	460	1.8 J
BENZO(K)FLUORANTHENE	6200	ND	ND	4 U
CAPROLACTAM	NVP	420 U	ND	NA
CARBAZOLE	NVP	250 J	ND	NA
CHRYSENE	400	450	730	4 U
DIBENZO(A,H)ANTHRACENE	60	ND	ND	4 U
FLUORANTHENE	2790	1300	2400	3.1 J
FLUORENE	35	76 J	240	4 U
INDENO(1,2,3-CD)PYRENE	620	230	300	4 U
NAPHTHALENE	340	ND	ND	4 U
PHENANTHRENE	810	730	1900	3.9 J
PYRENE	350	1000	1800	4.4
TOTAL PAHS	4000	5586	10920	13.2
Pesticides/PCBs (ug/kg)				
4,4'-DDD	2	89	45	6.1 J
4,4'-DDE	2	91	40	0.92 J
4,4'-DDT	1	81	90	0.79 UJ
TOTAL DDT	7	261	175	7.02
AROCLOR-1254	NVP	42 U	39 U	20 UJ
AROCLOR-1260	5	42 U	39 U	20 UJ
ENDRIN	16	ND	ND	0.79 UJ
GAMMA-BHC (LINDANE)	0.39	ND	ND	0.4 UJ
TOTAL PCBS	NVP	42	39	NC
ENDOSULFAN I	NVP	22 U	10 U	0.4 UJ
ENDOSULFAN II	NVP	22 U	10 U	0.79 UJ
TOTAL AROCLOR (Detected)	50	ND	ND	NC
Inorganics (mg/kg)				
COPPER	16	50.3	167	16.3
LEAD	28	57.6	159	8.9
MERCURY	0.06	0.09	0.15	0.016 U
ZINC	80	279	1240	43.2

NVP - No screening value provided
J - Estimated concentration
U - Contaminant not detected at indicated Concentration
ND - Contaminated not detected
NC - Value not calculated
NA - Contaminant not analyzed

Notes:
Black shading indicates exceedance of minimum screening value.
Gray shading indicates December 2008 sample.

TABLE 2-5

SUMMARY OF PRGs
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

COCs	PRG	Source[1]
PAHs (ug/kg)		
ANTHRACENE	960	Tier II
BENZALDEHYDE	4	Tier II
BENZO(A)ANTHRACENE	1,800	SBG
BENZO(A)PYRENE	2,500	Tier II
BENZO(B)FLUORANTHENE	2,000	SBG
BENZO(G,H,I)PERYLENE	NV	--
CARBAZOLE	400	Tier II
CHRYSENE	2,800	Tier II
FLUORANTHENE	9,920	Tier II
FLUORENE	640	Tier II
INDENO(1,2,3-CD)PYRENE	1,600	SBG
PHENANTHRENE	2,880	Tier II
PYRENE	2,200	Tier II
TOTAL PAHs	35,000	Tier II
Pesticides/PCBs (ug/kg)		
4,4'-DDD	20	Tier II
4,4'-DDE	15	Tier II
4,4'-DDT	7	Tier II
Total DDT	572	PEC
AROCLOR-1254	676	PEC
AROCLOR-1260	676	PEC
ENDOSULFAN I	0.5	Tier II
ENDOSULFAN II	0.5	Tier II
Inorganics (mg/kg)		
COPPER	149	PEC
LEAD	128	PEC
MERCURY	1.06	PEC
ZINC	459	PEC

1 - The source of the Tier II PRGs is Illinois EPA, September 2000, the source fo the PEC PRGs is MacDonald et al., 2000, and the source of the SBG PRGs is the Urban Area PAH study.

NV - No value

TABLE 2-6
HUMAN HEALTH NATIVE SEDIMENT ASSESSMENT
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Parameter	CAS No.	Minimum Result[1]	Maximum Result[1][2]	Average Positive Result	Overall Average	TACO Background Soil Within Metropolitan Areas	ILEPA Unsieved Stream Sediment Background	TACO Soil Ingestion[9]	Region 9 Residential Soil PRGs[8]	Region 9 Industrial Soil PRGs[8]	COPC Flag[10]	Rationale for Contaminant Deletion or Selection
Polynuclear Aromatic Hydrocarbons (ug/kg)												
2-METHYLNAPHTHALENE	91-57-6	2.3 J	20	6.9	6.4	NC	NC	NC	5600*	1600000*	NO	BSL
ACENAPHTHENE	83-32-9	1.9 J	11	6.4	4.2	NC	NC	NC	NC	NC	NO	BSL
ANTHRACENE	120-12-7	3 J	71	30.0	18.8	NC	NC	23000000	22000000	100000000	NO	BSL
BENZO(A)ANTHRACENE	56-55-3	33	260	123.4	62.7	NC	NC	900	620	2900	NO	BSL
BENZO(A)PYRENE	50-32-8	24	200	100.6	51.3	NC	NC	90	62	290	YES	ASL
BENZO(B)FLUORANTHENE	205-99-2	20	240	113.6	57.8	NC	NC	900	620	2900	NO	BSL
BENZO(G,H,I)PERYLENE	191-24-2	1.8 J	120	31.0	31.0	NC	NC	3100000	56000	54000000	NO	BSL
BENZO(K)FLUORANTHENE	207-08-9	6.4	64	31.7	16.8	NC	NC	9000	6200	29000	NO	BSL
CHRYSENE	218-01-9	29	200 J	98.8	50.4	NC	NC	88000	62000	290000	NO	BSL
DIBENZO(A,H)ANTHRACENE	53-70-3	4.2 J	27 J	16.3	7.7	NC	NC	NC	NC	NC	NO	BSL
FLUORANTHENE	206-44-0	3.1 J	620 J	166.3	149.9	NC	NC	3100000	2300000	30000000	NO	BSL
FLUORENE	86-73-7	2.8 J	19	9.8	6.6	NC	NC	3100000	2600000	33000000	NO	BSL
INDENO(1,2,3-CD)PYRENE	193-39-5	17	100	58.8	24.7	NC	NC	900	620	2900	NO	BSL
NAPHTHALENE	91-20-3	4.8	6.5	5.8	3.2	NC	NC	NC	NC	NC	NO	BSL
PHENANTHRENE	85-01-8	3.9 J	320 J	95.0	95.0	NC	NC	3100000	56000	54000000	NO	BSL
PYRENE	129-00-0	4.4	460 J	167.0	117.5	NC	NC	2300000	2300000	54000000	NO	BSL
TOTAL PAHS-FULLND	NA	13.2	2617.8	691.7	691.7	NC	NC	NC	NC	NC	NO	BSL
Pesticides/PCBs (ug/kg)												
4,4'-DDD	72-54-8	2.1 J	19 J	7.7	4.8	NC	NC	3000	2400	17000	NO	BSL
4,4'-DDE	72-55-9	0.92 J	68 J	16.7	10.1	NC	NC	2000	1700	12000	NO	BSL
4,4'-DDT	50-29-3	1.4 J	19 J	8.5	4.4	NC	NC	2000	1700	12000	NO	BSL
TOTAL DDT	NA	6.4	106	31.4	19.0	NC	NC	NC	NC	NC	NO	BSL
AROCLOR-1260	11096-82-5	7.2 J	7.2 J	7.2	9.9	NC	NC	1000	220	1000	NO	BSL
ENDRIN	72-20-8	1.5 J	2 J	1.8	0.7	NC	NC	23000	18000	260000	NO	BSL
GAMMA-BHC (LINDANE; GAMMA-HEXACHLOROCYCLOHEXANE)	58-89-9	0.25 J	0.25 J	0.3	0.2	NC	NC	NC	NC	NC	NO	BSL
TOTAL AROCLOR	NA	7.2	7.2	7.2	9.9	NC	NC	NC	NC	NC	NO	BSL
Inorganics (mg/kg)												
COPPER	7440-50-8	16.3	167	40.6	40.6	19.6	38	2900	2900	76000	NO#	BSL
LEAD	7439-92-1	8.9	103	26.9	26.9	36	28	400	400	750	NO#	BSL
MERCURY	7439-97-6	0.018	0.061	0.03	0.02	0.06	0.07	23	23	610	NO#	BSL
ZINC	7440-66-6	43.2	1070	180.6	180.6	95	80	23000	23000	100000	NO#	BSL

TABLE 2-6
HUMAN HEALTH NATIVE SEDIMENT ASSESSMENT
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Notes:

1 - Duplicate analytical results are not be used for the EPC calculations. Data values less than sample-specific detection limits are reported as the detection limit.

2 - The maximum detected concentration is used for screening purposes

3 - Section 742 Table A, Tier 1, Soil Remediation Objectives - Residential/Industrial/Commercial (Ingestion or Inhalation)(Online, 2010)

4 - Soil Remediation Objectives for Residential/Industrial/Commercial roperties, Non-TACO Chemicals (2009)

5 - USEPA ORNL Screening Level. The noncarcinogenic values (denoted with a "N" flag) are the ORNL value divided by 10 to correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1.0E-06 (carcinogens denoted with a "C" flag) (USEPA Region IX, October 2004, Updated Decemt

6 - Soil Screening Levels for Migration from Soil to Air for Construction Worker Scenario were calculated by Tetra Tech, NUS using methodology and equations presented in the Supplemental Guidance For Developing Soil Screening Levels for Superfund Sites, OSWER 93355.4-24, December 2002.

7 - SSLs for the migration of chemicals from soil to groundwater and soil to air were calculated by Tetra Tech, NUS using the methodology and equations presented in the Supplemental Guidance For Developing Soil Screening Levels for Superfund Sites, OSWER 93355.4-24, December 2002 and online at http://rais.oml.gov/epa/ssl1.shtml since these values are more recent than those published in the 1996 and 2002 SSL guidance documents.

8 - Criteria previously used in screening in the original Site 17 risk assessment - Based on Preliminary Remediation Goals, USEPA Region 9, November 2000, Residential and Industrial land use (Cancer benchmark value = 1E-06, Hazard Quotient = 0.1).

9 - Criteria previously used in screening in the original Site 17 ris assessment - Residential Soil Remediation Objective (SRO) for ingestion pathway, Illinois EPA, TACO, online March 2002.

10 - The chemical is selected as a COPC if the maximum detected concentration exceeds a screening level.

Exceeds ILEPA background concentrations but does not exceed any screening criteria, therefore is not retained as a COPC

* 2-Methylnaphthalene evaluated as naphthalene in the previous risk assessment

Pyrene is used as a surrogate for benzo(ghi)perylene and phenanthrene

A chemical is selected as a COPC if the maximum concentration exceeds any of the criteria AND the constituent is present at concentrations greater than the concentrations of inorganic chemicals in background sediment provided in Illinois EPA's Evaluation of Illinois Sieved Stream Sediment Data.

BAP equivalent criteria based on BaP

Illinois EPA TACO and Non-TACO criteria for endrin used as a surrogate for TACO and NON-TACO criteria for endrin + endrin aldehyde

Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

4,4 DDT is used as a surrogate for Total DDT

Aroclor 1260 used as a surrogate for Total Aroclor

Definitions:

C = Carcinogen

COPC = Chemical of potential concern

J = Estimated value

N = Non-carcinogen

NA = No criteria available

NC = No criteria were previously listed for this compound in the prior Site 17 risk assessment

Rationale Codes:

For Selection as a COPC:

ASL = Above COPC screening level

BSL = Below COPC screening level

TABLE 2-7
COMPARISON OF NATIVE AND CONTAMINATED SEDIMENT TOTAL CANCER RISKS
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

	NATIVE SEDIMENT Adolescent Recreational User Total Cancer Risk	CONTAMINATED SEDIMENT Adolescent Recreational User Total Cancer Risk	NATIVE SEDIMENT Adult Recreational User Total Cancer Risk	CONTAMINATED SEDIMENT Adult Recreational User Total Cancer Risk
Total Cancer Risk - RME	9.3E-08	3.0E-06	2.7E-07	7.9E-06
Total Cancer Risk - CTE	1.3E-08	4.8E-07	7.7E-09	2.6E-07

TABLE 2-8

POTENTIAL ECOLOGICAL RISK REDUCTION FOR PETTIBONE CREEK
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Receptor	Chemicals of Concern	RI/RA ERA EEQ[1]	Expected Post Remediation EEQ
Benthic invertebrates	PAHs	2.3 to 1,364	0.03 to 2.5
	4,4'-DDT	1800	19
	4,4'-DDE	105	34
	4,4'-DDD	85	9.5
	Endosulfan II	80	NC
	Copper	30	10.5
	Lead	10	3.2
	Mercury	24	0.3
	Zinc	18	9.1
	4,4'-DDT	43	1.1
Piscivorous Birds	4,4'-DDE	94	11.7

RI RA ERA - Remdial Investigation-Risk Assessment Ecological Risk Assessment
NC - Not calculated. This chemical was not detected in 2008

1. EEQ – Environmental Effects Quotient calculated by dividing chemical concentration or chronic daily intake by appropriate sediment benchmarks/toxicity reference values. Benthic Invertebrate EEQs calculated using Screening Values from RI Table 7-2 and maximum sediment concentrations. Piscivorous Bird EEQs are calculated using mean sediment concentrations, average inputs, and using the LOAEL.

TABLE 2-9

COMPARISON OF 2008 NATIVE SEDIMENT DATA TO BENTHIC INVERTEBRATE PRGS AT PETTIBONE CREEK
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Chemicals of Concern	PRGs[1]	Number of Sample Stations Exceeding PRGs	Sample Station Exceeding PRGs	Concentration Exceeding PRGs
Organics (ug/kg)				
PAHs	640-35,000	0	None	None
4,4'-DDD	20	0	None	None
4,4'-DDE	15	1	NTC17PCSD49	68
4,4'-DDT	7	2	NTC17PCSD49 NTC17PCSD44	19 13
Endosulfan II	0.5	0	Not Detected	None
Inorganics (mg/kg)				
Copper	149	1	NTC17PCSD48	167
Lead	128	0	None	
Mercury	1.06	0	None	
Zinc	459	1	NTC17PCSD48	1070

1. PRGs from Table 2-6 of FS (TTNUS, 2005)

TABLE 2-10

COMPARISON OF 2008 NATIVE SEDIMENT TO PISCIVOROUS BIRD PRGS AT PETTIBONE CREEK
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Chemicals of Concern	PRGs (ug/kg)	Mean 2008 Native Sediment (ug/kg)
4,4'-DDE	16	10.3
4,4'-DDT	75	4.6

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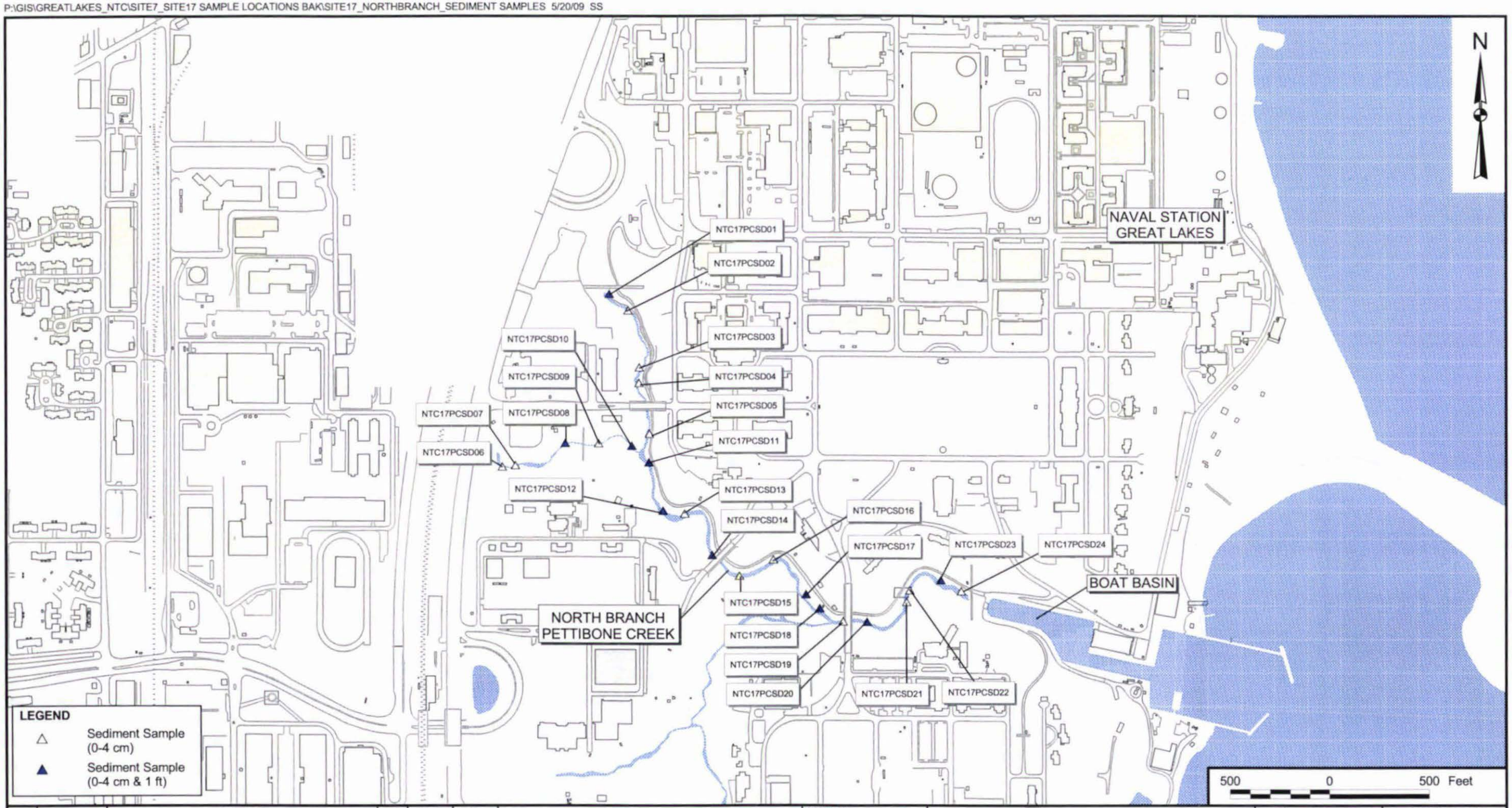

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY S. STROZ	DATE 02/26/08
CHECKED BY T. SMITH	DATE 05/20/09
COST/SCHEDULE-AREA	
SCALE AS NOTED	

Tetra Tech NUS, Inc.

2001 RI SEDIMENT SAMPLES
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER 01021	OWNER NUMBER 0747
APPROVED BY RFD	5/15/09
APPROVED BY	DATE —
DRAWING NO. FIGURE 2-1	REV 0

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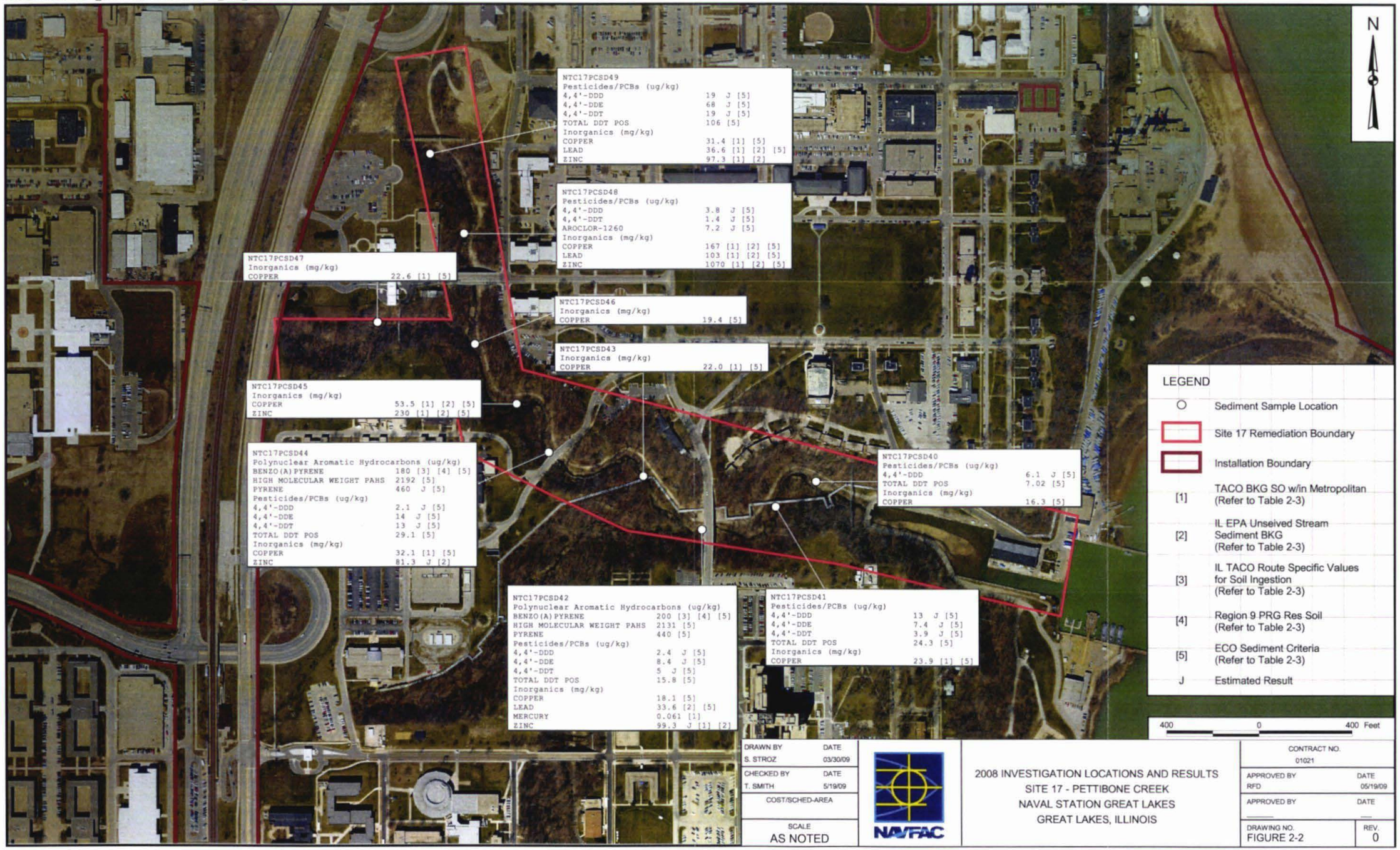


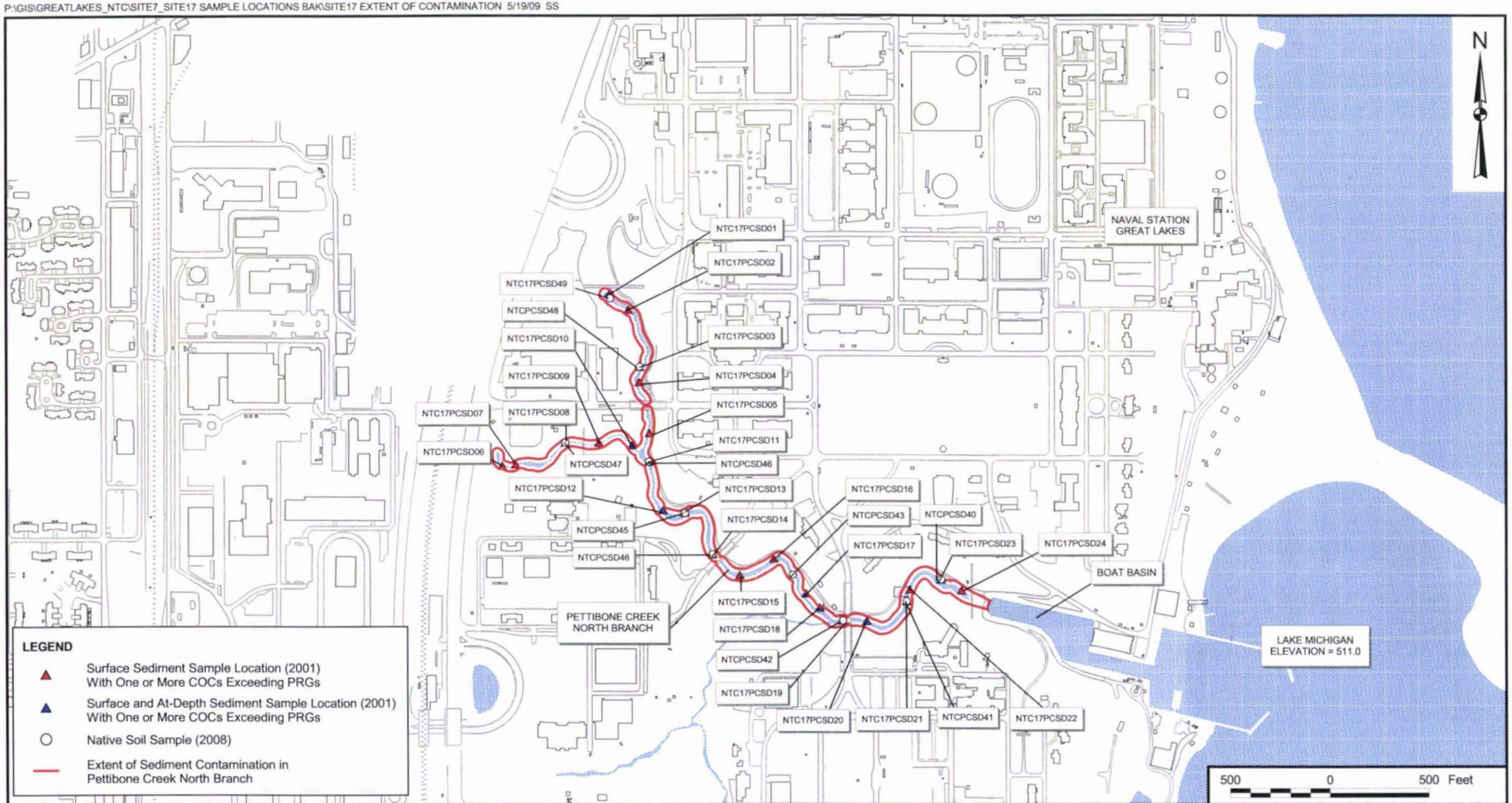
DRAWN BY	DATE
S. STROZ	03/30/09
CHECKED BY	DATE
T. SMITH	5/19/09
COST/SCHED-AREA	
SCALE	AS NOTED

NAVFAC

2008 INVESTIGATION LOCATIONS AND RESULTS
SITE 17 - PETTIBONE CREEK
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NO.	
01021	
APPROVED BY	DATE
RFD	05/19/09
APPROVED BY	DATE
DRAWING NO.	REV.
FIGURE 2-2	0

P:\GIS\GREATLAKES_NTC\SITE7_SITE17 SAMPLE LOCATIONS BAK\SITE17 EXTENT OF CONTAMINATION 5/19/09 SS



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY S. STROZ	DATE 2/26/08	Tetra Tech NUS, Inc.	CONTRACT NUMBER 01021 / OWNER NUMBER 0474
CHECKED BY T. SMITH	DATE 5/19/09	EXTENT OF CONTAMINATION SITE 17 - PETTIBONE CREEK RAP NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	APPROVED BY RFD / DATE 5/15/09
COST/SCHEDULE-AREA			APPROVED BY / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 2-3 / REV 0

3.0 REMEDIAL ACTION WORK PLAN

The intent of this RAP is to remove sediment with PAH, PCB, pesticide, and metal concentrations greater than the PRGs identified in Table 2-5 from the North Branch Pettibone Creek portion of Site 17. The activities associated with this RAP are intended to decrease human health and ecological risks associated with the sediment in the North Branch Pettibone Creek within the limits of Naval Station Great Lakes property.

3.1 DESCRIPTION OF THE REMEDIAL ACTION

The RAP specifies the removal of contaminated sediment from Site 17 Pettibone Creek within the property limits of Naval Station Great Lakes. In addition, the RAP specifies the restoration of the creek and tributary disturbed/impacted by RAP activities. The contaminated sediment to be removed has been identified as containing PAHs, PCBs, pesticides, and metals at concentrations greater than the PRGs. A list of the specific COCs detected in the sediment at concentrations greater than PRGs is presented in Table 2-5. The volumes of sediment to be excavated are in-place estimates; it is anticipated that these volumes will increase 2 to 5 percent after the sediment is excavated and is in an unconsolidated state.

A work assignment responsibility chart (Table 3-1) identifies the responsibilities of the Environmental Multiple Award Contract (EMAC) contractor, Naval Station Great Lakes, and Tetra Tech in the implementation of this RAP.

Specifically, this RAP consists of the following major components:

- Sediment Excavation/Removal - Sediment with PAH, PCB, pesticide, and metal concentrations greater than PRGs are present in the North Branch Pettibone Creek (3,540 linear feet of stream) and a small unnamed tributary that feeds the North Branch Pettibone Creek from the west (900 linear feet of tributary). The sediment will be excavated/removed from the creek and tributary to a depth that exposes native stream bed soil. The excavated sediment will be dewatered, processed, characterized for disposal purposes, and transported and disposed off site. The locations of the sediment excavation/removal areas are identified on Figure 3-1.

- Dewatering of Excavated/Removed Sediment - Prior to off-site disposal, the sediment will be stockpiled on a dewatering pad (or approved other) located within the construction area. It is expected that the water drained from the sediment will be filtered and discharged back to Pettibone Creek. It is the EMAC contractors responsibility to verify the water can be discharged back to Pettibone Creek. Due to the sandy nature of the sediment to be removed from Pettibone Creek, the

volume of water collected through dewatering is not expected to be large, unless sediment excavation/removal is performed during periods of heavy rain.

- Sediment Processing – During excavation, larger stone and rock material (greater than 3-inches in diameter) will be removed along with the sediment. Following dewatering and prior to off-site disposal characterization sampling, the sediment will be processed through a screening mechanism that will remove rock material with a nominal diameter of 3 inches or more. This material will be stockpiled, washed if necessary, and reused during stream restoration.

- Post-Removal Sampling and Analysis – Following the excavation/removal of contaminated sediment from the creek and tributary, the Navy's representative will sample the exposed native stream bed, unless exposed native stream bed is bed rock, to determine the extent of contamination (if any) remaining following the implementation of this remedial action. The post-removal samples will not be used to determine if excavation limits need to be extended; rather, the analytical results from these samples will be used to perform a risk assessment to determine if COC concentrations in the remaining native stream bed soil cause an unacceptable risks to human health or the environment. Section 5.0 presents the post-removal sampling and analysis procedures.

- Stream Backfilling and Restoration - After the collection of post-removal samples, the creek and tributary will be backfilled to pre-construction conditions and restored using stabilization practices that include use of the stabilized rock material from the sediment processing, gravel, rock, and vegetation.

- Verification Sampling and Analysis - At the completion of remedial action activities and following the removal of the support facilities (e.g., haul roads, dewatering pad, decontamination pad, and material storage area), the Navy's representative will collect verification samples within the footprint of each support facility to confirm that remedial action activities did not result in the spreading of contamination. If it is determined that contamination was spread to the soil below the support facilities, the EMAC contractor will be required to remove and dispose of that contamination at their expense. Section 5.0 presents the verification sampling and analysis procedures.

- Off-Site Disposal of Sediments - Sediments will be disposed at an off-site Naval Station Great Lakes-approved, waste disposal facility. It is expected that the excavated sediments can be directly loaded and transported to a non-hazardous waste disposal facility following dewatering and characterization. Verification of this disposal assumption will be the responsibility of the EMAC contractor through characterization sampling and analysis that follows the Naval Station Great Lakes Hazardous Waste Management Plan (NSGL, 2002) and satisfies the requirements of the selected and approved disposal facility.

3.2 PERFORMANCE STANDARDS

The performance standards for this RAP are presented in the following paragraphs.

3.2.1 Stream Excavation

The sediment in the North Branch Pettibone Creek and tributary, within the limits identified in Figure 3-1, have PAH, PCB, pesticide, and metal COC concentrations greater than PRGs. This sediment will be removed from the identified limits to a depth that exposes the native stream bed soil. For comparison purposes, the sediment to be removed is brown to brownish gray in color and consists of sand and silty sand. The native stream bed soil is gray in color and consists of clay and silty clay. The removed sediment will be processed, characterized, and disposed at an approved off-site non-hazardous waste disposal facility. Excavated sediment will be placed in a small off-road dump truck with a sealed tail-gate to prevent the loss of sediment while the material is transported to a dewatering pad. The excavated sediment will gravity-drain within the dewatering pad prior to processing, characterization, off-site transport, and disposal. Creek and tributary excavation will occur along the North Branch Pettibone Creek upstream of the Boat Basin to the discharge end of the culverts located near Sheridan Road at the northern Naval Station Great Lakes property boundary. Sediment will also be removed from the unnamed tributary the feeds North Branch Pettibone Creek within the Naval Station property limits, north of the confluence of the North and South Branches of Pettibone Creek.

Because the remedial action construction activities will be occurring within a perennial stream, excavation of sediments will begin at the upstream reaches of the removal limits and proceed downstream in manageable construction increments not to exceed 300 feet in length. Creek and tributary increments in which construction activates will occur will be isolated from the rest of the creek and tributary using potable dam and a filtration device. The portable dam will be located on the upstream end of each construction increment. This portable dam will be impermeable to prevent flow into the construction area. The filtration device will be located on the downstream end of each construction increment. This filtration device will be a permeable structure designed to trap sediment but allow water to pass. During operational hours the stream must be diverted around the construction area. At the end of each work day and during storm events (down time), a flexible pipe or series of flexible pipes will be place through the construction area discharging downstream of the construction area. This pipe will be used to convey twice the base flow through the construction areas during operation down times. To allow for gravity flow through the piping, the pipes used to convey flow through the construction areas must be sized so that the exit invert elevation of the pipe is a minimum of one full inside pipe diameter below the inlet invert elevation of the pipe. Pipe sizes and diversion system sizes are not provided because the length of construction increment will be determined by the EMAC contractor. Prior to starting excavation within the

next downstream construction area the current construction area must be restored and the portable dam and filtration structures must be moved. Multiple construction increments can be open at one time in the event that these areas are adjacent to one another and that the total length of stream disturbance does not exceed 300 feet.

The estimated volume of sediment to be removed from the North Branch Pettibone Creek and the unnamed tributary to the North Branch Pettibone Creek is based on the average thickness of sediment, average width of the stream (base width plus height of channel banks), and length of each stream segment. The average depth of sediment (1 foot) was determined during the December 2008 investigation (see Section 2.4). However, the EMAC contractor should expect that portions of the creek and tributary will require no sediment removal and portions of the creek and tributary will require removal of sediment in layers that exceed a depth of 3 feet. The extent of excavation is identified on Figure 3-1. A typical excavation detail is provided as Figure 3-2. The calculations for excavated sediment volumes are provided in Appendix C. The average channel dimensions and anticipated sediment volume from each stream segment are summarized below.

Creek / Tributary	Avg. Sediment Thickness	Avg. Stream Width	Stream Length	Volume of Sediment
North Branch Pettibone Creek (Boat Basin to North/South Branch Junction)	1 foot	25 feet	1,000 feet	930 cy
North Branch Pettibone Creek (North/South Branch Junction to Tributary)	1 foot	20 feet	1,580 feet	1,170 cy
North Branch Pettibone Creek (Tributary to Upstream Culverts)	1 foot	15 feet	960 feet	530 cy
Tributary to North Branch Pettibone Creek	1 foot	15 feet	900 feet	500 cy
Total Volume of Stream Sediment to be Excavated				**3,130 cy**

In addition to the sediment material, man-made materials (concrete, pipe material, lumber, etc.) and rock (3-inch nominal diameter and greater) are also expected within the limits of excavation. Man-make materials will be cleaned of adhering sediments and stockpiled for off-site disposal as construction debris. Unless otherwise indicated, man-made material encountered outside the stream (excavation area) will not be removed and will remain in place. Rock material will be excavated along with the sediment. Large rock material (average nominal diameter of 9 inches or more) will be removed, cleaned of adhering sediment, and placed along the side of the stream (out of the way of construction activities) in the general vicinity from where they were removed so that they can be placed back in the stream during drainage channel restoration activities. Note, as with the man-made material, rock encountered outside the limits

of excavation, will remain in place. The following table summarizes the anticipated volumes of material to be removed from North Branch Pettibone Creek and tributary within the limits of excavation (volume calculations are provided in Appendix C).

Material	Estimated Volume	Material Disposition
Sediment	3,130 cy	Off-site disposal (non-hazardous subtitle D)
Man-made Material	30 cy	Off-site disposal (non-hazardous construction debris)
Rock Material	1,440 cy	Reused for Stream Restoration
Total Volume removed from North Branch Pettibone Creek	4,600 cy	NA

Sediment that accumulates at the erosion and sediment control devices (see Section 4.0) prior to stream segment restoration and completion of sediment off-site disposal will be disposed off site along with the contaminated sediment. Following verification of contaminated sediment removal, sediment that accumulate in the erosion and sediment control devices will be used to restore the areas of disturbance.

To move excavated sediment, rock, and man-made materials form the excavation areas to the dewatering and process locations the EMAC contractor may use the existing roadway along Norht Branch Pettibone Creek. The EMAC contractor will ensure that this access road is not contaminated with excavated sediment. In the event that the EMAC contractor spills excavated sediments on this access road, the EMAC contractor will be responsible for removing the contaminated sediments along with the impacted surface soil, verifying that the contaminated materials have been removed, and disposing of that material at their expense.

3.2.2 Dewatering And Processing

Excavated/removed rock and sediment will be transported to a centrally located dewatering pad where the sediment can be dewatered prior to processing, off-site transportation, and off-site disposal. This material will be placed on the dewatering pad at a lift thickness no greater than 3 feet and allowed to drain by gravity. The dewatering pad must be constructed in accordance with Section 3.2.11. It is estimated that following 24 hours of dewatering, the moisture content of the material will have been sufficiently reduced to allow the material to be processed. Following dewatering, the EMAC contractor will process the material through a screening device that is capable of segregating rock with a nominal diameter of 3 inches or greater from the sediment. This segregated rock material will be stockpiled for reuse during stream restoration activities. Based on site observations, it is anticipated that approximately 20 percent of

the excavated/removed material will contain rock with a nominal diameter of 3 inches or more, resulting in a retained rock volume of approximately 620 cy. The removed rock fraction will be washed within a containment system to remove adhering sediment particles, and sediment particles removed will be dewatered and added to the sediment to be disposed off site. Water used in washing process will be filtered and tested to determine the proper disposal method.

Following material processing, the EMAC contractor will collect the required disposal characterization samples from the segregated sediment pile (material passing through a 3-inch screen). The disposal characterization sampling will follow the requirements discussed in the following sections and in Section 5.0 and any additional sampling requirements established by the selected and approved disposal facility. Following processing and sampling, the sediment will not require the addition of an absorbent agent to be suitable for transportation and disposal.

3.2.3 Post-Removal Sampling and Analysis

Post-removal samples will be collected by Tetra Tech from the native stream bed soil following removal of overlying sediment. Post removal samples will be collected from each construction increment after the native stream bed material has been reached. The EMAC contractor must make time in the construction schedule to allow for the collection of the post removal samples prior to restoring each construction increment. However, the EMAC contractor will not have to wait for the post-removal sample to be analyzed prior to beginning restoration activities. The post-removal samples will be sent off-site to a fixed base laboratory for analysis. These samples will be analyzed for PAHs, PCBs, pesticides, and metals. Following the receipt of the post-removal sample analytical results the data will be fully validated and used to perform an ecological risk assessment. In addition to using this data to perform a risk assessment, this data will be directly compared to PRGs, and the analytical results from the December 2008 investigation. The results of the risk assessment and the data comparisons will be used to determine the need for further action within North Branch Pettibone Creek. Post-removal sampling and analysis procedures are provided in Section 5.0.

3.2.4 Disposal

Following the dewatering process, excavated sediments will be sampled and analyzed for waste disposal characterization in accordance with the Naval Station Great Lakes Hazardous Waste Management Plan (NSGL, 2002). In addition, the EMAC contractor is responsible for satisfying the disposal requirements of the selected and approved disposal facility. Section 5.0 presents the Naval Station Great Lakes sampling requirements for off-site disposal. It is anticipated that the excavated sediment will be disposed as non-hazardous waste in a Subtitle D Landfill. In the event that excavated sediment characterization identifies a volume of sediment as a hazardous waste, the volume of hazardous sediment will be disposed of within

a Subtitle C landfill or pre-treatment will be required to allow for non-hazardous disposal. The following is a summary of the volumes expected to be disposed off site.

Locations	Volume
North Branch Pettibone Creek	2,630 cubic yards
Tributary to North Branch Pettibone Creek	500 cubic yards
Man-Made Debris	30 cubic yards
Material in Sediment Usable for Restoration	(620 cubic yards)
Total Off-site Disposal Volume	**2,510 cubic yards**

As indicated above, it is assumed that all excavated sediment and man-made debris will be disposed as non-hazardous waste. This assumption must be verified through disposal characterization samples.

3.2.5 Stream Backfilling/Restoration

Restoration activities associated with the stream excavation areas include seeding and placing bank-run sands and gravels (imported from an off-site source), retained rock from sediment processing, and large rocks removed during excavation. Seeding will be performed on the banks of the excavated creek and tributary. Placing bank-run sands and gravels, rocks retained from sediment processing, and large rocks moved aside during excavation will be performed within the limits of the disturbed stream bed. The EMAC contractor will identify and document pre-construction stream conditions and take photographs of natural pools, locations of natural aquatic features, and locations of stream bed condition transitions prior to excavation so that disturbed stream sections can be restored to pre-construction conditions.

The bank-run sand and gravel obtained from an off-site borrow source will have properties similar to the exposed North Branch Pettibone Creek sediment and will be subject to analytical testing to assure that the material satisfies the following requirements:

- Total petroleum hydrocarbon, diesel-range organics, USEPA SW-845 8015M DRO - less than 1 part per million (ppm)
- Total petroleum hydrocarbon, gasoline-range organics, USEPA SW-845 8015M GRO - less than 1 ppm
- Sum of benzene, toluene, ethylbenzene, and xylenes, USEPA SW-846 5030 / 8021 - less than 1 ppm
- Characteristic waste determination (ignitability, corrosivity, reactivity, and toxicity), USEPA SW-846 1311 - shall not fail the test for characteristic waste

- PAH COCs only, USEPA SW-846 8310 – less than individual PRGs (COCs and their PRGs are identified in Table 2-5).

- Pesticide COCs only, USEPA SW-846 8081A – less than individual PRGs (COCs and their PRGs are identified in Table 2-5).

- PCB COCs only, USEPA SW-846 8082 – less than individual PRGs (COCs and their PRGs are identified in Table 2-5).

- Metal COCs only, USEPA SW-846 6010B/7471A – less than individual PRGs (COCs and their PRGs are identified in Table 2-5).

Additionally, the backfill soil for the stream excavation areas will be placed and compacted by track-walking across the backfilled area with a track-type tractor or equivalent. The backfill material to be used to re-establish the creek and tributary beds will satisfy the Illinois Department of Transportation (Illinois DOT) requirements for bank-run sands and gravel. Large rocks that were removed from the creek and tributary, cleaned, and saved during excavation activities and smaller rocks that were removed from the waste stream through screening will be used to help re-establish the creek and tributary. The creek and tributary banks will be lined with large rock material average stone size of 1.5 feet (nominal diameter) with a unit weight of 150 lbs per cubic foot). Figure 3-3 presents the typical backfilling detail.

Each creek and tributary construction increment must be restored prior to removing the upstream dam structures

3.2.6 Verification Sampling and Analysis

Following the completion of the remedial action activities, verification samples will be collected from the surface soil below the decontamination pad, material storage area, dewatering pad, temporary access roads, and any other construction support features on which contaminated sediment was placed to make sure contamination was not spread during remedial action activities. The verification samples will be collected by the Navy's representative. Although not required, the EMAC contractor may collect pre-excavation samples in areas where support facilities are planned, so that results of the pre-construction samples can be compared to verification sample results. If verification sample results exceed the PRGs, or pre-construction sample results and PRGs, the EMAC contractor will remove the impacted soil and dispose of this soil at the same facility as the contaminated sediment at their expense. Verification sampling and analysis procedures are provided in Section 5.0.

3.2.7 Erosion and Sediment Control

Before excavation activities begin, erosion and sediment controls will be established to prevent impacts to surface water bodies (North Branch Pettibone Creek, Boat Basin, and Lake Michigan) downstream of the disturbance areas. Implementation (placement and maintenance) of erosion and sediment control devices must comply with the requirements identified in the Illinois Procedures and Standards for Urban Soil Erosion and Sediment Control Handbook (Illinois EPA, 1988). During excavation, backfilling, and restoration operations and until vegetation is established, the erosion and sediment controls will be regularly inspected and maintained. Erosion and sediment control requirements to be complied with during RAP implementation are identified in Section 4.0 of this report.

3.2.8 Stabilized Construction Entrance

Ingress and egress to and from the disturbed areas will be controlled using a stabilized construction entrance, which is described in detail in Section 4.0. The EMAC contractor is required to minimize the amount of disturbance to the wooded areas adjacent to where excavation activities will be performed. As a result, the EMAC contractor may use the existing access road along the northern side of Pettibone Creek to access work areas. The EMAC contractor will be required to have a stabilized construction entrance at both ends of this access road or restrict traffic to only one end of this access road.

3.2.9 Decontamination Pad

A temporary decontamination pad will be set up to clean equipment used to excavate and transport contaminated sediment. The pad will be sized to accommodate the equipment to be used at the site and will be constructed in a manner that contains the contaminated materials removed from equipment and the liquids used to clean the equipment. Contaminated materials removed from the equipment will be disposed off site with the excavated sediment. Wash water will be filtered, characterized and discharged to the creek or tributary. Additional decontamination pad requirements are discussed in Section 4.5. Care will be taken to keep off-road transport equipment clean to minimize the spread of contaminated sediment to areas adjacent to the excavations or the access road. Any soil or sediment removal from these areas and the associated disposal and restoration costs will be the responsibility of the EMAC contractor.

3.2.10 Dewatering Pad

A temporary dewatering pad will be set up to dewater sediments excavated from the identified excavation areas. The dewatering pad will be sized to accommodate excavated sediments, material processing equipment, and loading equipment as necessary. The dewatering pad will be constructed in such a manner that will retain all materials that will allow the water that drains by gravity from the sediment to be

collected in a sump. The collected water will then be filtered to remove any remaining sediments. Following filtration, with the approval of the Officer in Charge of Construction (OICC), the water will be discharged back to a stabilized portion of the creek or tributary. At a minimum, the dewatering pad shall be constructed of a minimum 10-mil-thick polyethylene geomembrane overlain by a 6-inch thick gravel drainage layer (the EMAC contractor should evaluate the geomembrane thickness and gravel layer thickness to support the equipment used in this area). During rain events and downtime, stockpiled materials within the dewatering pad must be covered with a minimum 8-mil-thick polyethylene geomembrane to prevent movement of material to surrounding areas and to minimize the collection of additional water. The geomembrane cover will be secured daily. Additional dewatering pad requirements are discussed in Section 4.5.

3.2.11 Access Roads

As indicated above, the existing access road along the northern side of Pettibone Creek will be available to the EMAC contractor to access the excavation areas. This access road will provide access to areas of the excavation with the exception of the tributary that feeds North Branch Pettibone Creek from the west, near the Farragut Avenue Bridge. Access to this portion of the excavation area will require the construction of a temporary access road or use of the stream bed itself. Material for construction of the temporary access road will be restricted to wood chips and/or mulch material obtained from an on-site or off-site borrow source. The temporary access roads will not be constructed with gravel, and will be left in place following the completion of RAP activities. The existing access road along Pettibone Creek will be restored to pre-construction conditions or better following RAP implementation.

3.2.12 Clearing

Clearing will be performed only within the limits of disturbance shown on Figure 3-1. Clearing activities will be kept to a minimum to minimize impacts to natural habitat. It is anticipated that the EMAC contractor will need to clear some trees and underbrush between the existing access road and Pettibone Creek to access the creek with excavation and restoration equipment. However, the EMAC contractor will be restricted to clearing one access point to each length of disturbed stream segment. Clearing vegetation along the entire length of disturbed stream segment will not be allowed. Cleared vegetation will be chipped and used for the construction of the temporary access road along the western tributary or stored where directed by the OICC. Prior to the removal of standing trees the EMAC contractor will identify trees to be removed and approval for tree removal must be obtained from the OICC and Naval Station Great Lakes Environmental prior to removal.

3.3 SEQUENCE OF RAP IMPLEMENTATION

The time required to perform the proposed RAP activities at the site is estimated to be approximately 15 weeks. The generalized sequence of construction activities is presented below. This sequence of construction is subject to change based on the EMAC contractor's work plan.

1. Hold a pre-remedial action implementation meeting with the Naval Station Great Lakes OICC, Contracting Officer, EMAC contractor, and Tetra Tech, at a minimum.

2. Inspect limits of Pettibone Creek excavation area to document existing site conditions and overhead and underground utility locations, and obtain the required permits as detailed in Table 3-1.

3. Install perimeter controls for the gravel construction entrance(s) and construct the gravel construction entrance(s). Install the remaining perimeter controls as indicated in the Erosion and Sediment Control Plan (Section 4.0).

4. Clear areas for support features including, but not limited to, the decontamination pad, dewatering pad, and materials storage area. Construct the support features.

5. Begin excavating sediments from upper reaches of the Pettibone Creek excavation area by establishing an isolated stream segment using an upstream impermeable dam structure and a downstream permeable dam structure. Excavation should continue from the uppermost reaches and continue in the direction of stream flow in consecutive stream segments that do not exceed 300 feet in length. Following excavation in each stream segment, Navy representative will collect post removal samples as identified in Section 5.0 of this RAP to evaluate potential risks (if any) that might remain following the remedial action. Following the collection of the post removal samples, restore the drainage channels as required (restoration includes stream backfilling, and seeding). Following stream restoration, move the permeable and impermeable dam structures to the next downstream stream segment and repeat the excavation, sampling, and restoration process.

6. Transport excavated sediments to the dewatering pad. Mixing excavated sediments to promote additional dewatering is allowed. Following dewatering, process the excavated material to remove reusable material from the waste stream. Following material processing, collect disposal characterization samples from the sediment stockpiled for off-site disposal. After obtaining permission from the OICC and Naval Station Great Lakes-approved off-site disposal facility, load and transport sediment to the Naval Station Great Lakes-approved off-site disposal facility. During excavation, material processing, and loading operations, maintain erosion and sediment controls.

7. Following transportation and disposal of the excavated sediments and restoration of the construction increments within North Branch Pettibone Creek and tributary, remove the dewatering pad, decontamination pad and the support facilities. The Navy's representative will collect verification samples from within the footprint of the support features including the access roads and temporary access road as described in Section 5.0. Following verification that the temporary access roads and the ground below the support features was not impacted by construction activities, regrade as necessary and establish permanent stabilization.

8. Following permanent stabilization of the disturbed areas, and with the approval of the OICC, remove the remaining perimeter controls and immediately stabilize the remaining disturbed areas.

3.4 STORMWATER POLLUTION PREVENTION

The disturbed area is estimated to be approximately 2.3 acres (including support areas and access roads); therefore, an Illinois DOT Stormwater General Permit is required (stormwater permits are required for disturbances greater than 1 acre). In addition, because RAP activities include working in and around a water course, United States Army Corps of Engineers permits are also required. These permits are discussed in Section 3.5.2 and are identified on Table 3-1. Additionally, RAP implementation activities require the use of best management practices for erosion and sediment control and stormwater pollution prevention as described in Section 4.0.

Because the limits of construction are confined to the limits of Pettibone Creek itself, the watershed that contributes flow to the construction site will remain unchanged between pre- and post-construction conditions. Additionally, the stream will be restored to its original alignment. Therefore, pre- and post-construction runoff from the limits of disturbance will be the same; and additional stormwater detention capacity is not required. However, the existing flows that are conveyed by Pettibone Creek are often greater than current steam depth and alignment can handle. As a result severe erosion occurs during storm events. EMAC contractor should be prepared for storm events to minimize disruption to construction schedule

3.5 OTHER RAP IMPLEMENTATION REQUIREMENTS

3.5.1 Existing Stabilization Structures

During the removal of contaminated sediment, the EMAC contractor will encounter man made slope stabilization devices. Construction activities must be performed in a manner that does not disturb these stabilization features. The restoration of these stabilization features is not a part of this RAP.

3.5.2 Permits

The removal of contaminated sediments from Pettibone Creek involves excavation and filling of wetlands (the stream itself is designated as a wetland), which would require a Section 404 permit under the Federal Clean Water Act. This would require a category 13 bank stabilization permit.

The project also requires a regional statewide permit under the Illinois Rivers, Lakes, and Streams Act, which regulates activities in floodplains designated by Federal Emergency Management Administration (FEMA) or in streams with an upstream watershed area of over 1 square mile. The permit is required because of the associated upstream watershed. Floodplains are not found within the project area due to the steep stream banks that characterize the water course (FEMA mapping provided in Appendix B). The Lake County Stormwater Management Commission would issue the permit as the delegated authority under this legislation.

In addition to Lake County requirements, the Illinois Soil and Water Conservation District requires the submission of erosion and sediment control plans, stormwater pollution prevention plans, notice of intent forms, and notice of termination forms. The Illinois Soil and Water Conservation District has developed requirements for the contents of these plans and will provide the EMAC contractor with the required notification forms.

3.5.3 Utilities

The EMAC contractor is required to verify the utility locations and adequately protect any utilities located in the active work areas before any earth-disturbing activities begin.

Potable water for project personnel and equipment decontamination will be provided by Naval Station Great Lakes.

3.5.4 Traffic Control Plan

Access to Naval Station Great Lakes is via three gates located off Sheridan Road. The Main Gate provides access to the station via Farragut Avenue and the remaining gates are contractor gates located off Sheridan Road north of the Main Gate. The gate providing access to the station via Culverius Avenue is the preferred access location for this project. The gate providing access to the station via Meyer Circle is an alternative access gate for contractors. Using the preferred gate located on Culverius Avenue, the identified site access point can be found by following Culverius Avenue to Isherwood Avenue and following Isherwood Avenue to the construction area entrance at the intersection of Isherwood Avenue and Bronson Avenue. The primary traffic route and alternative traffic route to access the work area are

illustrated on Figure 3-4. The EMAC contractor is not permitted to use other routes for construction equipment without permission from the OICC. Waste hauling vehicles will be weighed upon arrival and at time of departure using the certified weight scale. The EMAC contractor must supply scales at the construction access location.

3.5.5 EMAC Contractor Requirements

The EMAC contractor will be required to perform the RAP implementation activities in accordance with the EMAC Basic Contract and supplemental specifications provided in Appendix D. The EMAC contractor will also submit a work plan and other documents necessary to describe the procedures the EMAC contractor plans to implement to achieve the requirements of this RAP.

The RAP will be implemented by the EMAC contractor, Naval Station Great Lakes, and Tetra Tech, with work assignments summarized on Table 3-1.

3.6 IMPLEMENTATION

The EMAC contractor will coordinate the field work through the OICC. RAP implementation may be impacted by Naval Station Great Lakes activities and the facility's "Protective Measures." Naval Station Great Lakes implements a "Protective Measures" based on the warnings provided by the Homeland Security Advisory System in the form of graduated "Threat Conditions." The EMAC contractor will be subject to any implemented "Protective Measures."

The Navy will provide a full-time oversight representative during RAP implementation.

TABLE 3-1

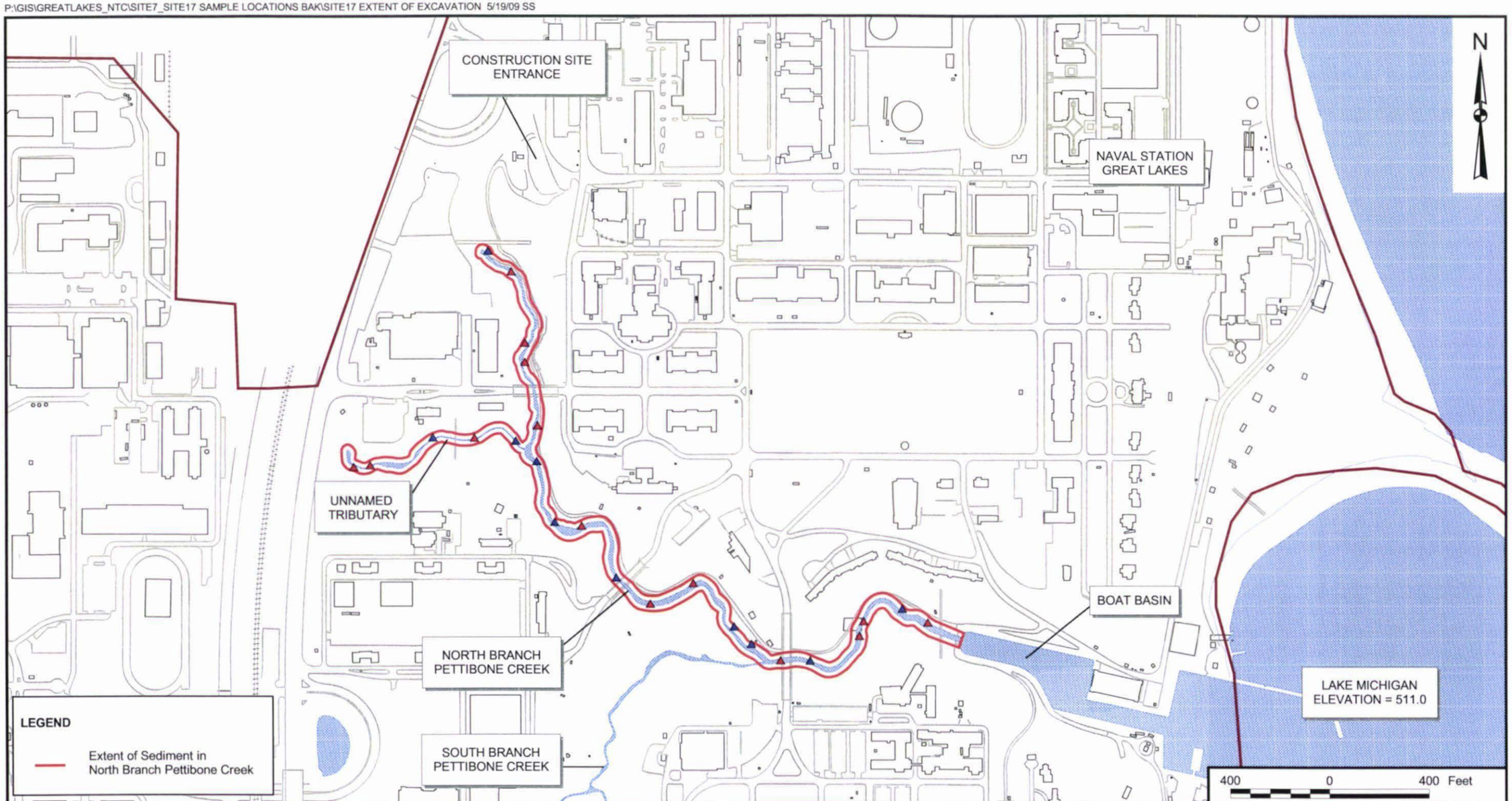
WORK ASSIGNMENT RESPONSIBILITY CHART
SITE 17 – PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

WORK ITEM	EMAC CONTRACTOR	NAVAL STATION	TETRA TECH
Pre-RAP Implementation Meeting	X	X	X
RAP Implementation	X		
EMAC Contractor Work Plan (1)	X		
Site Specific Health and Safety Plan / Activity Hazard Analysis	X		
Project Quality Control Plan	X		
Environmental Conditions Report	X(2)		X
Field Work Reports and Submittals (3)	X		
Sampling and Analysis	X(4)	X(4)	
Wastewater Disposal (Decontamination Water)	X(5)		
CTO Closure Report	(6)		X
Permits (7)			
- Digging Permit / Utility Clearance	X(8)		
- Tree Clearing Permit (if needed)	X		
- IEPA Stormwater General Permit	X		
- 404 Permit Under Federal Clean Water Act	X		
- Category 13 - Bank Stabilization Permit (9)	X		

1. EMAC contractor Work Plan includes, but is not limited to, an excavation and handling plan, waste management plan, environmental protection plan, erosion and sediment control plan, stormwater pollution prevention plan, and transportation and disposal plan.
2. EMAC contractor will document environmental conditions before, during, and after implementation of the RAP.
3. EMAC contractor will furnish items identified in the Basic Contract and the Supplemental Specifications provided in Appendix D.
4. EMAC contractor will be responsible for the collection of characterization samples required for off-site disposal of excavated sediment. Post-removal and verification samples from the sediment removal areas and from the surface soils below the support facilities following the removal of the support facilities will be collected by the Tetra Tech. The EMAC contractor will need to coordinate and accommodate all sampling and field activities.
5. EMAC contractor will be responsible for collection, storage, characterization, and discharge of water to the Naval Station Great Lakes approved discharge location.
6. EMAC contractor will furnish items identified in the Supplemental Specifications provided in Appendix D and any other field information requested by the Navy for the completion of the CTO Closure Report.
7. EMAC contractor will obtain any and all permits specified by their general contract regardless as to whether the permit is listed on this table.
8. EMAC contractor will coordinate with Naval Station Great Lakes and the Illinois JULIE system. Utility location by Naval Station Great Lakes and the Illinois JULIE system must be complete prior to intrusive activities.
9. The Category 13 – Bank Stabilization Permit is a part of the 404 Permit under the Federal Clean Water Act.

CTO - Contract Task Order
EMAC - Environmental Multiple Award Contract
X – Indicates responsible party
RAP – Remedial Action Plan
Tetra Tech – Tetra Tech NUS, Inc.

P:\GIS\GREATLAKES_NTC\SITE7_SITE17 SAMPLE LOCATIONS BAK\SITE17 EXTENT OF EXCAVATION 5/19/09 SS



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY S. STROZ	DATE 2/26/08
CHECKED BY T. SMITH	DATE 5/19/09
COST/SCHEDULE-AREA	
SCALE AS NOTED	

Tetra Tech NUS, Inc.

EXTENT OF EXCAVATION
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER 01021	OWNER NUMBER 0474
APPROVED BY RFD	5/19/09
APPROVED BY	DATE —
DRAWING NO. FIGURE 3-1	REV 0

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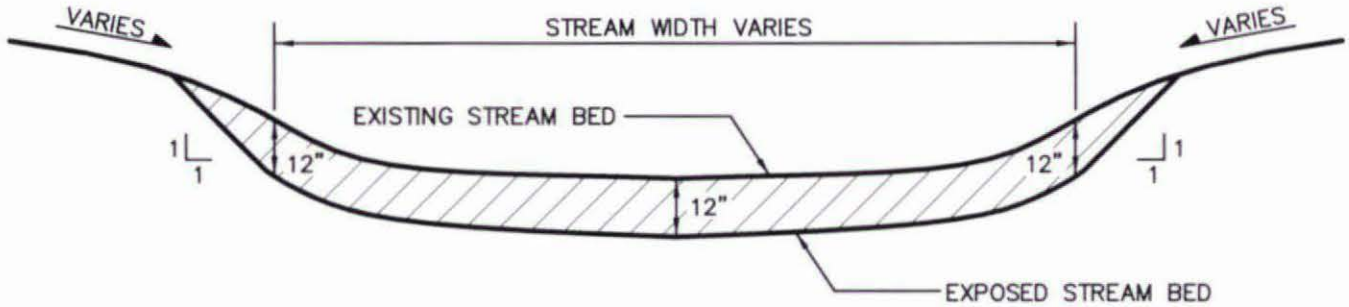

LEGEND:

SEDIMENT REMOVAL

0 20 40

GRAPHIC SCALE IN FEET

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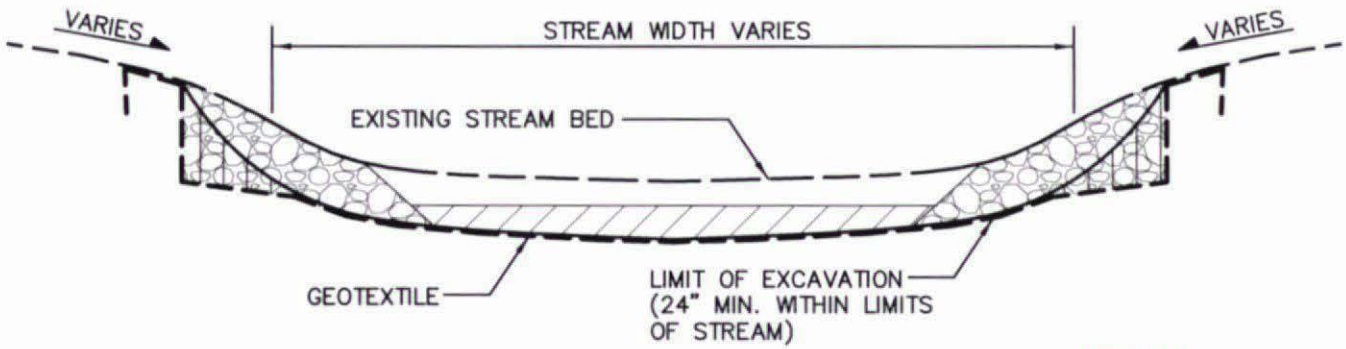
CHECKED BY TWS	DATE 5/15/09			OWNER NO. 474
REVISED BY	DATE			APPROVED BY RFD / DATE 5/15/09
SCALE AS NOTED				DRAWING NO. FIGURE 3-2 / REV. 0

FORM CADD NO. SDIV-AH.DWG – REV 1 – 9/10/98



LEGEND:

- SAND AND GRAVEL
- ROCK (D_{50} = 18 INCHES)
- OVER EXCAVATION FOR ROCK INSTALLATION

0 20 40
GRAPHIC SCALE IN FEET

DRAWN BY MF	DATE 3/3/08	TYPICAL STREAM RESTORATION SITE 17 PETTIBONE CREEK ROD NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. 01021
CHECKED BY TWS	DATE 5/15/09		OWNER NO. 474
REVISED BY	DATE		APPROVED BY RFD / DATE 5/15/09
SCALE AS NOTED			DRAWING NO. FIGURE 3-3 / REV. 0

NAVFAC

P:\GIS\GREATLAKES_NTC\QAPP_2001BAK\APR\TRAFFIC PLAN LAYOUT 5/19/09 SS

DRAWN BY S. STROZ	DATE 2/28/08	TRAFFIC PLAN SITE 17 - PETTIBONE CREEK RAP NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NUMBER 01021
CHECKED BY T. SMITH	DATE 5/19/09		APPROVED BY RFD — DATE 5/15/09
COST/SCHEDULE-AREA			APPROVED BY — DATE
SCALE AS NOTED	NAVFAC		DRAWING NO. FIGURE 3-4 — REV 0

4.0 EROSION AND SEDIMENT CONTROL PLAN

4.1 PURPOSE

The purpose of this section is to provide the steps that are required to minimize and/or eliminate erosion and sedimentation during the implementation of the RAP at Site 17. The Erosion and Sediment Control Plan has been developed in accordance with the guidelines defined in the Illinois Procedures and Standards for Urban Soil Erosion and Sediment Control (Illinois EPA, 1988) (E&S Manual). Relevant standards and specifications from the E&S Manual are included in this section and Appendix E. The erosion and sediment control devices described in this text can be modified based on construction equipment and techniques presented in the EMAC contractor's Work Plan. Selected erosion and sediment control devices must be identified in the Erosion and Sediment Control Plan submitted with the EMAC contractor Work Plan. After the Erosion and Sediment Control Plan is approved, no changes can be made without approval by the OICC and the Illinois EPA.

4.2 EROSION AND SEDIMENT CONTROL REQUIREMENTS

Erosion and sediment control measures are implemented to reduce or eliminate erosion and sedimentation of soil that would be detrimental to surface water quality. These devices are particularly important because the excavation activities associated with the RAP are within North Branch Pettibone Creek and the unnamed tributary to North Branch Pettibone Creek. The surface water runoff from the disturbed areas eventually discharges to the lower reaches of Pettibone Creek and Lake Michigan. Past investigations indicate that North Branch Pettibone Creek receives flow from dozens of storm drains during storm events and has a base flow fed by groundwater. The limits of excavation extend from Pettibone Creek's discharge point at the Boat Basin (Lake Michigan) and extends 3,540 feet up the North Branch Pettibone Creek. The excavation also extends 900 feet up a small tributary of the North Branch Pettibone Creek which is located 2,580 feet upstream of Lake Michigan.

RAP implementation activities for Site 17 Pettibone Creek consist of excavation and off-site disposal PAH-, pesticide-, PCB-, and metal-contaminated sediments, backfilling excavations, and restoration of disturbed areas. Because of site conditions, temporary access trails will need to be constructed to allow access to the excavation areas.

Based on the type of RAP activities and access issues, the proposed erosion and sediment control measures include the following:

- Synthetic Filter Fence – Placed along the downslope sides of the surface soil disturbance areas and the gravel construction entrances to provide a temporary sediment barrier. Synthetic filter fences (silt fencing) consists of synthetic filter fabric and wooden posts. Procedures and standards for the synthetic filter fence are provided in Appendix E.

- In-Stream Sediment Trap – Placed within the streams from which the contaminated sediment will be removed to provide a temporary sediment barrier while allowing flow within the disturbed stream. Multiple in-stream sediment traps will be required based on the proposed segments of channel to be disturbed within a given time period. In-stream sediment traps are constructed of gabion baskets wrapped with filter fabric, are located downstream of disturbed stream segments and will remain in place until the disturbed areas upstream are restored and stabilized. The in-stream sediment traps will not be placed greater than 300 feet apart. A construction detail for the in-stream sediment trap is provided as Figure 4-1.

- In-stream Impermeable Berm and Outfall - Placed within the streams from which the contaminated sediment will be removed to provide a temporary dry construction area. Multiple in-stream impermeable berm and outfall structures will be required based on the proposed segments of stream to be disturbed within a given time period. In-stream impermeable berm and outfall structures are constructed of gabion baskets wrapped with an impermeable membrane, and are equipped with a flexible pipe that will convey base and stormwater flow through the disturbed portion of stream. The flexible pipe will then discharge downstream of the associated in-stream sediment trap. These devices will remain in place until the disturbed areas downstream restored and stabilized, and until the next in-stream impermeable berm and outfall structure is constructed. Consecutive in-stream impermeable berm and outfall structures will not be placed greater than 300 feet apart. A construction detail for the in-stream impermeable berm and outfall structure is provided as Figure 4-2.

- Stabilized Construction Entrance – Placed as a controlled site entrance to reduce the amount of sediment transported by construction vehicles onto facility and public roads. A stabilized construction entrance will be placed at all points of egress from the work area. Procedures and standards for the stabilized construction entrance are provided in Appendix E and shown in Figure 4-1.

- Dust Control – Utilized to prevent surface and air movement of dust from exposed excavation areas and to reduce the amount of airborne substances that may present health hazards, traffic safety problems, or harm plant/animal life. Procedures and standards for dust control are provided in Appendix E.

- Permanent Seeding – Utilized to establish perennial vegetation on disturbed areas by planting seeds of native grasses. Procedures and standards for permanent seeding are provided in Appendix E.

The construction, implementation, and maintenance of these erosion and sediment control devices will be in accordance with the E&S Manual. Figure 4-3 presents the proposed excavation areas along with the limits of disturbance and the locations of the proposed erosion and sediment control devices. As indicated above Figures 4-1 and 4-2 provide typical details of the in-stream sediment trap and the in-stream impermeable berm and outfall structure and Appendix E contains procedures and standards for the synthetic filter fence, stabilized construction entrances, dust control, and permanent seeding. Permanent seeding is further discussed in Section 4.4. Dust control will be addressed in the EMAC contractor's Work Plan. All erosion and sediment controls will remain in place until all upstream areas have been stabilized. Stabilization will be determined by the OICC.

4.3 INSPECTION AND MAINTENANCE OF EROSION AND SEDIMENT CONTROLS

In general, the erosion and sediment control measures will be inspected daily and after each runoff-producing rainfall event. Required repairs will be made immediately. The following items will be checked:

- The stabilized construction entrance will be maintained in a condition that will minimize tracking sediment onto facility or public roads.

- The synthetic filter fence will be checked for undermining or deterioration of the fabric. Sediment will be removed from the device when the level of sediment causes bulging, after each storm event, and when the sediment reaches one-half of the fabric height.

- In-stream sediment traps will be checked for undermining or erosion around the edges of the trap(s). Sediment will be removed when the level of sediment reaches one-half the height of the in-stream sediment trap or when the quantity of flow through the in-stream sediment trap is significantly reduced. Sediment removed from the device prior to verification that COCs have been removed from the upstream stream segment will be disposed off-site. Sediment removed from the device following verification of COC removal will be used for stream restoration activities.

- In-stream impermeable berm and outfall structures will be checked for undermining or erosion around the edges of the structure. Sediment will be removed from the structure when the level of sediment reaches one-half the height of the structure. Sediment removed from the device will be used for stream restoration activities. The outfall piping will be checked for leaks and worn connections that may result in failure during construction activities. The outfall piping should flow by gravity, if needed

during construction activities, the gravity flow pipe can be replaced by pumps and hoses. However, during downtime the gravity pipe will be in place.

- Seeded areas will be checked regularly to make sure that a good growth of vegetation is maintained and these areas will be fertilized and reseeded, as needed.

The erosion and sediment control devices will be inspected and maintained until the OICC has formally accepted the permanent stabilization of the disturbed areas. The EMAC contractor will maintain a log book of erosion and sediment control device inspections and maintenance. This log book will be available at the site for inspection by duly authorized officials including Naval Station Great Lakes personnel, Navy representatives, and the Illinois EPA.

4.4 SITE RESTORATION

The areas disturbed by the RAP implementation activities (excavation and support facility areas) will be restored/stabilized to pre-construction conditions using gravel, bank-run sands and gravels, riprap/rock, and permanent seeding. Activities to establish permanent stabilization will be implemented as soon as possible following the establishing of final grades and removal of support facilities. The establishment of permanent vegetation includes site/seed bed preparation, seeding, and mulching along the banks of restored Pettibone Creek and on the surface soils below support facilities. Note that the areas suitable for support facility placement are currently gravel paved or bituminous concrete paved areas. Permanent vegetation will only be required in areas that are vegetated prior to support facility construction.

The procedures and requirements for permanent seeding activities are presented in Section 6 of the E&S Manual. These procedures are provided in Appendix E. The seed mixture proposed for use along the banks of Pettibone Creek is a mixture of native ground cover species that was recommended in the Restoration and Maintenance Plan for Pettibone Creek Ravine (EQM, 2000). This mixture includes bottlebrush grass (*Elymus hystrix*), rice grass (*Oryzopsis racemosa*), lang-awned wood grass (*Brachyelytrum erectum*), panic grasses (*Panicum virgatum*), native bromes (native *Bromus* species), Bluegrass (*Poa annua*) and a variety of woodland sedges (*Carex* species). If canopy reduction from removal of trees for access to North Branch Pettibone Creek or tributary is not achieved during clearing operations, this seed mixture should be replaced with a standard Illinois seed mixture that is tolerant of shade and wet conditions. Following seeding, the seeded areas will be covered with temporary erosion control matting (e.g., coconut fiber matting) to provide additional stabilization until vegetation is established.

The seed mixture proposed for use on surface soil following the removal of the support facilities is a standard Illinois permanent seed mixture that includes Kentucky Bluegrass (*Poa pratensis*) and Perennial

Ryegrass (*Lolium perenne*). Planting rates and optimum soil pH for this mixture and soil amendments are presented in Section 6 of the E&S Manual (this section is provided in Appendix E). In the event that RAP activities disturb an area requiring restoration with sod, sodding requirements are found in the E&S Manual (section provided in Appendix E).

In the event that disturbed areas are brought to final grade outside of the optimal growing season for the proposed permanent seed mixtures, the disturbed areas will be temporarily stabilized using a temporary seed mixture. The procedures and requirements for establishing temporary stabilization are also provided in the seeding exhibit provided in Appendix E. Permanent seeding will then occur during the next optimal growing season.

As indicated in the E&S Manual, erosion and sediment control devices will remain in place until permanent stabilization is established over the disturbed areas. Therefore, erosion and sediment control devices will not be removed by the EMAC contractor until directed by the OICC.

4.5 RESPONSE PROCEDURES FOR SPILL MITIGATION

Potential non-stormwater discharges anticipated during RAP implementation activities include wash water resulting from decontamination of field equipment and vehicles, fuel and lubricant spills from vehicle fueling, lubrication, and maintenance; spills of fertilizers; and small quantities of laboratory chemicals used in sample collection.

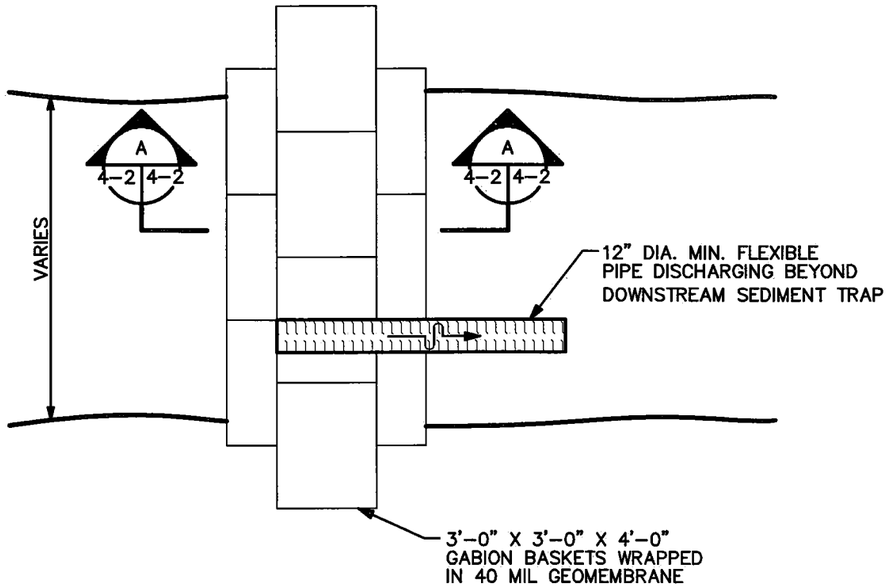
The decontamination wash water will be collected in a lined decontamination and equipment wash pad area. The wash water generated from decontamination and/or other washing activities will be collected, characterized, and transported to an approved off-site treatment facility. Vehicle fueling, lubrication, and maintenance will be performed utilizing drip pans to contain spills that may occur during maintenance activities. Containers of detergents and vehicle maintenance fluids (oil, grease, antifreeze, hydraulic fluid, etc.) will be stored within an enclosed, lined, diked area along with equipment fuel, which will be stored in tanks. This area, referred to as the materials storage area, will be bermed and lined with a 40-mil low-density polyethylene (LDPE) geomembrane and will be sized to contain 110 percent of the volume stored within the area. A small sump or low point in the liner will be designed to serve as a collection and monitoring point for leaks or spills from the containers stored within the materials storage area. The materials storage area will be checked daily to make sure that stored containers are not leaking and that the lining system is functioning properly. When not in use, chemicals, paints, and other flammable substances will be stored in a flammable storage cabinet located within the EMAC contractor's equipment trailer.

Good housekeeping procedures will be followed to reduce risks associated with these materials. These procedures include, but are not limited to, keeping materials in their original containers whenever possible, maintaining original labels and Material Safety Data Sheets (MSDSs), and using proper disposal methods for surplus materials. Accidental spills that may occur will be contained as appropriate for the spilled medium (liquid or solid) and collected and containerized immediately after discovery of the spill. Containerized material will be characterized for off-site transportation and disposal. The following spill mitigation equipment should be available on site during construction activities:

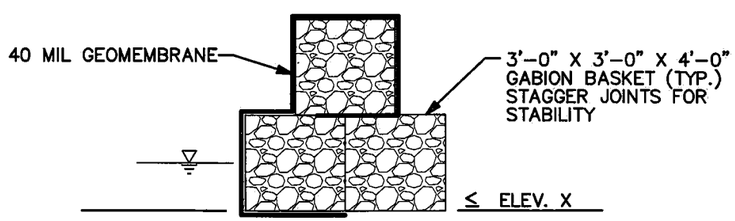
- Drip pans
- Oil-dry or similar compound
- Absorbent socks
- Shovels
- 55-gallon drums or storage tank (for containerization)
- Labels for contents identification

Following spill cleanup, the cause of the spill will be investigated, and material storage and handling procedures will be reviewed and revised where appropriate. Spills will be reported to the Naval Station Great Lakes Environmental Department. Following removal of the materials storage area, if not located within the decontamination pad area or dewatering area, verification samples will be collected from exposed surface soil per Section 5.0 of this RAP.

ACAD:1021CD03.dwg 05/18/09 MF PIT



PLAN VIEW

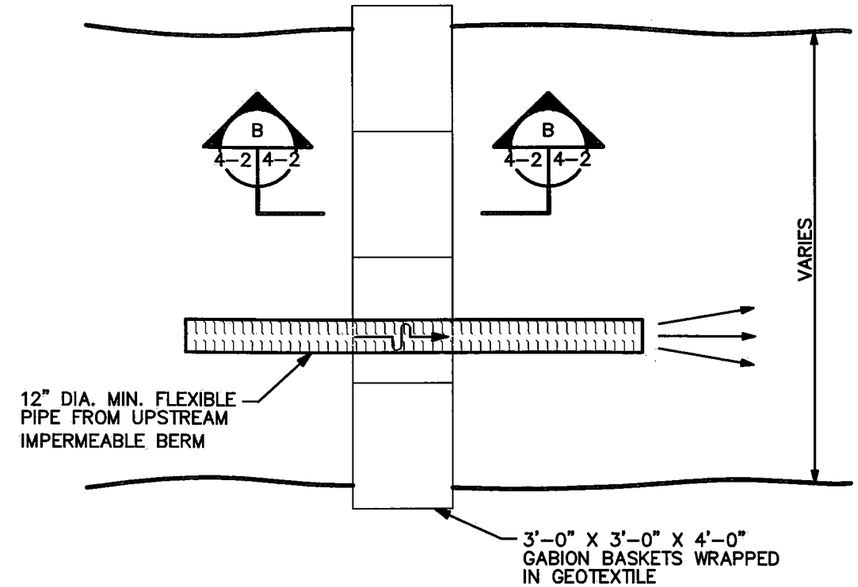


SECTION A – A'

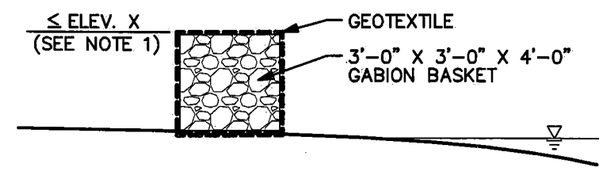
NOTES:

1. UPSTREAM IMPERMEABLE BERM MUST REMAIN IN PLACE UNTIL THE SECTION OF STREAM BETWEEN THE IMPERMEABLE BERM AND DOWNSTREAM SEDIMENT TRAP HAS BEEN EXCAVATED AND RESTORED.
2. DISTANCE TO DOWNSTREAM SEDIMENT TRAP SHOULD NOT EXCEED 150 FEET.
3. USE PUMPS AND HOSES ALONG WITH FLEXIBLE SPILLWAY PIPE TO TRANSPORT BASE FLOW TO DOWNSTREAM SIDE OF THE DOWNSTREAM SEDIMENT TRAP.

UPSTREAM IMPERMEABLE BERM



PLAN VIEW



SECTION B – B'

NOTES:

1. THE TOP ELEVATION OF THE DOWNSTREAM SEDIMENT TRAP SHOULD BE AT THE SAME ELEVATION OR LOWER THAN THE BOTTOM ELEVATION OF THE UPSTREAM IMPERMEABLE BERM. IF THIS CANNOT BE ACHIEVED THE SPILLWAY PIPE MUST GO THROUGH THE DOWNSTREAM SEDIMENT TRAP RATHER THAN OVER IT.
2. TO ACCOMODATE CONSTRUCTION SCHEDULE, A SECOND DOWNSTREAM SEDIMENT TRAP CAN BE INSTALLED (150 FEET MAXIMUM DISTANCE) AS LONG AS SPILLWAY PIPING IS EXTENDED. THIS WILL ALLOW FOR THE 300 FOOT MAXIMUM LENGTH OF DISTURBANCE AT ONE TIME. IF THIS APPROACH IS USED, THE FIRST DOWNSTREAM SEDIMENT TRAP MUST BE CONVERTED TO AN UPSTREAM IMPERMEABLE BERM BEFORE REMOVING THE ORIGINAL UPSTREAM IMPERMEABLE BERM.

DOWNSTREAM SEDIMENT TRAP

DRAWN BY MF	DATE 3/10/08	EROSION AND SEDIMENT CONTROL DEVICES SITE 17 PETTIBONE CREEK RAP NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. 01021
CHECKED BY TWS	DATE 5/15/-09		OWNER NO. 474
REVISED BY	DATE		APPROVED BY RFD / DATE 5/15/09
SCALE NOT TO SCALE		NAVFAC	DRAWING NO. FIGURE 4-1 / REV. 0

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

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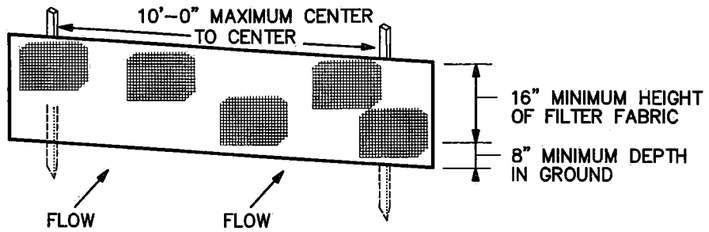
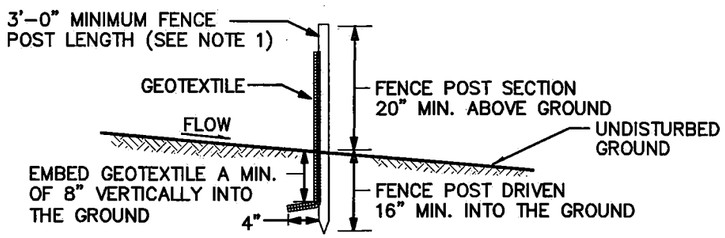
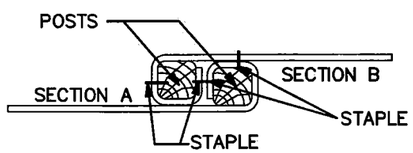


PERSPECTIVE VIEW



CROSS SECTION

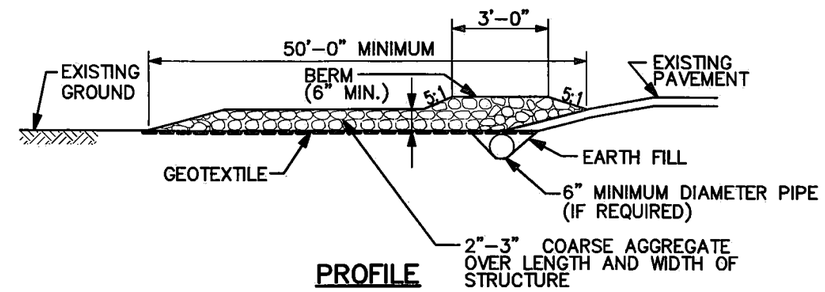


TOP VIEW – JOINING TWO
ADJACENT SILT FENCE SECTIONS

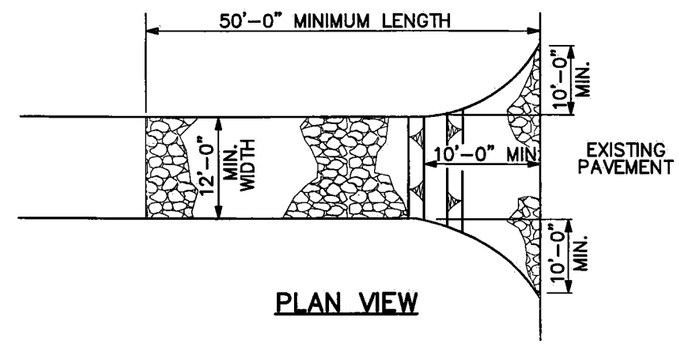
NOTES:

1. WOOD POSTS SHALL BE 1.5" BY 1.5" SQUARE (MIN) CUT OR 1.75" DIAMETER (MIN) ROUND AND SHALL BE OF SOUND QUALITY HARDWOOD. STEEL POSTS WILL BE STANDARD T OR U SECTION WEIGHING NOT LESS THAN 1.00 POUND PER LINEAR FOOT.
2. GEOTEXTILE SHALL BE FASTENED SECURELY TO EACH FENCE POST WITH WIRE TIES OR STAPLES AT TOP AND MID-SECTION.
3. INSTALL SILT FENCE PARALLEL TO THE CONTOUR OF THE LAND.

SYNTHETIC FILTER FENCE



PROFILE



PLAN VIEW

NOTES:

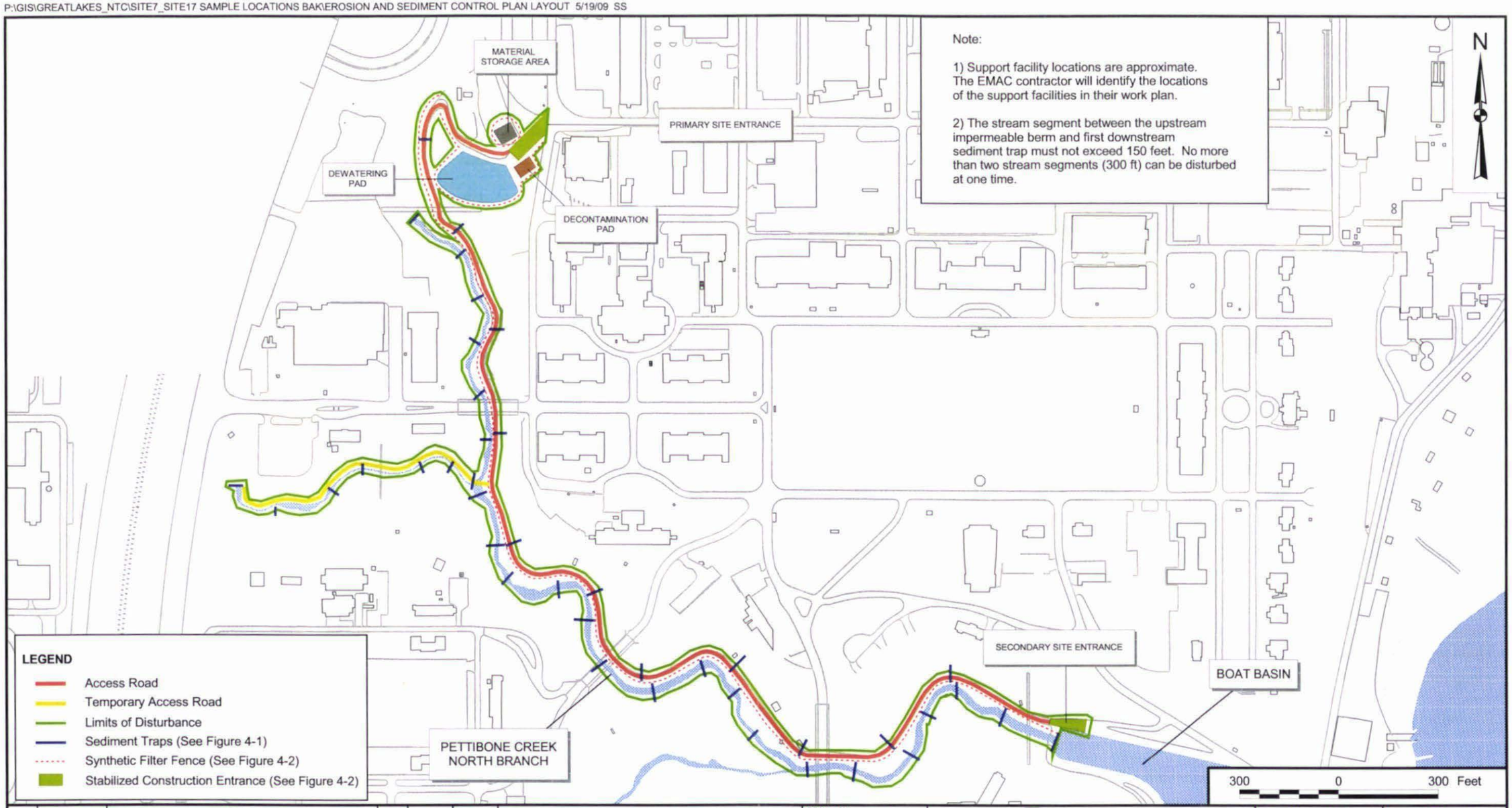
1. ALL SURFACE WATER FLOWING TO OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED THROUGH THE ENTRANCE, MAINTAINING POSITIVE DRAINAGE.
2. IF REQUIRED PIPE SHOULD BE SIZED ACCORDING TO THE AMOUNT OF RUNOFF TO BE CONVEYED. A 6" MINIMUM DIAMETER WILL BE REQUIRED.

STABILIZED CONSTRUCTION ENTRANCE

DRAWN BY MF	DATE 3/7/08	EROSION AND SEDIMENT CONTROL DEVICES SITE 17 PETTIBONE CREEK RAP NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. 01021
CHECKED BY TWS	DATE 5/15/09		OWNER NO. 474
REVISED BY	DATE		APPROVED BY RFD / DATE 5/15/09
SCALE NOT TO SCALE		NAVFAC	DRAWING NO. FIGURE 4-2 / REV. 0

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

P:\GIS\GREATLAKES_NTC\SITE7_SITE17 SAMPLE LOCATIONS BAK\EROSION AND SEDIMENT CONTROL PLAN LAYOUT 5/19/09 SS



Note:

1) Support facility locations are approximate. The EMAC contractor will identify the locations of the support facilities in their work plan.

2) The stream segment between the upstream impermeable berm and first downstream sediment trap must not exceed 150 feet. No more than two stream segments (300 ft) can be disturbed at one time.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY S. STROZ	DATE 3/06/08	Tetra Tech NUS, Inc.	CONTRACT NUMBER 01021 / OWNER NUMBER 0474
CHECKED BY T. SMITH	DATE 5/19/09	EROSION AND SEDIMENT CONTROL PLAN SITE 17 - PETTIBONE CREEK RAP NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS	APPROVED BY RFD / 5/19/09
COST/SCHEDULE-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 4-3 / REV 0

5.0 POST-REMOVAL AND VERIFICATION SAMPLING PLAN

5.1 PURPOSE

The purpose of this section is to present the two types of samples to be collected during and following implementation of the RAP. The two types of samples include post-removal samples and verification samples. Post-removal samples will be collected from the native stream bed soil once the overlying sediment has been removed. Verification samples will be collected from surface soil located beneath support facilities (decontamination pad, dewatering pad, material storage area, access roads, etc.) to make sure that RAP implementation did not spread contamination to support facility areas. This section also presents criteria and procedures used to evaluate post-removal and verification sample data to determine the acceptability of residual soil contamination, if present. The sampling procedures and fixed-base laboratory analytical methods will be performed in accordance with the procedures specified in the Quality Assurance Project Plan (QAPP) dated July 2001 (Tetra Tech, 2001).

5.2 POST REMOVAL SAMPLING OF EXPOSED STREAM BED

RAP implementation includes the excavation and off-site disposal of sediment within North Branch Pettibone Creek and the unnamed tributary containing COCs at concentrations greater than their PRGs. These excavation areas are shown on Figures 3-1, 4-3, and 5-1. Following the removal of contaminated sediment, post-excavation samples will be collected from the exposed native stream bed soil. Although it is not anticipated that bedrock will be encountered during excavation activities, portions of the exposed stream bed that consists of competent bedrock will not be included in the post-removal sampling program (i.e., no post-removal samples will be collected from exposed competent bedrock). To be consistent with the sampling protocol used during the RI, post-removal samples from the exposed native stream bed soil will be collected at a rate of one composite sample for every 150 linear feet of exposed native stream bed soil. The 150 foot exposed stream bed represents a sampling area. Based on the length of stream requiring sediment removal (4,440 linear feet), 30 post-removal sampling areas will be established and 30 post-removal samples will be collected from the exposed native stream bed sampling areas. Proposed post removal sample locations are identified on Figure 5-1. Post-removal sample will be analyzed for PAHs, PCBs, pesticides, and select metals (copper, lead, mercury, and zinc) and the results will be compared to the PRGs presented in this RAP (Table 2-5) and the results of the December 2008 investigation and will be used to perform a ecological risk assessment if necessary. The comparisons to PRGs and December 2008 investigation results and risk assessment (if necessary) will be used to determine the need for additional remedial activities within Pettibone Creek.

As indicated above, each post-removal sample will be a composite sample collected by combining and mixing soil from two or more distinct locations (grab sample locations) within a designated sample area. The number of grab sample locations is dependent upon the size of the designated area. The goal in determining the number of grab sample locations is to establish one sample that is representative of the entire excavation area. Because composite samples were not collected during the RI process, sampling methods for composite sampling are not addressed in the 2001 QAPP. Therefore, the Standard Operation Procedure (SOP) for composite sample collection is provided in Appendix F of this RAP. To obtain a representative sample within each 150 foot stream length excavation area, each composite sample will be made up of soil material obtained from six grab sample locations within each stream length excavation area. The location of the six grab samples will be determined by dividing each 150 foot stream bed lengths into six 25 foot long subsections. A grab sample will then be randomly located within each of the six 25 foot long subsections. To avoid biasing the location of each grab sample, the locations of each grab sample have been generated using a random number generator. The random number generator will establish the location of each grab sample by identifying the percent distance along the stream and a percentage distance across the stream as measured in the direction of flow and from left to right bank (facing in the direction of flow). Table 5-1 presents the anticipated post removal samples to be collected within the stream bed along with the percent distances locating each grab sample location for each composite sample. Figure 5-2 presents an example of how the percent distances are used to locate each grab sample.

Sampling will be performed in accordance with the SOP provided in Appendix F, and sample preparation, sample shipment, and fixed-base laboratory sample analysis, will be performed in accordance with the 2001 QAPP.

5.3 VERIFICATION SAMPLING OF SUPPORT FACILITIES

The support facilities requiring verification sampling following RAP implementation include the access roads, dewatering pad, material storage area, decontamination pad, and any other pad or trail used to contain or transport contaminated sediment. The frequency of verification sample collection for these support facilities varies. For the access roads, verification samples will be collected at a rate of one sample for every 300 linear feet of access road. Each 300 linear feet of access road used during RAP activities will represent an individual sampling area. For the dewatering pad, material storage area, and decontamination pad, verification samples will be collected at a rate of one sample per 1,000 square feet of disturbed area, with a minimum of one verification sample from each of the support facilities. Based on the anticipated areas of the dewatering pad, decontamination pad, material storage area, and access roads, it is estimated that two verification samples will be collected from two defined sampling areas within the dewatering pad, one verification sample will be collected from the decontamination pad, one verification sample will be collected from the material storage area, and 15 verification samples will be

collected from the access roads. To avoid biasing the location of each grab sample, the locations of each grab sample have been generated using a random number generator. The random number generator will establish the location of each grab sample by identifying the percent distance along the access road and a percentage distance across the access road measured from left to right bank (facing in the direction of flow). Table 5-2 presents the anticipated verification samples to be collected beneath the support facilities along with the percent distances locating each grab sample location for each composite sample. The proposed verification sample areas for the support facilities are identified on Figure 5-1.

The results of these verification samples will be compared to PRGs to determine if contamination was spread to the temporary access roads or the surface soil below the foot print of the support facilities at concentrations greater than PRGs. In the event that the EMAC contractor collects pre-construction samples from each support area the results of the verification samples will also be compared to these results. In the event that a verification sample result for one or more COC exceeds PRGs, 6-inches of soil will be removed from the associated access road section or support facility footprint (support facility footprint equals the actual footprint plus an additional 10 feet in all directions). In the event that pre-construction samples are collected and verification sample results are less than the pre-construction results excavation will not be required even if the verification sample results exceed PRGs. Following additional excavation (if needed), additional verification samples will be collected and analyzed. Excavation expansion may continue until the verification samples indicate that COC concentrations are less than PRGs. Excavation of surface soil beneath the support facilities and associated handling and disposal of that material will be completed at EMAC contractor's expense.

As with the post-removal samples collected for the creek and tributary, the verification samples for the support facilities will be composite samples made up of material collected from six randomly located grab sample locations. For access roads, each 300 foot length of access road will be divided into 50 foot long sub-sections, and one grab location will be randomly located in each sub-section. For the dewatering pad and decontamination pad areas, each grab location will be randomly located within each designated sample area. Each verification sample collected will be analyzed for the COCs identified in Section 2 and the results will be compared to the PRGs presented on Table 2-5. Sampling procedures will follow the SOP presented in Appendix F and sample preparation, sample shipment, and fixed-base laboratory sample analysis will be performed in accordance with the 2001 QAPP.

TABLE 5-1

POST-REMOVAL SAMPLES
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Area	Sample ID Number	Grab Sample Location			Analysis		
		Grab Number	Percent X (1)	Percent Y (2)	PAHs (3)	Pest/PCBs (4)	Metals (5)
SA01	NTC17PC-SDCP-SA01	1	79	65	X	X	X
		2	48	7			
		3	74	13			
		4	48	87			
		5	55	20			
		6	78	92			
SA02	NTC17PC-SDCP-SA02	1	99	34	X	X	X
		2	27	36			
		3	81	68			
		4	37	66			
		5	100	9			
		6	74	13			
SA03	NTC17PC-SDCP-SA03	1	31	24	X	X	X
		2	47	11			
		3	53	53			
		4	56	61			
		5	89	27			
		6	37	33			
SA04	NTC17PC-SDCP-SA04	1	27	18	X	X	X
		2	36	82			
		3	23	70			
		4	34	17			
		5	20	53			
		6	10	38			
SA05	NTC17PC-SDCP-SA05	1	7	51	X	X	X
		2	36	49			
		3	84	13			
		4	41	82			
		5	50	41			
		6	37	96			
SA06	NTC17PC-SDCP-SA06	1	88	38	X	X	X
		2	54	46			
		3	82	37			
		4	37	64			
		5	75	9			
		6	36	80			
SA07	NTC17PC-SDCP-SA07	1	92	89	X	X	X
		2	10	12			
		3	62	18			
		4	12	19			
		5	94	73			
		6	20	67			

TABLE 5-1

POST-REMOVAL SAMPLES
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Area	Sample ID Number	Grab Sample Location			Analysis		
		Grab Number	Percent X (1)	Percent Y (2)	PAHs (3)	Pest/PCBs (4)	Metals (5)
SA08	NTC17PC-SDCP-SA08	1	4	62	X	X	X
		2	56	69			
		3	92	84			
		4	44	20			
		5	48	73			
		6	66	7			
SA09	NTC17PC-SDCP-SA09	1	21	46	X	X	X
		2	6	68			
		3	8	85			
		4	49	80			
		5	88	86			
		6	72	12			
SA10	NTC17PC-SDCP-SA10	1	6	56	X	X	X
		2	62	74			
		3	48	82			
		4	0	97			
		5	24	87			
		6	8	34			
SA11	NTC17PC-SDCP-SA11	1	7	60	X	X	X
		2	77	98			
		3	38	47			
		4	95	59			
		5	35	61			
		6	66	84			
SA12	NTC17PC-SDCP-SA12	1	91	68	X	X	X
		2	44	40			
		3	29	85			
		4	14	85			
		5	33	14			
		6	47	93			
SA13	NTC17PC-SDCP-SA13	1	45	54	X	X	X
		2	94	23			
		3	3	28			
		4	93	72			
		5	88	44			
		6	48	21			
SA14	NTC17PC-SDCP-SA14	1	18	79	X	X	X
		2	62	52			
		3	31	56			
		4	53	6			
		5	54	21			
		6	89	91			

TABLE 5-1

POST-REMOVAL SAMPLES
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Area	Sample ID Number	Grab Sample Location			Analysis		
		Grab Number	Percent X (1)	Percent Y (2)	PAHs (3)	Pest/PCBs (4)	Metals (5)
SA15	NTC17PC-SDCP-SA15	1	10	80	X	X	X
		2	50	23			
		3	41	20			
		4	32	49			
		5	7	11			
		6	85	86			
SA16	NTC17PC-SDCP-SA16	1	24	40	X	X	X
		2	48	67			
		3	62	82			
		4	99	86			
		5	16	64			
		6	21	22			
SA17	NTC17PC-SDCP-SA17	1	91	21	X	X	X
		2	55	76			
		3	90	1			
		4	88	75			
		5	30	56			
		6	46	23			
SA18	NTC17PC-SDCP-SA18	1	94	43	X	X	X
		2	97	86			
		3	82	60			
		4	47	56			
		5	5	81			
		6	19	69			
SA19	NTC17PC-SDCP-SA19	1	47	18	X	X	X
		2	24	15			
		3	67	90			
		4	88	19			
		5	13	16			
		6	26	61			
SA20	NTC17PC-SDCP-SA20	1	54	34	X	X	X
		2	55	92			
		3	9	50			
		4	63	49			
		5	96	56			
		6	45	36			
SA21	NTC17PC-SDCP-SA21	1	56	72	X	X	X
		2	54	88			
		3	9	58			
		4	45	58			
		5	98	83			
		6	92	5			

TABLE 5-1

POST-REMOVAL SAMPLES
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Area	Sample ID Number	Grab Sample Location			Analysis		
		Grab Number	Percent X (1)	Percent Y (2)	PAHs (3)	Pest/PCBs (4)	Metals (5)
SA22	NTC17PC-SDCP-SA22	1	67	55	X	X	X
		2	81	83			
		3	53	95			
		4	43	90			
		5	50	3			
		6	1	1			
SA23	NTC17PC-SDCP-SA23	1	60	44	X	X	X
		2	89	84			
		3	28	31			
		4	8	25			
		5	90	7			
		6	48	51			
SA24	NTC17PC-SDCP-SA24	1	66	72	X	X	X
		2	90	50			
		3	4	25			
		4	27	12			
		5	61	68			
		6	58	64			
SA25	NTC17PC-SDCP-SA25	1	72	25	X	X	X
		2	25	28			
		3	72	79			
		4	39	75			
		5	62	9			
		6	54	51			
SA26	NTC17PC-SDCP-SA26	1	16	64	X	X	X
		2	3	43			
		3	68	59			
		4	2	68			
		5	88	8			
		6	51	65			
SA27	NTC17PC-SDCP-SA27	1	60	45	X	X	X
		2	2	34			
		3	30	59			
		4	29	6			
		5	28	69			
		6	13	54			
SA28	NTC17PC-SDCP-SA28	1	72	52	X	X	X
		2	39	47			
		3	60	51			
		4	99	4			
		5	87	91			
		6	7	24			

TABLE 5-1

POST-REMOVAL SAMPLES
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Area	Sample ID Number	Grab Sample Location			Analysis		
		Grab Number	Percent X (1)	Percent Y (2)	PAHs (3)	Pest/PCBs (4)	Metals (5)
SA29	NTC17PC-SDCP-SA29	1	63	33	X	X	X
		2	12	39			
		3	65	64			
		4	90	99			
		5	76	77			
		6	56	80			
SA030	NTC17PC-SDCP-SA30	1	12	23	X	X	X
		2	4	30			
		3	61	81			
		4	50	87			
		5	86	86			
		6	82	20			

1 Percent X represents the percentage along the creek or tributary sub-segment (in direction of flow) where the grab sample is located.

2 Percent Y represents the percentage across the creek or tributary sub-segment (from left to right looking in the direction of flow) where the grab sample is located.

3 PAHs include anthracene, benzaldehyde, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, caprolactam, carbazole, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, and total PAHs.

4 Pest/PCBs include 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Total DDT, Aroclor-1254, Aroclor-1260, Endosulfan I, and Endosulfan II.

5 Metals include copper, lead, mercury, and zinc.

TABLE 5-2

VERIFICATION SAMPLES
SITE 17 - PEETIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Area	Sample ID Number	Grab Sample Location			Analysis		
		Grab Number	Percent X (1)	Percent Y (2)	PAHs (3)	Pest/PCBs (4)	Metals (5)
SA31	NTC17PC-SSCP-SA31	1	90	32	X	X	X
		2	80	69			
		3	28	68			
		4	52	14			
		5	46	78			
		6	3	33			
SA32	NTC17PC-SSCP-SA32	1	36	51	X	X	X
		2	8	34			
		3	19	69			
		4	56	24			
		5	98	50			
		6	18	64			
SA33	NTC17PC-SSCP-SA33	1	58	98	X	X	X
		2	20	12			
		3	13	85			
		4	67	78			
		5	55	42			
		6	93	54			
SA34	NTC17PC-SSCP-SA34	1	15	48	X	X	X
		2	31	26			
		3	78	11			
		4	65	98			
		5	5	53			
		6	42	22			
SA35	NTC17PC-SSCP-SA35	1	44	10	X	X	X
		2	52	38			
		3	69	61			
		4	17	49			
		5	28	49			
		6	86	21			
SA36	NTC17PC-SSCP-SA36	1	41	8	X	X	X
		2	59	64			
		3	45	63			
		4	49	78			
		5	83	57			
		6	99	39			
SA37	NTC17PC-SSCP-SA37	1	79	93	X	X	X
		2	17	6			
		3	58	36			
		4	51	73			
		5	64	45			
		6	85	7			

TABLE 5-2

VERIFICATION SAMPLES
SITE 17 - PEETIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Area	Sample ID Number	Grab Sample Location			Analysis		
		Grab Number	Percent X (1)	Percent Y (2)	PAHs (3)	Pest/PCBs (4)	Metals (5)
SA38	NTC17PC-SSCP-SA380	1	17	65	X	X	X
		2	83	99			
		3	29	84			
		4	14	75			
		5	68	12			
		6	40	56			
SA39	NTC17PC-SSCP-SA390	1	76	39	X	X	X
		2	23	73			
		3	32	2			
		4	30	87			
		5	49	18			
		6	73	71			
SA40	NTC17PC-SSCP-SA40	1	34	14	X	X	X
		2	19	86			
		3	24	35			
		4	1	90			
		5	43	90			
		6	90	24			
SA41	NTC17PC-SSCP-SA41	1	32	8	X	X	X
		2	69	25			
		3	17	71			
		4	54	87			
		5	92	78			
		6	33	41			
SA42	NTC17PC-SSCP-SA42	1	72	59	X	X	X
		2	97	4			
		3	65	30			
		4	79	15			
		5	25	9			
		6	26	13			
SA43	NTC17PC-SSCP-SA43	1	98	7	X	X	X
		2	66	79			
		3	27	70			
		4	94	94			
		5	78	4			
		6	92	59			
SA44	NTC17PC-SSCP-SA44	1	64	8	X	X	X
		2	54	63			
		3	76	55			
		4	38	35			
		5	36	60			
		6	8	86			

TABLE 5-2

VERIFICATION SAMPLES
SITE 17 - PEETIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

Sample Area	Sample ID Number	Grab Sample Location			Analysis		
		Grab Number	Percent X (1)	Percent Y (2)	PAHs (3)	Pest/PCBs (4)	Metals (5)
SA45	NTC17PC-SSCP-SA45	1	5	72	X	X	X
		2	20	57			
		3	62	37			
		4	73	61			
		5	2	28			
		6	70	94			
SA46	NTC17PC-SSCP-SA46	1	87	93	X	X	X
		2	99	67			
		3	19	28			
		4	2	9			
		5	36	71			
		6	66	41			
SA47	NTC17PC-SSCP-SA47	1	14	74	X	X	X
		2	17	88			
		3	37	95			
		4	80	49			
		5	32	48			
		6	47	31			
SA48	NTC17PC-SSCP-SA48	1	48	20	X	X	X
		2	70	92			
		3	64	97			
		4	37	66			
		5	12	87			
		6	13	23			

Notes Sampling Areas SA31 through SA45 represtent verification samples collected on the access road. Sampling Areas SA46 and SA47 represent verificaiton samples collected from the dewatering pad footprint. Sample Area SA48 represents the verificaiton sample locaiton collected from the decontamination pad footprint.

In the event that additional soil excavtion is required, the subsiqent verification sample will be labled NSGL-SAxx-02. The last numbers would continue to increas in icraments of 1 if additional samples area required.

1 Percent X represents the percentage along the creek or tributary sub-segment (in direction of flow) where the grab sample is located.

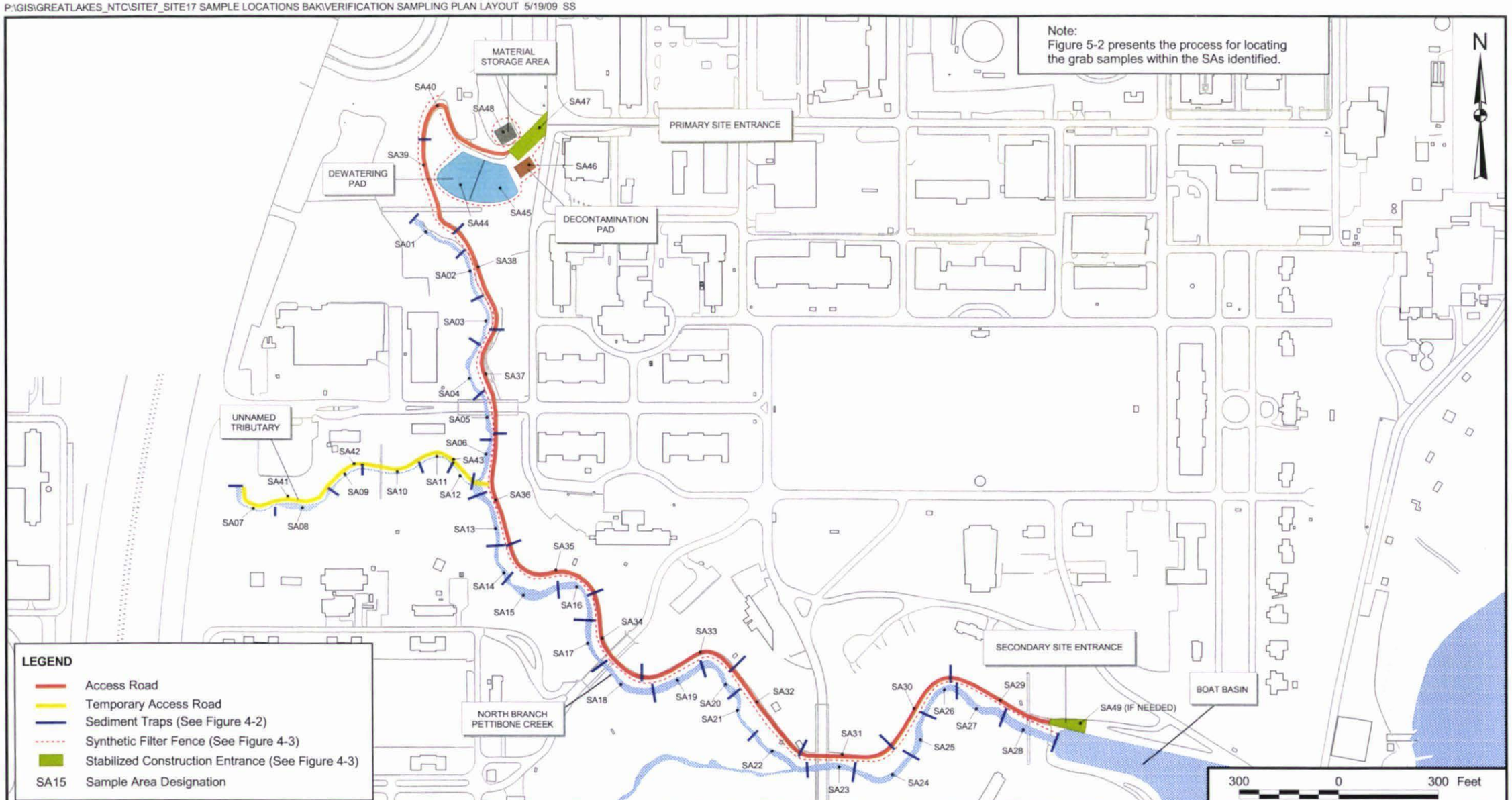
2 Percent Y represents the percentage across the creek or tributary sub-segment (from left to right looking in the direction of flow) where the grab sample is located.

3 PAHs include anthracene, benzaldehyde, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, caprolactam, carbazole, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, and total PAHs.

4 Pest/PCBs include 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Total DDT, Aroclor-1254, Aroclor-1260, Endosulfan I, and Endosulfan II.

5 Metals include copper, lead, mercury, and zinc.

P:\GIS\GREATLAKES_NTC\SITE7_SITE17 SAMPLE LOCATIONS BAK\VERIFICATION SAMPLING PLAN LAYOUT 5/19/09 SS



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

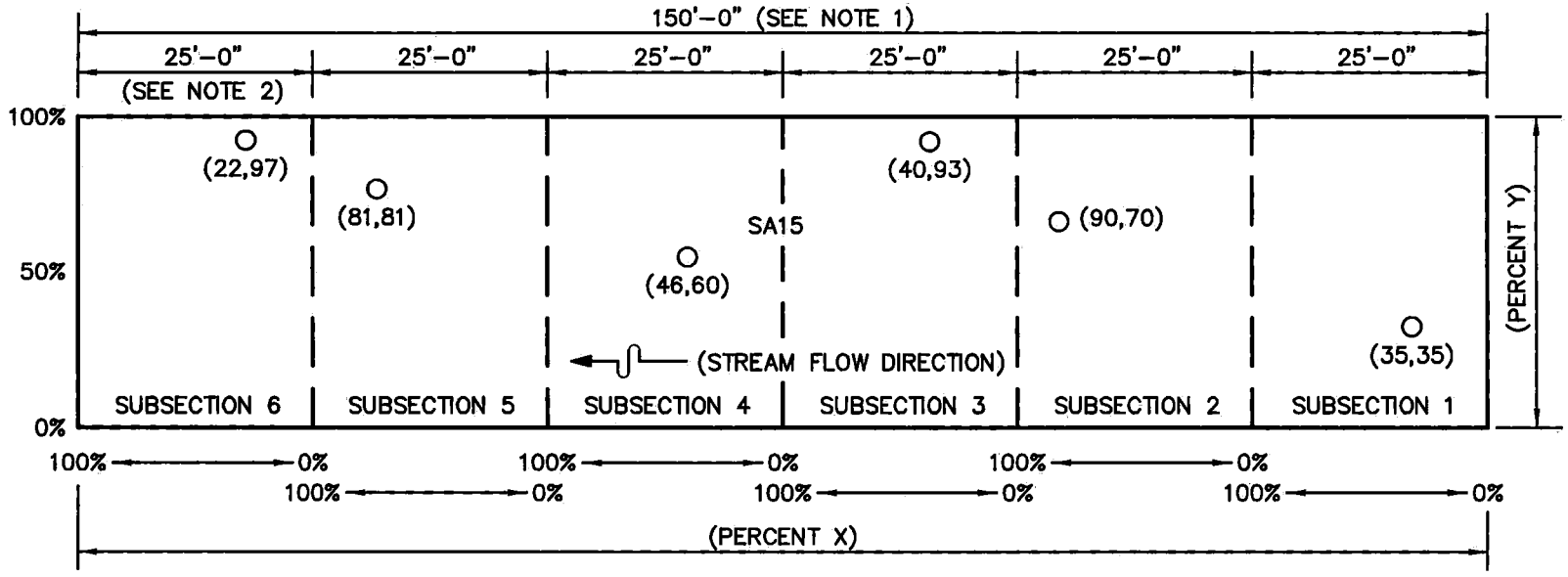
DRAWN BY S. STROZ	DATE 3/07/08
CHECKED BY T. SMITH	DATE 5/19/09
COST/SCHEDULE-AREA	
SCALE AS NOTED	

Tetra Tech NUS, Inc.

POST-REMOVAL AND VERIFICATION SAMPLING PLAN
SITE 17 - PETTIBONE CREEK RAP
NAVAL STATION GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NUMBER 01021	OWNER NUMBER 0474
APPROVED BY RFD	DATE 5/19/09
APPROVED BY	DATE —
DRAWING NO. FIGURE 5-1	REV 0

ACAD:1021CDX6.dwg 05/19/09 MF PIT



SAMPLE AREA	SUBSECTION	GRAB LOCATION	
		PERCENT X	PERCENT Y
SA___	1	35	35
	2	90	70
	3	40	93
	4	46	60
	5	81	81
	6	22	97

NOTES:

1.) AREA REPRESENTS A 150 FEET SEGMENT OF STREAM LENGTH DESIGNATED AS A VERIFICATION SAMPLING AREA.

2.) 25 FEET CHANNEL LENGTH REPRESENTS THE STREAM SUBSECTIONS FROM WHICH THE INDIVIDUAL GRAB LOCATIONS ARE COLLECTED.

3.) GRAB LOCATIONS WITH IN SAMPLING AREAS BELOW ACCESS ROAD ARE DETERMINED THE SAME WAY AS THOSE FOR THE STREAM BED. HOWEVER AN ACCESS ROAD SA IS APPROXIMATELY 300 FOOT IN LENGTH.

DRAWN BY MF	DATE 3/3/08	POST-REMOVAL SAMPLING PROCEDURE SITE 17 PETTIBONE CREEK ROD NAVAL STATION GREAT LAKES GREAT LAKES, ILLINOIS
CHECKED BY TWS	DATE 5/15/09	
REVISED BY	DATE	
SCALE AS NOTED		

NAVFAC

CONTRACT NO. 1021	
OWNER NO. 474	
APPROVED BY RFD	DATE 5/15/09
DRAWING NO. FIGURE 5-2	REV. 0

FORM CADD NO. SDIV-AH.DWG – REV 1 – 9/10/98

6.0 PETTIBONE CREEK SUPPLEMENTAL REMEDIAL ACTION

6.1 PURPOSE

The purpose of this section is to present the proposed remedial (stream restoration) action that will address both erosion and sedimentation issues currently present within the North Branch of Pettibone Creek (Site 17). The primary focus of the stream restoration activities will be on the North Branch of Pettibone Creek (Figure 6-1) where it flows onto the Naval Station Great Lakes through culverts. The implementation of this remedial action falls under Phase 5 of the Navy's Installation Restoration (IR) Program. Appendix H (Northern Branch-Pettibone Creek Photographs) provides existing condition photographs of areas of the North Branch of Pettibone Creek requiring stream restoration. Note that the locations of each photo are depicted on Figure 6-1. Selected photos are enlarged on Figure 6-1 highlighting particularly important areas requiring stream remedial actions.

6.2 DESCRIPTION OF THE SUPPLEMENTAL REMEDIAL ACTION

The North Branch of Pettibone Creek north of Naval Station Great Lakes has been previously evaluated for site-specific flood mitigation planning (Ciorba, 2004). As discussed in the Ciorba study, the North Branch of Pettibone Creek area has received a large amount of flooding occurrences experienced by North Chicago due in part to urbanization and addition of impervious areas within the Pettibone Creek watershed.

The sediment associated with flows emanating upstream of the North Branch Pettibone Creek are potentially impacted with contaminants typically associated with industrial activities. Therefore, in addition to remedial activities directed at removal of contaminated sediments as described in Section 3.0, this section includes remedial activities that will address erosion prior to discharge into the Boat Basin, Inner Harbor, and Outer Harbor and remedial activities directed at stabilizing the banks of the North Branch of Pettibone Creek. Also note that in March 2011, Tetra Tech performed a site visit to document specific areas of the North Branch of Pettibone Creek that required stream bank stabilization. Appendix H provides the photographs taken during this field investigation that were used in the formulation of the stream bank stabilization strategy. Select photographs are presented on Figure 6-1. Figure 6-2 presents the North Branch of Pettibone Creek along with the site location contouring.

In the past, Pettibone Stream bank stabilization efforts have included placement of hard-surfaced structures such as Gabion baskets walls and placements of dumped rock and concrete debris. While measures such as these provide limited, localized stabilization to severely eroded stream banks, they increase downstream sediment deposits due to their ability to increase stream velocities, thus carrying

sediment farther downstream, eventually settling in the Boat Basin. The stream stabilization approach recommended in this section includes measures that provide stream bank stabilization but also are designed to reduce stream velocities during high flow periods. Finally, engineered wetlands are proposed to act as natural flood plains to address high flow period sediment capture.

The proposed remedial (stream restoration) action includes construction of select stream bank stabilization chosen specifically for riparian sites and disturbed/steep slope sites. These remedial alternatives were chosen based on "environmental friendliness" and effectiveness in both sediment retention and stream bank stabilization. Particular stream stabilization and sediment collection features proposed for the North Branch of Pettibone Creek include:

- ERTEK Bank Stabilization System™;
- Rootwads;
- Log Vanes;
- J-Hook Vanes;
- LUNKERS (Little Underwater Neighbor Keepers Encompassing Rheotaxic Salmonids); and,
- Engineered Side Channel Wetlands.

It is important to note that the effectiveness of the recommended stream stabilization and sediment collection measures proposed herein will be dramatically reduced if storm water piping outfalls remain in their current state of little to no outfall protection and energy dissipation. It is recommended that Naval Station Great Lakes Inventory design and install energy dissipation structures at each of the 30 plus existing storm water outfall.

6.3 BASELINE FLOW ANAYSIS

Given the history of flooding in the North Chicago area during most storm events, local governmental agencies have stressed the importance of evaluating impacts to Pettibone Creek when construction practices occur within the associated watershed.

In order to evaluate the impacts of installing and implementing stream bank stabilization and sediment retention measures in the North Branch of Pettibone Creek, peak storm water flows from various storm events were calculated using the Army Corps of Engineers HEC-HMS computer program. The HEC-HMS computer program input (cross sections, design flows, etc.) and output (water surface profiles, cross sections) are provided in Appendix I. Flows from the unnamed tributaries were estimated as well. The design storms evaluated include:

- 1 Year;
- 2 Year
- 5 Year;
- 10 Year;
- 50 Year;
- 25 Year; and,
- 100 Year.

Upon determining the various peak flow discharges from Pettibone Creek, a HEC-RAS analysis was performed to estimate the water surface profiles resulting from the above-mentioned storm events under "pre-development" (existing) conditions. Flow results from this HEC RAS analysis are shown in Appendix I. The design storm peak flows were estimated for the tributaries using HEC-HMS to calculate the flows. TR-55 was utilized to estimate the times of concentration. Refer to Appendix J for peak flow calculations.

Illinois Department of Transportation estimated peak flows for the 50-year, 100-year, and 500 year storms during the reconstruction of Sheridan Road in 1989. The purpose of these estimated peak flows for the culvert design that discharge onto Naval Station Great Lakes. These calculations are included in Appendix J and correlates well with the HEC-HMS modeling. The Lake County Storm Water Management Commission required James Anderson Company to use 321 cfs for a 10 year flow and 750 cfs for a 100 year design flow as part of a storm water management design for the EMCO Truck Repair facility. This facility is just north of the culverts that discharge onto the Naval Station Great Lakes property and these flows also correlate well with this HEC-HMS modeling.

6.4 POST CONSTRUCTION FLOW ANALYSIS

A post construction flow analysis of the previously mentioned design storms was performed with cross sections added that account for the constructed wetlands. The other stream bank stabilization features proposed do not change the stream configuration to a degree that they affect the subsequent water surface profile. By comparing the water surface profiles for both the pre- and post-development scenarios, the resultant difference in water surface profiles is minor. Flow results from this HEC-RAS analysis are shown on Appendix K. The resultant impact of the proposed alternatives (specifically the side channel wetlands), is negligible. Therefore, according to the analysis of the impact of water surface profiles upon implementation of the proposed remedial actions, upstream water surface profiles during the design events analyzed are not predicted to change.

6.5 PROPOSED STREAM BANK STABILIZATION MEASURES

The remedial action is designed to reduce the amount of sediment entering into the Boat Basin from Pettibone Creek, stabilize the banks of Pettibone Creek, and consists of various elements to be installed at strategic locations along and adjacent to the bank of the North Branch of Pettibone Creek. The following sections provide details on each element. Refer to Drawing C-1 for an overall depiction of the proposed location of the remedial alternatives. A detailed location description of each proposed remedial action is shown on Drawings C-2 and C-3 (Drawing C-2 - Proposed Remedial Site Plan, Sheet 1/2 and Drawing C-3 - Proposed Remedial Site Plan, Sheet 2/2). A summary of the stream bank stabilization/sediment retention devices is provided in Table 6-1 along with the appropriate station of Pettibone Creek.

6.5.1 ERTEK BANK STABILIZATION SYSTEM (BSS)

The Bank Stabilization System (BSS) by ERTEK was selected as a major remedial feature for the stabilization of the North Branch of Pettibone Creek. Once in place, BSS allows water flow-through and significantly reduces velocity of stream flow. The BBS system contains an integrated filter and retains soil particles in place, creating a barrier to further erosion. BSS is made from durable and UV stable HDPE. The ERTEK Installation and Maintenance Guide is provided in Appendix L along with the product data sheet. The proposed location of the ERTEK Bank Stabilization System (BSS) is shown of Drawings C-2 and C-3 and summarized on Table 6-1.

6.5.2 ROOTWADS

A rootwad composite is a combination of interlocking tree materials where a mass of tree roots, commonly called a rootwad, is utilized with other tree parts and revegetation methods to stabilize stream banks and provide aquatic habitat. Rootwad composites are often a cost-effective bank stabilization and habitat enhancement treatment. Rootwad composites move the current line away from the stream bank so that the bank is less susceptible to erosion through hydraulic forces. This, in effect, reduces the energy environment along the stream bank/water interface so that riparian vegetation can provide the necessary bank protection and habitat values. Rootwad composites also generate turbulence that creates streambed scour and provides cover and substrate for aquatic organisms.

A rootwad is the lower trunk and root fan of a large tree as shown on Detail 2 of Drawing C-7. Individual rootwads are placed in series and utilized to protect stream banks along meander bends. Rootwads are constructed by grading the stream bank back and establishing a desired meander radius. A trench is excavated parallel with the stream bank along the radius. Starting at the downstream end of the meander, a footer log (18 to 24-inch diameter, 8 to 10 foot long) is placed in this trench. A second trench

is cut perpendicular to the first back into the stream bank angling downstream. The rootwad is placed in this trench so the trunk side of the root fan rests against the footer log and the bottom of the root fan faces into the flow of water. Large boulders are then placed on the top and sides of the footer and rootwad to hold them in place. Moving upstream, the next footer log is placed in the trench with its downstream end extending behind the first footer log and the next root wad is put in place. This process continues until the rootwads have been installed. Some installation methods utilize a cut-off log on top of each rootwad to hold it in place, rather than boulders.

Once the rootwad revetment is in place the area between and behind the rootwads is backfilled with rock/fill. The top of the stream bank is graded to transition into the rootwads and this area and the area between the rootwads is stabilized with vegetation.

Rootwad revetments have the potential to greatly enhance stream habitat. Rootwad revetments promote the formation of pool habitat along the outside of meander bends and the root fan portion of the rootwads provides overhead cover for the pools. Once rootwads are installed, they provide up to 15 years of stream bank stabilization at which time the stream bank and riparian system recover from instability. Rootwads are typically spaced 3 to 4 times the projected rootwad length. In practice, spacing of root wads are field determined based on the availability of the wads. Refer to Appendix M for a reference document providing various design, installation, and overall description of rootwad bank stabilization features. Proposed Rootwad locations are depicted on Drawings C-2 and C-3 and summarized on Table 6-1.

6.5.3 LOG VANES

The purpose of log vanes (Detail 4 of sheet C-7) is to reduce erosion along the stream bank by redirecting the stream flow toward the center of the stream. They essentially mimic the effect of a tree partially falling into the stream. Log vanes are linear structures that extend out from the stream bank into the stream channel in an upstream direction. In addition, they tend to create scour pools on the downstream side.

Log vanes grade down from the bankfull elevation at the stream bank to the channel invert at their terminus in the stream. Vanes generally extend out from the stream bank 1/3 of the bankfull width and are angled upstream from the bank at a 20 to 30 degree angle. The top elevation of the vane will decrease from ½ bankfull elevation toward the center of the channel at a slope of 4 to 20 percent. Header and footer rocks will be buried along the upstream end of the log under the streambed as shown on Detail 4 and plate the upstream side of the vane with Type 2 filter fabric and No. 57 stone. The filter fabric will be securely fastened to the back of the log using galvanized roofing nails on approximately 8" centers. Voids between the header and footer rocks can be filled with hand-placed Class A riprap as directed. Footer rocks will be placed such that the header rock is at streambed elevation. The downstream end of the log at the ½ bankfull elevation shall be anchored by pinning with header and footer rocks. The log vane will be keyed

into the bank at the downstream end as shown on Detail 4. Native hardwood trees encountered during clearing and grubbing may be identified and stockpiled for use as logs for the log vanes. Log vane locations were selected to provide the reduced bank erosion in areas with moderate, straight-line soil loss risk. The longevity of log vanes can vary from five to 15 years at which point natural stream processes become the dominant stream shaping feature (i.e., creation of scour pools downstream of each vain). Proposed Log Vane locations are depicted on Drawings C-2 and C-3 within Pettibone Creek and summarized on Table 6-1.

6.5.4 J-HOOK VANES

J-hook vanes are proposed at steam locations directly upstream of engineered wetlands in order to begin the diversion of high flows into the engineered flood plains provided by the engineered side channel wetlands. The longevity of J-hook vanes would essentially by permanent if all other stream stabilization measures are implemented.

J-Hook vanes (Detail 3 of Sheet 7) are linear structures that extend out from the stream bank into the stream channel in an upstream direction. They essentially mimic the effect of a tree partially falling into the stream. They are usually placed along the stream bank where erosion is occurring along the toe of the slope. The purpose of vanes is to reduce erosion along the stream bank by redirecting the stream flow toward the center of the stream. In addition, they tend to create scour pools on the downstream side.

Vanes can be made of rock or log. They grade down from the bankfull elevation at the stream bank to the channel invert at their terminus in the stream. Vanes generally extend out from the stream bank 1/3 of the bankfull width and are angled upstream from the bank at a 20 to 30 degree angle. They should be carefully located and installed so as not to produce additional erosion on the upstream side where they meet the bank (eddy scour) or allow flows to outflank them, exacerbating existing bank erosion problems. The only difference between the log vane and the rock vane is the material used.

The J–Hook vane is basically the same as a rock vane with the exception that it curls around at the end in the shape of a "J." The curved end portion serves to enhance downstream scour pool formation. The rock vane is constructed by first excavating a trench for the footer stones. The footer stones are then placed in the trench so that there is a gap between them equal to 1/3 of the stone diameter. This gap will allow the vane stones to interlock with the footer stones. The vane stones should be placed on top of the footer stones so they are staggered over two adjacent footer stones and skewed slightly upstream of the footer stones. As the vane is built out and slopes down from the bank, footer stones will become unnecessary when the vane stones can be placed in the trench and extend up to achieve the desired elevation. J-Hook vanes have significant habitat enhancement potential through the creation of downstream scour pools, narrowing and deepening of the base flow channel, and the enhancement of

riffle habitat along the upstream side. Drawings C-2 and C-3 depict the proposed locations of J-Hook Vanes along the stream bank of Pettibone Creek and are summarized on Table 6-1.

6.5.5 LUNKERS

Little Underwater Neighborhood Keepers Encompassing Rheotactic Salmonids (LUNKERS) are a technique to provide both stream bank stability and edge cover aquatic habitat. The location of the proposed LIUNKER systems (Detail 1 of Sheet C-7) were chosen based on visual observation of stream bank deterioration areas not subject to extreme stream velocities such as present in stream bends. A guidance document on the design and installation is provided for reference in Appendix N.

LUNKERS are crib-like, wooden structures installed along the toe of a stream bank to create overhead bank cover and resting areas for fish. These structures were originally developed in Wisconsin for trout stream habitat improvement projects, but have been found to work well in midwestern streams as bank protection devices.

A LUNKER consists of two planks with wooden spacers nailed between them. Additional planks are nailed across the spacers perpendicular and a crib like structure is formed. The structure is installed by first grading the stream bank back and creating a trench along the new bank line. This trench must be wide and deep enough so that the lunkers lay flat and are completely covered by water. The LUNKERS are secured to the stream bottom with rebar. Once in place, rock is placed on top of and behind the LUNKERS and the stream bank is graded down to meet the front edge of the LUNKER. The upper bank is then stabilized using bank stabilization techniques.

LUNKERS were originally developed as habitat enhancement structures. As such, they have a significant potential to improve stream habitat in the form of undercut banks and overhead cover. Drawings C-2 and C-3 depicts the proposed locations of LUNKERs along the stream bank of Pettibone Creek and are summarized on Table 6-1.

6.5.6 SOIL LOSS CALCULATION/RECOMMENDED ENERGY DISSAPATION STRUCTURE

The headwaters of the North Branch of Pettibone Creek are fed by a 60-inch and twin, 48-inch set of culverts emanating west of Sheridan Road. Soil loss calculations were performed to estimate the potential yearly loss of soil from erosion. It should be noted that, according to discussions with local Department of Agriculture personnel, the soil maps for Lake County are currently being revised to account for rapidly increased urbanization in the vicinity of the Naval Station Great Lakes. Therefore, current soil loss calculations are likely high due to the limitations imposed and the nature of the available soil data. Refer to Appendix O for the soil loss calculation using the RUSLE2 computer program.

With regard to the potential of installing a concrete settling basin to be constructed over the existing scour pool formed at the headwaters of Pettibone Creek where existing piping drains the upstream watershed, many factors were evaluated and include:

- Impact to the hydraulics at the piping outlet;
- Existing storm water flows;
- Available particle settling times; and,
- Constructability issues.

Each of these aspects is detailed herein.

Impact to the hydraulics at the piping outlet

The maximum height (elevation) of the walls of a constructed sediment containment basin should not exceed the lowest invert elevation of the existing piping. Extending the height of the walls of this structure would lead to surcharging of the existing culverts and potentially lead to backflows during peak flow periods increasing flooding potential in the drainage basin feeding the North Branch of Pettibone Creek. The Pettibone Creek watershed, as with many watershed surrounding the region, are susceptible to flooding given the relatively flat terrain and increased urbanization in recent years.

Additionally, given that the maximum wall height must be kept at or below the invert of the existing culverts, the resultant basin would essentially be submerged and the flow from the existing culverts would essentially fall onto the open surface of standing water, which is essentially the current situation (ie, a scour pool formed). Under larger storm events (i.e., 25 to 100 year storm events), flow from the existing culverts would be with enough velocity and force to essentially bypass or "flow over" the basin. The greatest potential for increased sediment loads from the contributing watershed would be under the occurrence of these storms.

Existing storm water flows

The Illinois Department of Transportation culverts control the flow of Pettibone Creek that discharges onto the Naval Station Great Lakes property. Stormwater systems are typically designed for 10 year storms. It was reported that the typical flow of Pettibone Creek is estimated to be 10 cfs and at this time of typical flow the culverts is flowing between 1/4 to 1/3 full, however a scour pool is located at the discharge point which may submerge part of the invert of the culverts. Based on the hydrologic study, the 10 year storm has a flow of approximately 390 cfs. The available flow capacity provided by the existing culverts is at most 220 cfs or almost 100,000 gpm at full flow conditions.

Available settling particle settling times

A cursory review of the particle settling was performed for a concrete settling basin roughly estimated to be 50 feet square and six feet deep. Given the limited storage volume that a concrete basin would provide versus the estimated soil losses from the contributing watershed, the time required for particle settling would most likely not be available for the given structure. Typical settling times for silt and clay particles are 2.5 to 24 hours. A settling basin of this size would provide settling times orders of magnitude less than what would likely be required during large storm events.

Constructability issues

The headwaters of the Northern Branch of Pettibone Creek are comprised of a scour pool formed by the flows from existing culverts draining the contributing watershed bounded by steep ravines on either side, thus limiting available space for constructing a basin in this area.

A more beneficial approach to addressing the velocity and energy of flows from the existing system of culverts at the headwaters and the associated sediments may be to construct and energy dissipation apron comprised of concrete with energy dissipation block ramp, followed by a revetment pad, and finally an engineered scour pool with designed weir.

6.5.7 ENGINEERED SIDE CHANNEL WETLANDS

Engineered side channel wetlands (see proposed locations on Drawings C-2 and C-3) are recommended to provide flood plains where sediment can deposit and accumulate in a controlled manner. Specifically, the design of meandering channels and increased flood plain storage is proposed to reduce storm water runoff rates from upstream sediments conveyed to the North Branch of Pettibone Creek. The design will reduce channel dimensions such that overflows into flood plain side channel wetlands will store additional floodwaters and reduce sediment transport to the Base Boat Basin. Three (3) engineered side channel wetlands (A, B, and C) are proposed as shown on Drawings C-4, C-5 and C-6 including cross sections and proposed berm elevations. The recommended plant list for the engineered side channel wetlands include:

Bank (upper, drier areas)

Shrubs

- Rough-leaved Dogwood (*Cornus drummondii*) or
- Gray Dogwood (*Cornus racemosa)*
- Nannyberry (*Viburnum lentago*)
- Arrow wood Viburnum (*Viburnum dentatum)*

Herbaceous

- Switch grass (*Panicum virgatum*) (plugs and seed)
- Big bluestem (*Andropogon gerardii*) (plugs and seed)
- Indian grass (*Sorghastrum nutans*)
- Canada wildrye (*Elymus canadensis*) or Virginia wildrye (*E. virginicus*) (seed only)

Bank Stabilization (lower, moist areas)

Trees/Shrubs

- Red osier dogwood (*Cornus sericea*)
- Sandbar Willow (*Salix interior*) (use as whips in embankment)
- Black Willow (*Salix nigra*)

Herbaceous

- Chairmaker's rush (*Scirpus americanus*) (plugs)
- *Carex* species (*C. vulpinoidea*, depends on nursery stock)(plugs)
- Rice cut grass (*Leersia oryzoides*) (plugs)

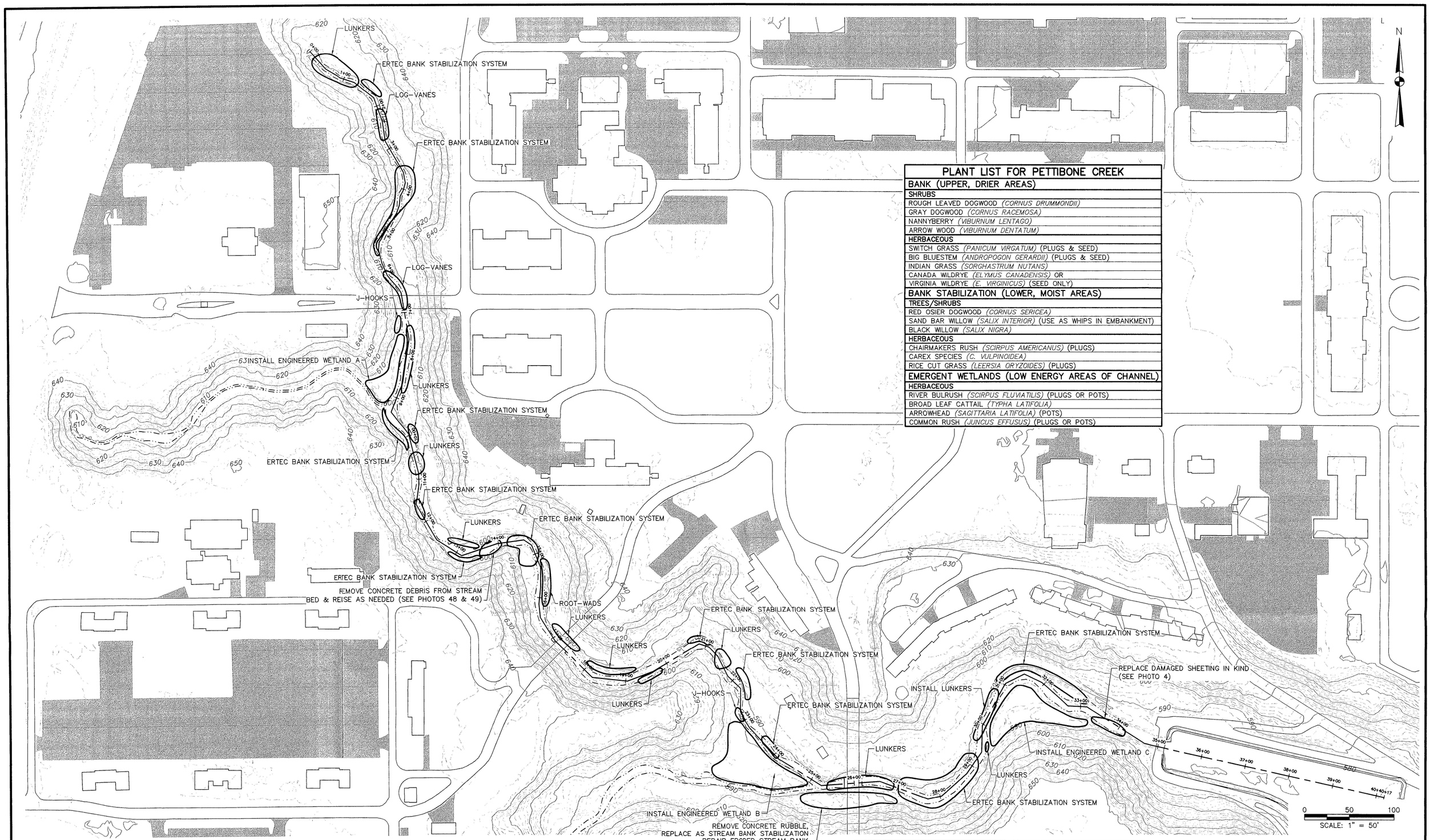
Emergent Wetland (low energy areas of Channel)

Herbaceous

- River bulrush (*Scirpus fluviatilis*) (plugs or pots)
- Broad-leaved Cattail (*Typha latifolia*)
- Arrowhead (*Sagittaria latifolia*) (pots)
- Common rush (*Juncus effusus*) (plugs or pots)

TABLE 6-1
PETTIBONE CREEK REMEDIAL ACTION TABLE
NAVAL STATION GREAT LAKES, GREAT LAKES, ILLINOIS

STATIONS	BANK	REMEDIAL ACTION TO BE TAKEN	Reference
0+10 to 1+80	Right	Lunkers.	--
0+25 to 1+80	Left	Lunkers.	--
1+80 to 1+95	Left	ERTEC Bank Stabilization System.	See photo 55.
1+85	--	Remove Fallen Tree Spanning Stream.	See photo 55.
1+95 to 2+55	--	Log Vanes.	See photo 53.
3+20 to 5+85	Right	ERTEC Bank Stabilization System.	See photo 52.
3+30 to 4+25	Left	ERTEC Bank Stabilization System.	See photo 52.
6+15 to 6+95	--	Log Vanes.	See photo 52.
7+00 to 7+35	Right	J-Hooks.	--
7+80 to 9+20	Left	Lunkers.	See photo 45.
7+95 to 9+00	Right	Engineered Wetlands A.	See Drawing C-4, See Photos 44, 46, & 47.
9+20 to 10+20	Right	ERTEC Bank Stabilization System.	See photo 41.
9+90 to 10+20	Left	ERTEC Bank Stabilization System.	See photo 41.
10+20 to 11+05	Right	Lunkers.	--
10+20 to 11+00	Left	Lunkers.	--
11+30 to 11+60	Right	ERTEC Bank Stabilization System.	See photo 41.
12+80 to 13+20	Left	Lunkers.	
12+85 to 13+50	Right	ERTEC Bank Stabilization System.	See photo 35.
13+50 to 14+05	--	Remove Concrete Debris From Stream Bed and Reuse as Needed.	See Photos 48 & 49.
14+10 to 15+00	Left	ERTEC Bank Stabilization System.	--
14+15 to 15+05	Right	ERTEC Bank Stabilization System.	--
15+10 to 16+90	Left	Root wad system.	See photo 34.
16+00 to 17+40	Right	Lunkers.	See photo 34.
17+00 to 17+40	Left	Lunkers.	See photo 34.
17+95 to 18+05	Left	Lunkers.	See photo 33.
19+65 to 20+00	Right	Lunkers.	See Photos 28 & 30.
20+50 to 21+05	Left	ERTEC Bank Stabilization System.	See Photos 28 & 30.
21+40 to 21+95	Left	Lunkers.	See photo 26.
21+45 to 21+95	Right	Lunkers.	See photo 26.
22+05 to 22+50	Left	ERTEC Bank Stabilization System.	--
22+40 to 22+90	Right	J-Hooks	--
22+90 to 24+75	Right	Install Engineered Wetlands B.	See Drawing C-5.
23+65 to 23+95	Left	ERTEC Bank Stabilization System.	See photo 23.
24+90 to 27+05	Right	Remove Concrete Rubble, Reuse as Stream Bank Stabilization as Required. Repair Eroded Stream Bank.	See Figure 6-9, See Photo 16.
25+30 to 26+90	Right	Lunkers.	See photo 16.
25+35 to 26+90	Left	Lunkers.	See photo 16.
27+15 to 28+80	Right	ERTEC Bank Stabilization System.	See photo 15.
27+15 to 28+75	Left	ERTEC Bank Stabilization System.	See photo 15.
29+20 to 29+40	Right	Lunkers.	--
29+40 to 33+35	Right	Install Engineered Wetlands C.	See Drawing C-6.
29+85 to 30+85	Left	Lunkers.	--
31+10 to 32+15	Left	Remove Accumulated Sediment From Stream Bank, Stabilize Channel Bank With ERTEC Bank Stabilization System.	See Photo 8.
33+45 to 34+15	Right	Replace damaged Sheeting in Kind.	See Photo 4.



PLANT LIST FOR PETTIBONE CREEK

BANK (UPPER, DRIER AREAS)	
SHRUBS	
ROUGH LEAVED DOGWOOD *(CORNUS DRUMMONDII)*	
GRAY DOGWOOD *(CORNUS RACEMOSA)*	
NANNYBERRY *(VIBURNUM LENTAGO)*	
ARROW WOOD *(VIBURNUM DENTATUM)*	
HERBACEOUS	
SWITCH GRASS *(PANICUM VIRGATUM)* (PLUGS & SEED)	
BIG BLUESTEM *(ANDROPOGON GERARDII)* (PLUGS & SEED)	
INDIAN GRASS *(SORGHASTRUM NUTANS)*	
CANADA WILDRYE *(ELYMUS CANADENSIS)* OR	
VIRGINIA WILDRYE *(E. VIRGINICUS)* (SEED ONLY)	
BANK STABILIZATION (LOWER, MOIST AREAS)	
TREES/SHRUBS	
RED OSIER DOGWOOD *(CORNUS SERICEA)*	
SAND BAR WILLOW *(SALIX INTERIOR)* (USE AS WHIPS IN EMBANKMENT)	
BLACK WILLOW *(SALIX NIGRA)*	
HERBACEOUS	
CHAIRMAKERS RUSH *(SCIRPUS AMERICANUS)* (PLUGS)	
CAREX SPECIES *(C. VULPINOIDEA)*	
RICE CUT GRASS *(LEERSIA ORYZOIDES)* (PLUGS)	
EMERGENT WETLANDS (LOW ENERGY AREAS OF CHANNEL)	
HERBACEOUS	
RIVER BULRUSH *(SCIRPUS FLUVIATILIS)* (PLUGS OR POTS)	
BROAD LEAF CATTAIL *(TYPHA LATIFOLIA)*	
ARROWHEAD *(SAGITTARIA LATIFOLIA)* (POTS)	
COMMON RUSH *(JUNCUS EFFUSUS)* (PLUGS OR POTS)	

DRAWN BY BH	DATE 7/27/11	
CHECKED BY RLS	DATE 7/27/11	
REVISED BY	DATE	
SCALE 1" = 100'		

NAVFAC

OVERALL SITE PLAN
PROPOSED REMEDIAL ACTION PLAN
NS GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NO. N62467-04-D-0055	
OWNER NO. 474	
APPROVED BY ---	DATE ---
DRAWING NO. C-1	REV. 0

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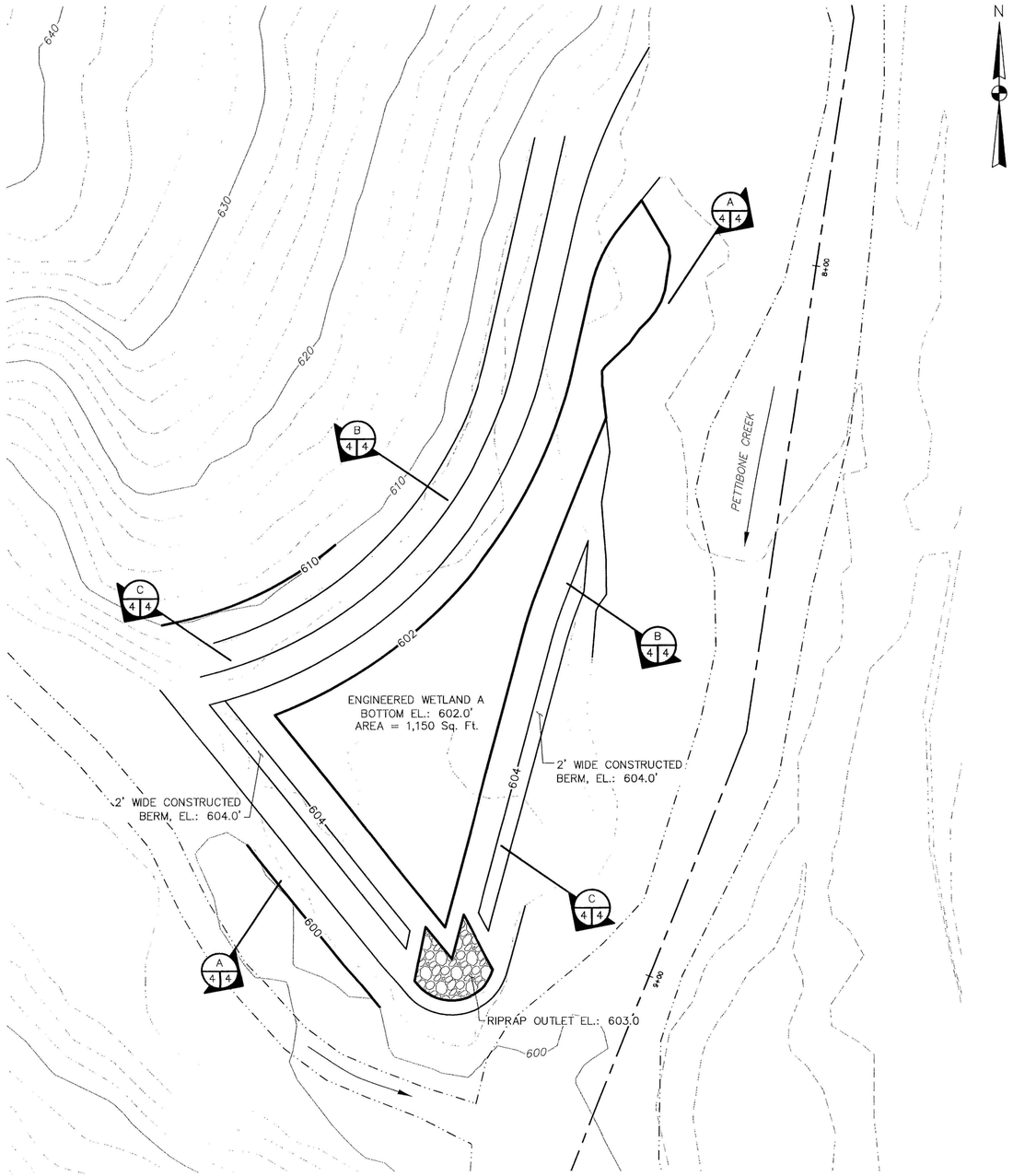
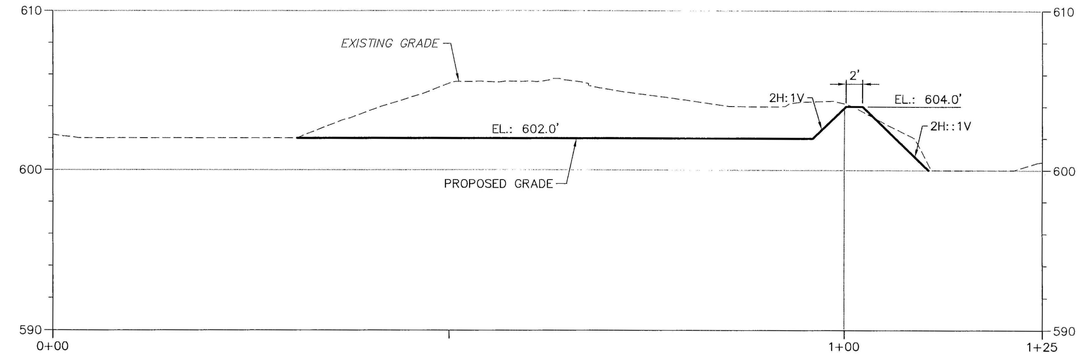


PLAN VIEW

SCALE: 1" = 10'

0 10 20

SCALE: 1" = 10'



SECTION A 4 4

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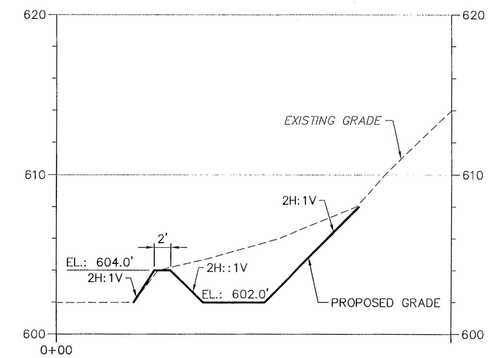

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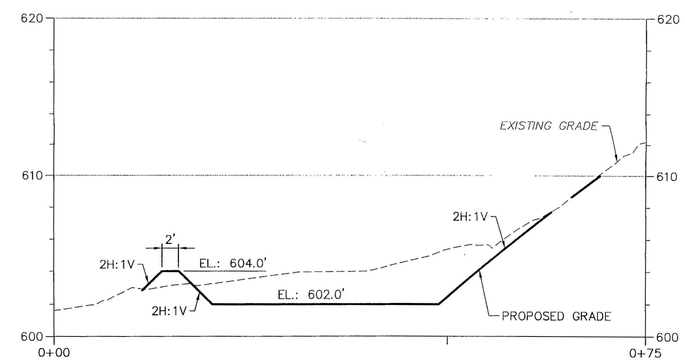

SECTION C 4 4

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HORIZONTAL SCALE: 1" = 10'

0 5 10
VERTICAL SCALE: 1" = 5'

DRAWN BY BH	DATE 7/27/11	NAVFAC	ENGINEERED WETLAND A PROPOSED GRADING & SECTIONS PROPOSED REMEDIAL ACTION PLAN NS GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. N62467-04-D-0055
CHECKED BY RLS	DATE 7/27/11			OWNER NO. 474
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. C-4 / REV. 0

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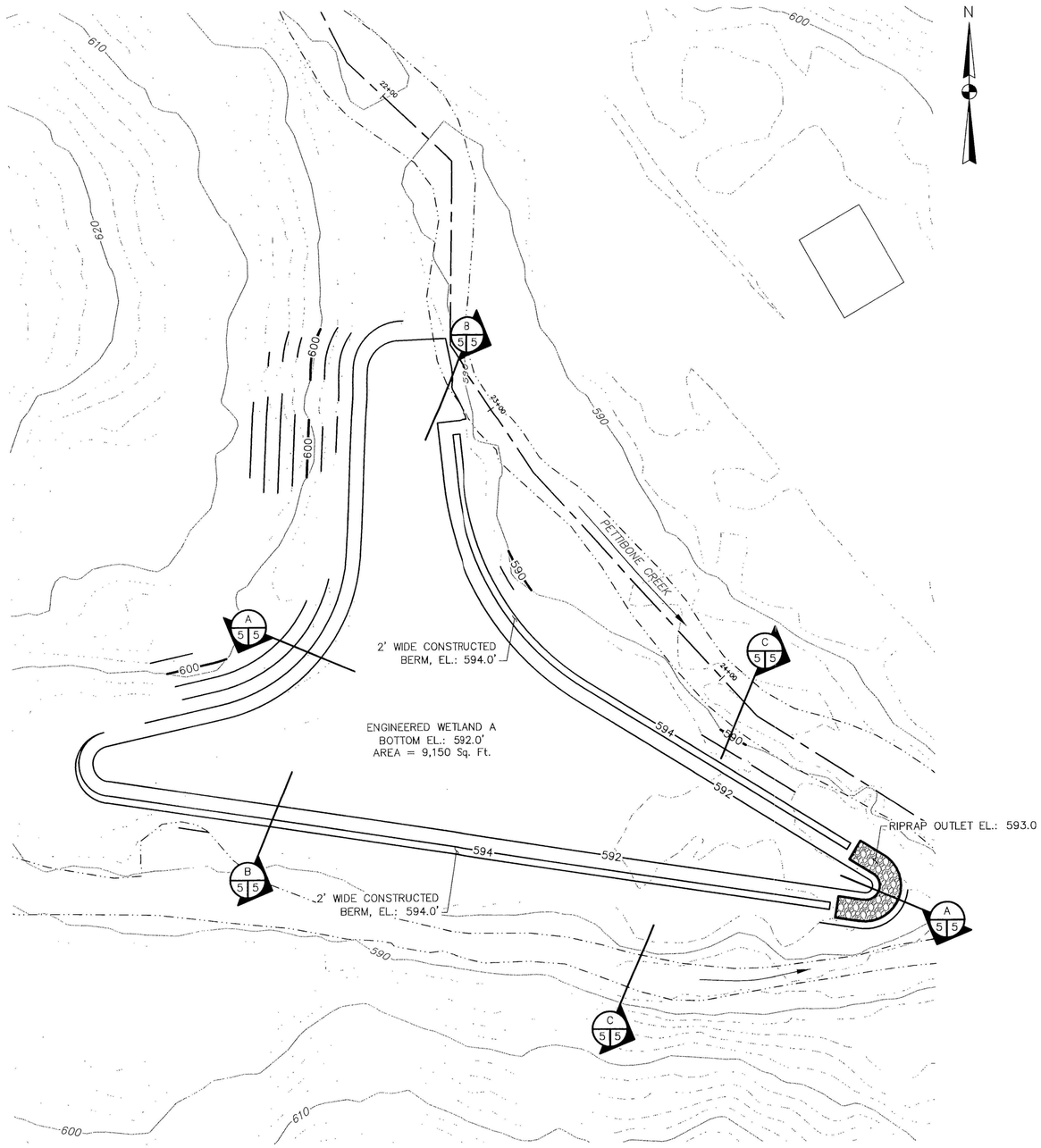

PLAN VIEW

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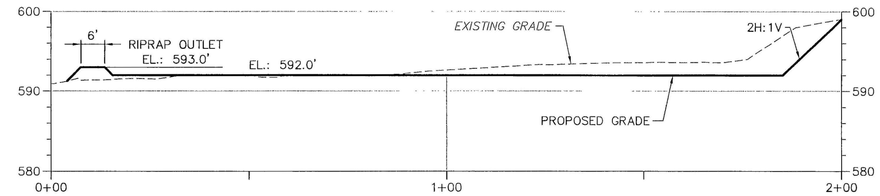
0 20 40

SCALE: 1" = 20'



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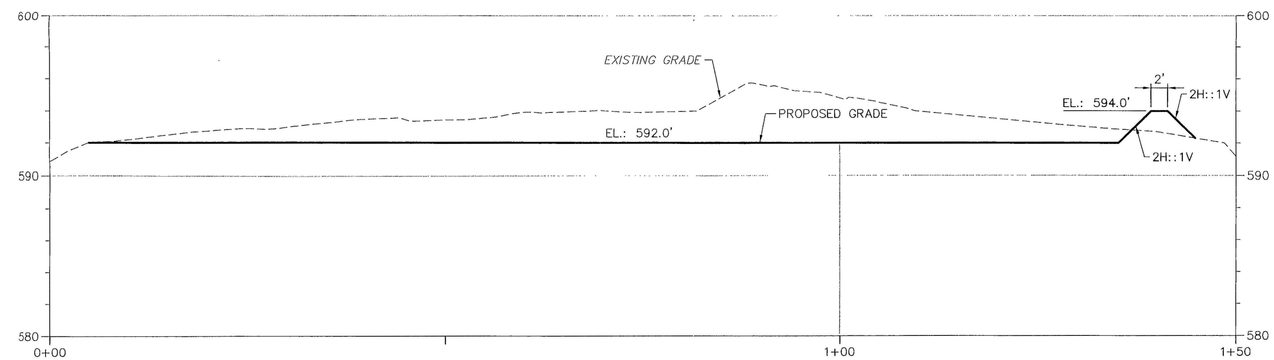

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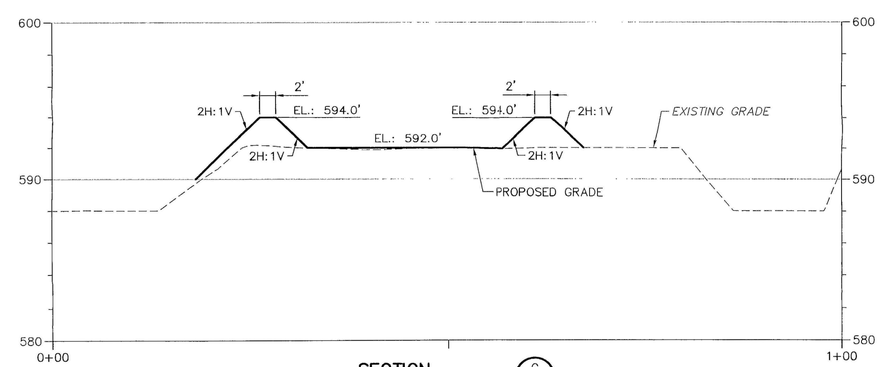

SECTION C 5 5

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VERT: 1" = 5'

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HORIZONTAL SCALE: 1" = 10'

0 5 10
VERTICAL SCALE: 1" = 5'

DRAWN BY BH	DATE 7/27/11	ENGINEERED WETLAND B PROPOSED GRADING & SECTIONS PROPOSED REMEDIAL ACTION PLAN NS GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. N62467-04-D-0055
CHECKED BY RLS	DATE 7/27/11		OWNER NO. 474
REVISED BY	DATE		APPROVED BY / DATE
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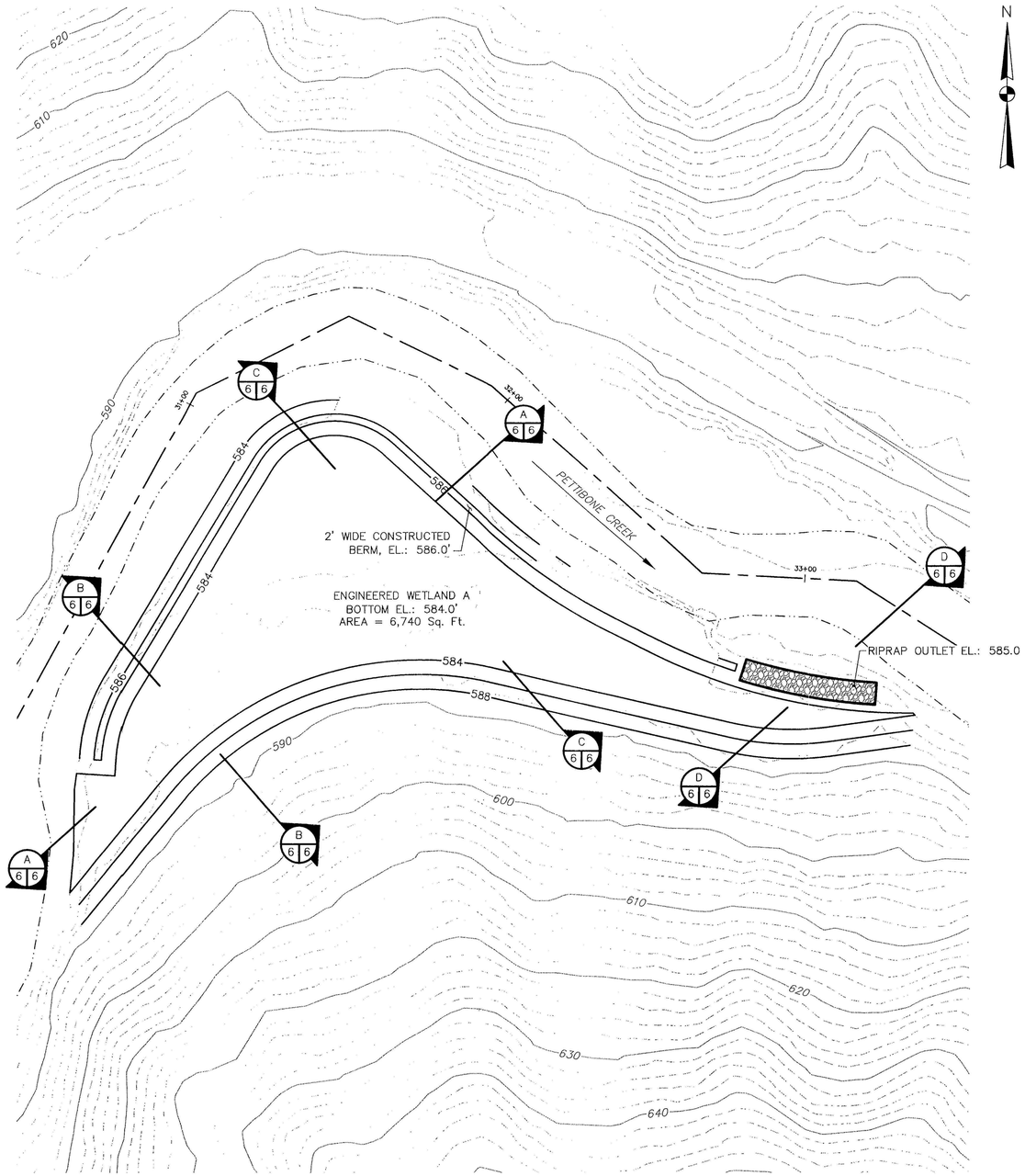
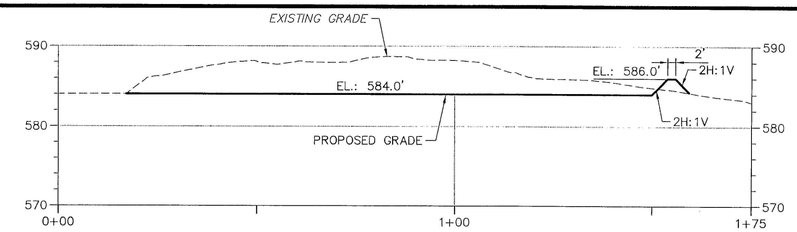


PLAN VIEW

SCALE: 1' = 20'

0 20 40

SCALE: 1" = 20'



SECTION A 6 6

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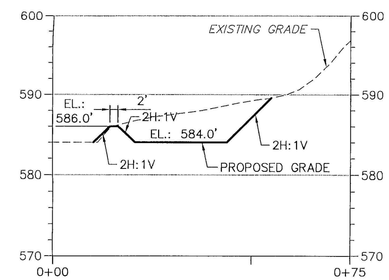

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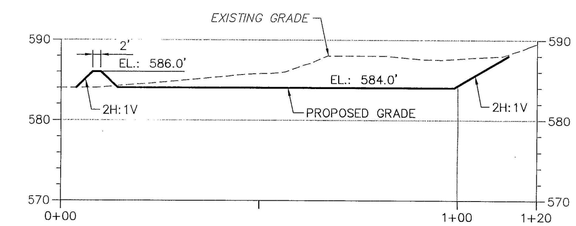

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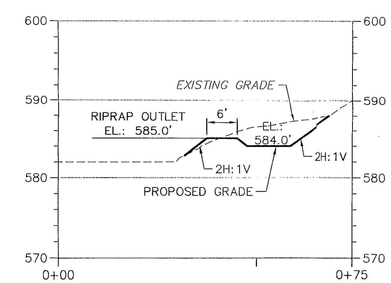

SECTION D 6 6

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VERT: 1" = 10'

0 20 40
HORIZONTAL SCALE: 1" = 20'

0 10 20
VERTICAL SCALE: 1" = 10'

DRAWN BY BH	DATE 7/27/11	
CHECKED BY RLS	DATE 7/27/11	
REVISED BY	DATE	
SCALE AS NOTED		

NAVFAC

ENGINEERED WETLAND C
PROPOSED GRADING & SECTIONS
PROPOSED REMEDIAL ACTION PLAN
NS GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NO. N62467-04-D-0055	
OWNER NO. 474	
APPROVED BY	DATE
DRAWING NO. C-6	REV. 0

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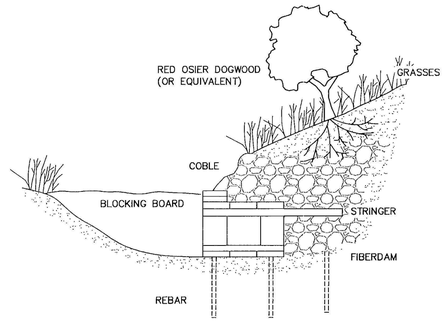
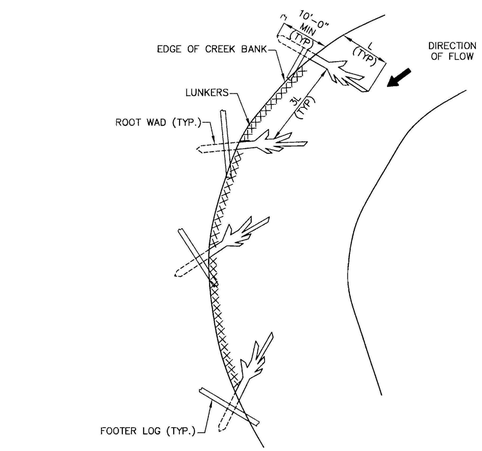
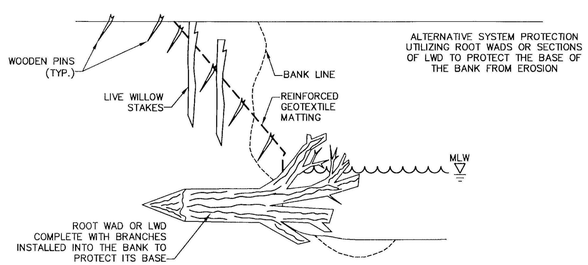


LUNKER DETAIL (1/7)
NOT TO SCALE

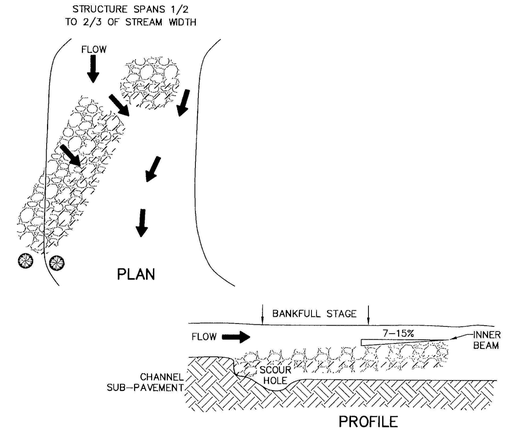


PLAN



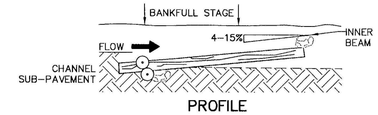
CROSS–SECTION

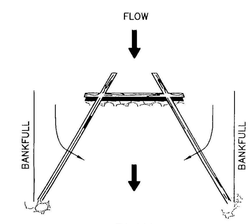
ROOT–WAD DETAIL (2/7)
NOT TO SCALE

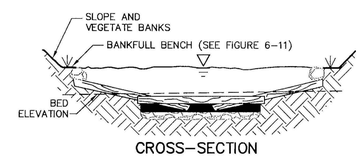


LEGEND:
- HEADER ROCK
- FOOTER ROCK
- VEGETATION

J–HOOK DETAIL (3/7)
NOT TO SCALE







LEGEND:
- HEADER ROCK
- HEADER LOG
- FOOTER LOG
- VEGETATION

LOG–VANE DETAIL (4/7)
NOT TO SCALE

DRAWN BY BH	DATE 7/29/11	CONSTRUCTION DETAILS PROPOSED REMEDIAL ACTION PLAN NS GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. N62467–04–D–0055
CHECKED BY RLS	DATE 7/29/11		OWNER NO. 474
REVISED BY	DATE		APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. C–7 / REV. 0

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MATCHLINE A

PLANT LIST FOR PETTIBONE CREEK
BANK (UPPER, DRIER AREAS)
SHRUBS
ROUGH LEAVED DOGWOOD *(CORNUS DRUMMONDII)*
GRAY DOGWOOD *(CORNUS RACEMOSA)*
NANNYBERRY *(VIBURNUM LENTAGO)*
ARROW WOOD *(VIBURNUM DENTATUM)*
HERBACEOUS
SWITCH GRASS *(PANICUM VIRGATUM)* (PLUGS & SEED)
BIG BLUESTEM *(ANDROPOGON GERARDII)* (PLUGS & SEED)
INDIAN GRASS *(SORGHASTRUM NUTANS)*
CANADA WILDRYE *(ELYMUS CANADENSIS)* OR
VIRGINIA WILDRYE *(E. VIRGINICUS)* (SEED ONLY)
BANK STABILIZATION (LOWER, MOIST AREAS)
TREES/SHRUBS
RED OSIER DOGWOOD *(CORNUS SERICEA)*
SAND BAR WILLOW *(SALIX INTERIOR)* (USE AS WHIPS IN EMBANKMENT)
BLACK WILLOW *(SALIX NIGRA)*
HERBACEOUS
CHAIRMAKERS RUSH *(SCIRPUS AMERICANUS)* (PLUGS)
CAREX SPECIES *(C. VULPINOIDEA)*
RICE CUT GRASS *(LEERSIA ORYZOIDES)* (PLUGS)
EMERGENT WETLANDS (LOW ENERGY AREAS OF CHANNEL)
HERBACEOUS
RIVER BULRUSH *(SCIRPUS FLUVIATILIS)* (PLUGS OR POTS)
BROAD LEAF CATTAIL *(TYPHA LATIFOLIA)*
ARROWHEAD *(SAGITTARIA LATIFOLIA)* (POTS)
COMMON RUSH *(JUNCUS EFFUSUS)* (PLUGS OR POTS)

ERTEC BANK STABILIZATION SYSTEM (PHOTOS 28 & 30)

LUNKERS (PHOTO 26)

LUNKERS (PHOTOS 28 & 30)

J-HOOKS (TYP.), SEE DETAIL 3/7

ERTEC BANK STABILIZATION SYSTEM (SEE PHOTO 23)

LUNKERS (TYP.), (SEE PHOTO 16), SEE DETAIL 1/7

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 15), SEE DETAIL

INSTALL ENGINEERED WETLAND B (SEE DRAWING C-5)

REMOVE CONCRETE RUBBLE, REUSE AS STREAM BANK STABILIZATION AS REQUIRED REPAIR ERODED STREAM BANK (SEE FIGURE 6-9, SEE PHOTO 16)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 15), SEE DETAIL

REMOVE ACCUMULATED SEDIMENT FROM STREAM BANK, STABILIZE CHANNEL BANK WITH ERTEC BANK STABILIZATION SYSTEM (SEE PHOTO 8)

REPLACE DAMAGED SHEETING IN KIND (SEE PHOTO 4)

INSTALL ENGINEERED WETLAND C (SEE DRAWING C-6)

N

LEGEND

- ENGINEERED SIDE CHANNEL WETLANDS
- LUNKERS
- ROOT WADS
- LOG VANES
- J-HOOKS
- ERTEC BANK STABILIZATION

0 50 100

SCALE: 1" = 50'

MATCHLINE A

DRAWN BY BH	DATE 7/27/11	NAVFAC	SITE PLAN (SHEET 2 OF 2) PROPOSED REMEDIAL ACTION PLAN NS GREAT LAKES GREAT LAKES, ILLINOIS
CHECKED BY RLS	DATE 7/27/11		CONTRACT NO. N62467-04-D-0055
REVISED BY	DATE		OWNER NO. 474
SCALE ---			APPROVED BY --- / DATE ---
			DRAWING NO. C-3 / REV. 0

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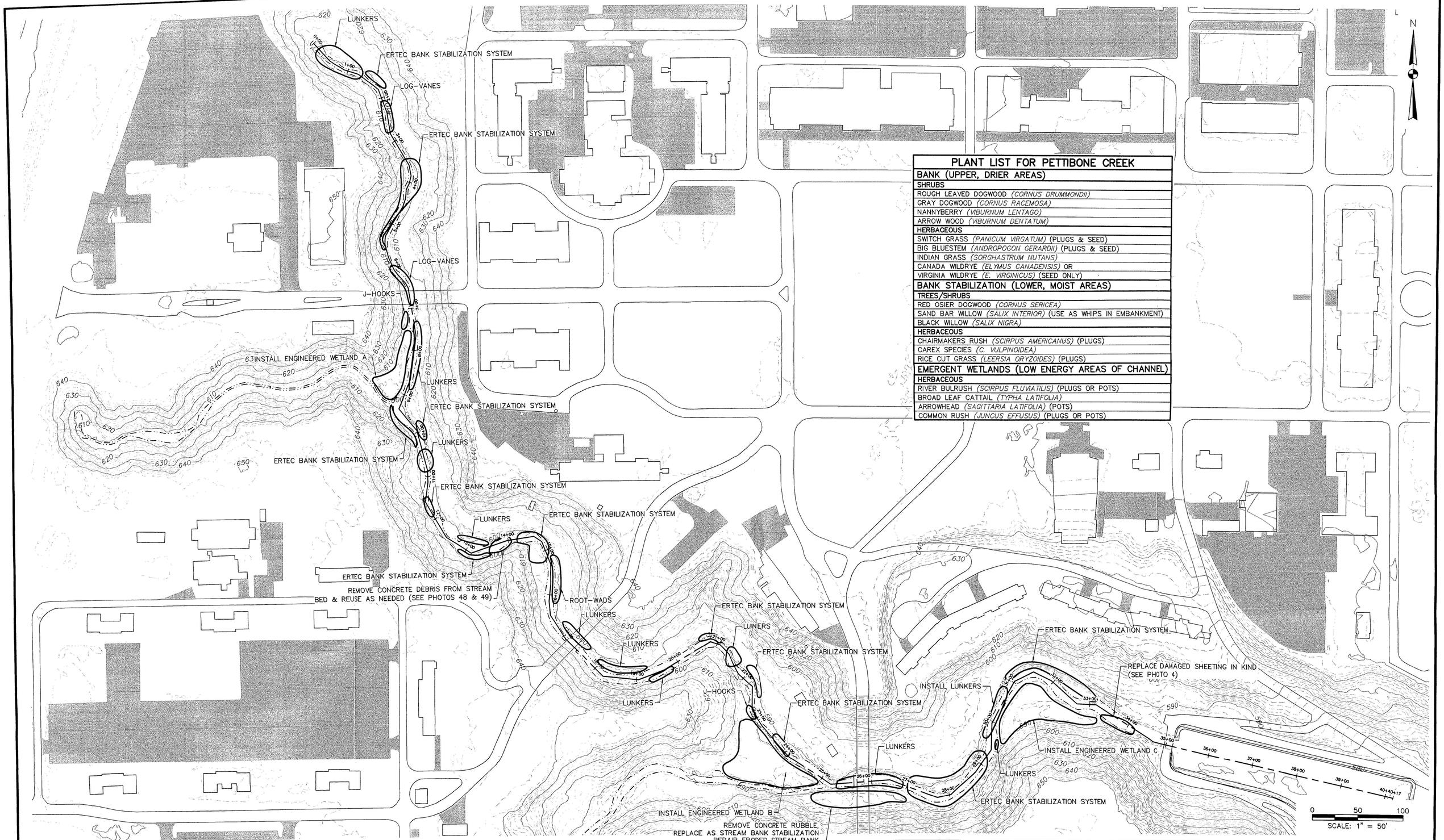

PLANT LIST FOR PETTIBONE CREEK

BANK (UPPER, DRIER AREAS)	
SHRUBS	
ROUGH LEAVED DOGWOOD *(CORNUS DRUMMONDII)*	
GRAY DOGWOOD *(CORNUS RACEMOSA)*	
NANNYBERRY *(VIBURNUM LENTAGO)*	
ARROW WOOD *(VIBURNUM DENTATUM)*	
HERBACEOUS	
SWITCH GRASS *(PANICUM VIRGATUM)* (PLUGS & SEED)	
BIG BLUESTEM *(ANDROPOGON GERARDII)* (PLUGS & SEED)	
INDIAN GRASS *(SORGHASTRUM NUTANS)*	
CANADA WILDRYE *(ELYMUS CANADENSIS)* OR	
VIRGINIA WILDRYE *(E. VIRGINICUS)* (SEED ONLY)	
BANK STABILIZATION (LOWER, MOIST AREAS)	
TREES/SHRUBS	
RED OSIER DOGWOOD *(CORNUS SERICEA)*	
SAND BAR WILLOW *(SALIX INTERIOR)* (USE AS WHIPS IN EMBANKMENT)	
BLACK WILLOW *(SALIX NIGRA)*	
HERBACEOUS	
CHAIRMAKERS RUSH *(SCIRPUS AMERICANUS)* (PLUGS)	
CAREX SPECIES *(C. VULPINOIDEA)*	
RICE CUT GRASS *(LEERSIA ORYZOIDES)* (PLUGS)	
EMERGENT WETLANDS (LOW ENERGY AREAS OF CHANNEL)	
HERBACEOUS	
RIVER BULRUSH *(SCIRPUS FLUVIATILIS)* (PLUGS OR POTS)	
BROAD LEAF CATTAIL *(TYPHA LATIFOLIA)*	
ARROWHEAD *(SAGITTARIA LATIFOLIA)* (POTS)	
COMMON RUSH *(JUNCUS EFFUSUS)* (PLUGS OR POTS)	

DRAWN BY BH	DATE 7/27/11
CHECKED BY RLS	DATE 7/27/11
REVISED BY	DATE
SCALE 1" = 100'	

NAVFAC

OVERALL SITE PLAN
PROPOSED REMEDIAL ACTION PLAN
NS GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NO. N62467-04-D-0055	
OWNER NO. 474	
APPROVED BY ---	DATE ---
DRAWING NO. C-1	REV. 0

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MATCHLINE A

MATCHLINE A

N

PLANT LIST FOR PETTIBONE CREEK

BANK (UPPER, DRIER AREAS)	
SHRUBS	
ROUGH LEAVED DOGWOOD *(CORNUS DRUMMONDII)*	
GRAY DOGWOOD *(CORNUS RACEMOSA)*	
NANNYBERRY *(VIBURNUM LENTAGO)*	
ARROW WOOD *(VIBURNUM DENTATUM)*	
HERBACEOUS	
SWITCH GRASS *(PANICUM VIRGATUM)*	(PLUGS & SEED)
BIG BLUESTEM *(ANDROPOGON GERARDII)*	(PLUGS & SEED)
INDIAN GRASS *(SORGHASTRUM NUTANS)*	
CANADA WILDRYE *(ELYMUS CANADENSIS)*	OR
VIRGINIA WILDRYE *(E. VIRGINICUS)*	(SEED ONLY)
BANK STABILIZATION (LOWER, MOIST AREAS)	
TREES/SHRUBS	
RED OSIER DOGWOOD *(CORNUS SERICEA)*	
SAND BAR WILLOW *(SALIX INTERIOR)*	(USE AS WHIPS IN EMBANKMENT)
BLACK WILLOW *(SALIX NIGRA)*	
HERBACEOUS	
CHAIRMAKERS RUSH *(SCIRPUS AMERICANUS)*	(PLUGS)
CAREX SPECIES *(C. VULPINOIDEA)*	
RICE CUT GRASS *(LEERSIA ORYZOIDES)*	(PLUGS)
EMERGENT WETLANDS (LOW ENERGY AREAS OF CHANNEL)	
HERBACEOUS	
RIVER BULRUSH *(SCIRPUS FLUVIATILIS)*	(PLUGS OR POTS)
BROAD LEAF CATTAIL *(TYPHA LATIFOLIA)*	
ARROWHEAD *(SAGITTARIA LATIFOLIA)*	(POTS)
COMMON RUSH *(JUNCUS EFFUSUS)*	(PLUGS OR POTS)

LUNKERS (SEE PHOTO 33)

LUNKERS (SEE PHOTO 34)

REMOVE & REPLACE EXISTING CONCRETE BLOCK & REPLACE WITH ROOT WAD SYSTEM (SEE PHOTO 34), SEE DETAIL 2/7

REMOVE CONCRETE DEBRIS FROM STREAM BED & REUSE AS NEEDED (SEE PHOTOS 48 & 49)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 35)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 52)

LOG VANES (SEE PHOTO 52)

LUNKERS (SEE PHOTO 45)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 55)

REMOVE FALLEN TREE SPANNING STREAM (SEE PHOTO 55)

J-HOOKS (TYP.), SEE DETAIL 3/7

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 41)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 41)

LOG VANES (TYP.) (SEE PHOTO 53), SEE DETAIL 4/7

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 54)

INSTALL ENGINEERED WETLAND A (SEE DRAWING C-4, SEE PHOTOS 44, 46 & 47)

LUNKERS (TYP.), SEE DETAIL 1/7

LEGEND

- ENGINEERED SIDE CHANNEL WETLANDS
- LUNKERS
- ROOT WADS
- LOG VANES
- J-HOOKS
- ERTEC BANK STABILIZATION

0 50 100

SCALE: 1" = 50'

DRAWN BY BH	DATE 7/27/11	NAVFAC	SITE PLAN (SHEET 1 OF 2) PROPOSED REMEDIAL ACTION PLAN NS GREAT LAKES GREAT LAKES, ILLINOIS
CHECKED BY RLS	DATE 7/27/11		
REVISED BY	DATE		
SCALE 1" = 50'			

CONTRACT NO. N62467-04-D-0055	
OWNER NO. 474	
APPROVED BY ---	DATE ---
DRAWING NO. C-2	REV. 0

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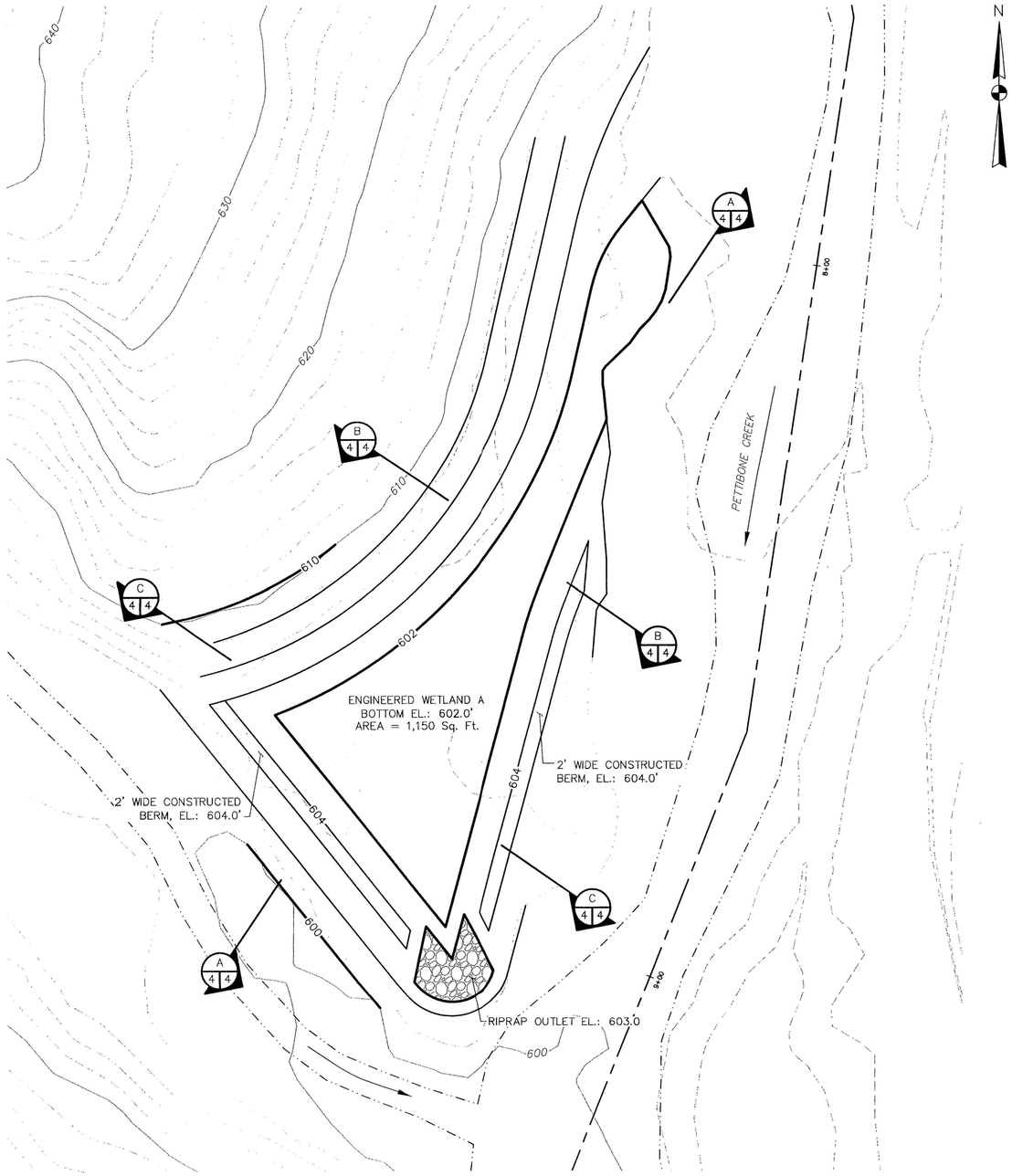
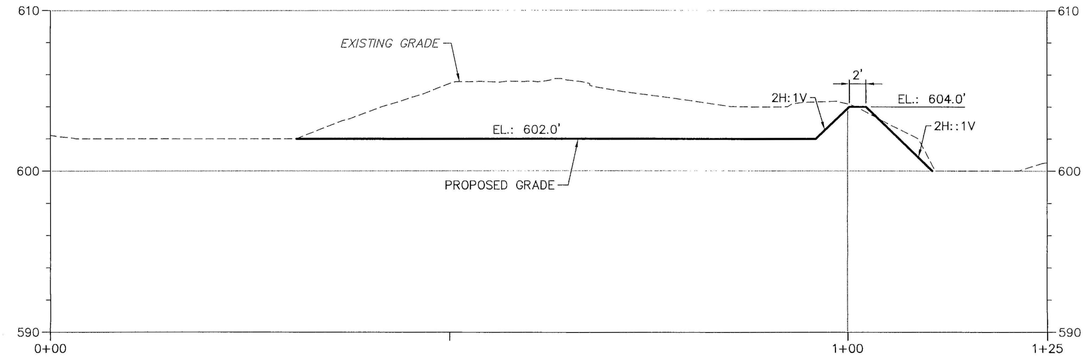


PLAN VIEW

SCALE: 1' = 10'

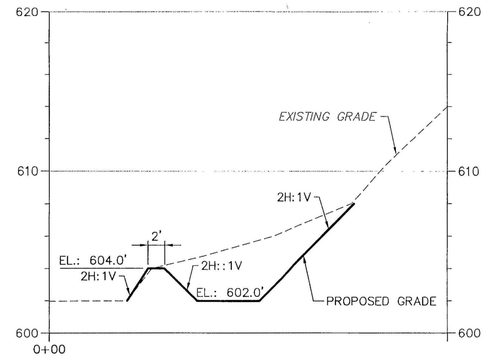
0 10 20

SCALE: 1" = 10'



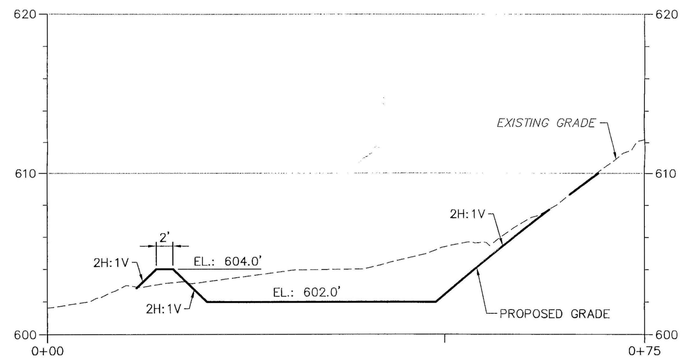
SECTION A 4 4

SCALE: HORIZ: 1" = 10'
VERT: 1" = 5'



SECTION B 4 4

SCALE: HORIZ: 1" = 10'
VERT: 1" = 5'



SECTION C 4 4

SCALE: HORIZ: 1" = 10'
VERT: 1" = 5'

0 10 20
HORIZONTAL SCALE: 1" = 10'

0 5 10
VERTICAL SCALE: 1" = 5'

DRAWN BY BH	DATE 7/27/11	ENGINEERED WETLAND A PROPOSED GRADING & SECTIONS PROPOSED REMEDIAL ACTION PLAN NS GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. N62467-04-D-0055
CHECKED BY RLS	DATE 7/27/11		OWNER NO. 474
REVISED BY	DATE		APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. C-4 / REV. 0

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MATCHLINE A

MATCHLINE A

PLANT LIST FOR PETTIBONE CREEK
BANK (UPPER, DRIER AREAS)
SHRUBS
ROUGH LEAVED DOGWOOD *(CORNUS DRUMMONDII)*
GRAY DOGWOOD *(CORNUS RACEMOSA)*
NANNYBERRY *(VIBURNUM LENTAGO)*
ARROW WOOD *(VIBURNUM DENTATUM)*
HERBACEOUS
SWITCH GRASS *(PANICUM VIRGATUM)* (PLUGS & SEED)
BIG BLUESTEM *(ANDROPOGON GERARDII)* (PLUGS & SEED)
INDIAN GRASS *(SORGHASTRUM NUTANS)*
CANADA WILDRYE *(ELYMUS CANADENSIS)* OR
VIRGINIA WILDRYE *(E. VIRGINICUS)* (SEED ONLY)
BANK STABILIZATION (LOWER, MOIST AREAS)
TREES/SHRUBS
RED OSIER DOGWOOD *(CORNUS SERICEA)*
SAND BAR WILLOW *(SALIX INTERIOR)* (USE AS WHIPS IN EMBANKMENT)
BLACK WILLOW *(SALIX NIGRA)*
HERBACEOUS
CHAIRMAKERS RUSH *(SCIRPUS AMERICANUS)* (PLUGS)
CAREX SPECIES *(C. VULPINOIDEA)*
RICE CUT GRASS *(LEERSIA ORYZOIDES)* (PLUGS)
EMERGENT WETLANDS (LOW ENERGY AREAS OF CHANNEL)
HERBACEOUS
RIVER BULRUSH *(SCIRPUS FLUVIATILIS)* (PLUGS OR POTS)
BROAD LEAF CATTAIL *(TYPHA LATIFOLIA)*
ARROWHEAD *(SAGITTARIA LATIFOLIA)* (POTS)
COMMON RUSH *(JUNCUS EFFUSUS)* (PLUGS OR POTS)

LUNKERS (SEE PHOTO 33)

LUNKERS (SEE PHOTO 34)

REMOVE & REPLACE EXISTING CONCRETE BLOCK & REPLACE WITH ROOT WAD SYSTEM (SEE PHOTO 34), SEE DETAIL 2/7

REMOVE CONCRETE DEBRIS FROM STREAM BED & REUSE AS NEEDED (SEE PHOTOS 48 & 49)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 35)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 52)

LOG VANES (SEE PHOTO 52)

LUNKERS (SEE PHOTO 45)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 55)

REMOVE FALLEN TREE SPANNING STREAM (SEE PHOTO 55)

J-HOOKS (TYP.), SEE DETAIL 3/7

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 41)

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 41)

LOG VANES (TYP.) (SEE PHOTO 53), SEE DETAIL 4/7

ERTEC BANK STABILIZATION SYSTEM, (SEE PHOTO 54)

LUNKERS (TYP.), SEE DETAIL 1/7

INSTALL ENGINEERED WETLAND A (SEE DRAWING C-4, SEE PHOTOS 44, 46 & 47)

LEGEND

- ENGINEERED SIDE CHANNEL WETLANDS
- LUNKERS
- ROOT WADS
- LOG VANES
- J-HOOKS
- ERTEC BANK STABILIZATION

0 50 100

SCALE: 1" = 50'

DRAWN BY BH	DATE 7/27/11	
CHECKED BY RLS	DATE 7/27/11	
REVISED BY	DATE	
SCALE 1" = 50'		NAVFAC

SITE PLAN (SHEET 1 OF 2)
PROPOSED REMEDIAL ACTION PLAN
NS GREAT LAKES
GREAT LAKES, ILLINOIS

CONTRACT NO. N62467-04-D-0055	
OWNER NO. 474	
APPROVED BY ---	DATE ---
DRAWING NO. C-2	REV. 0

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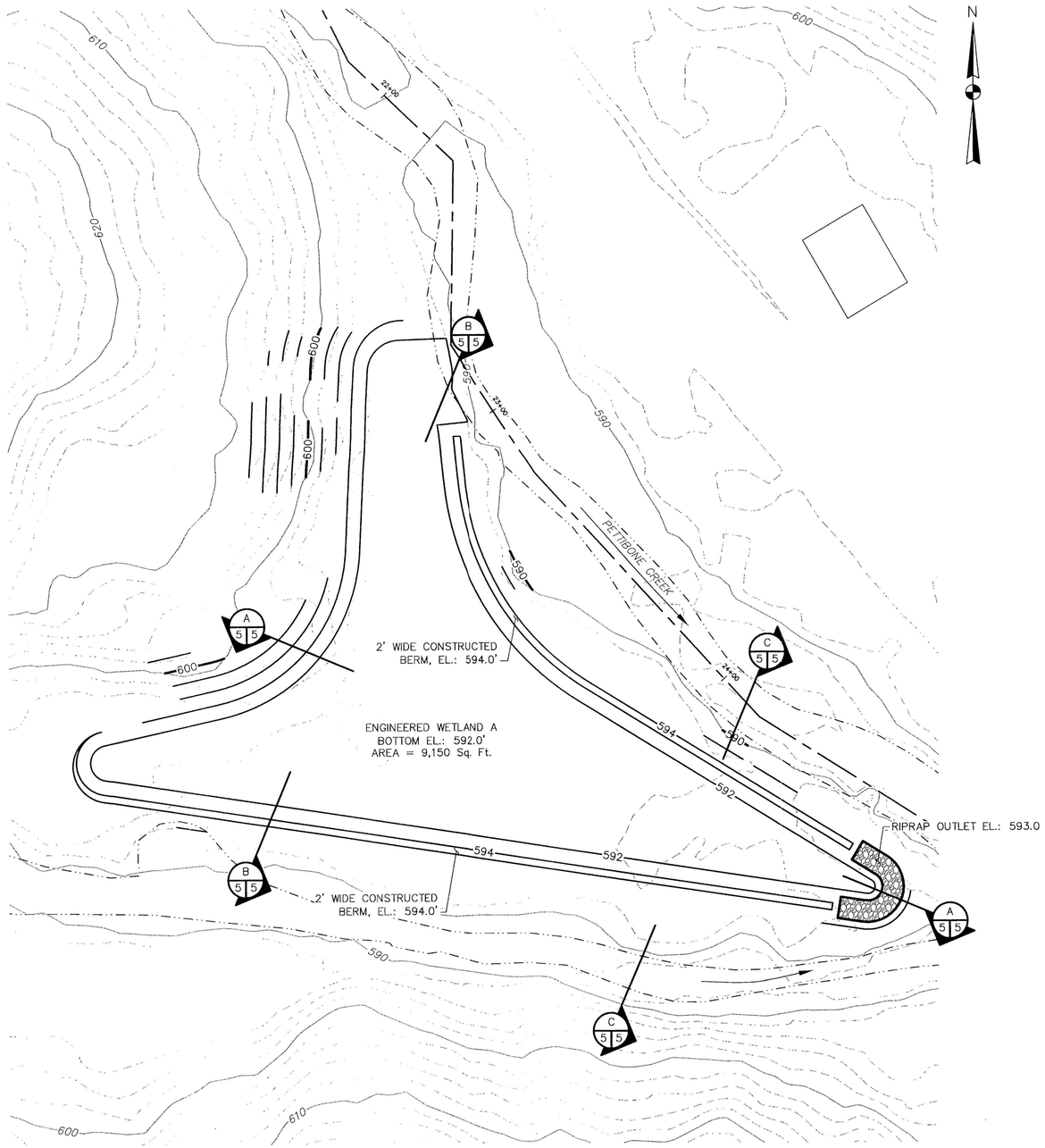
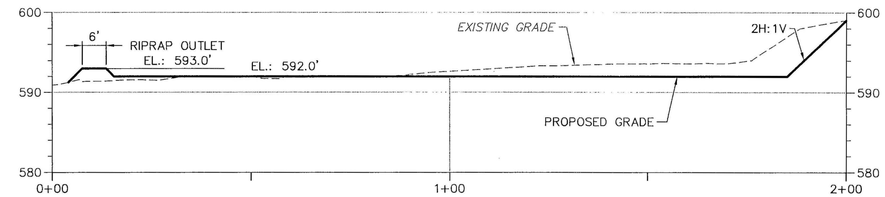


PLAN VIEW

SCALE: 1' = 20'

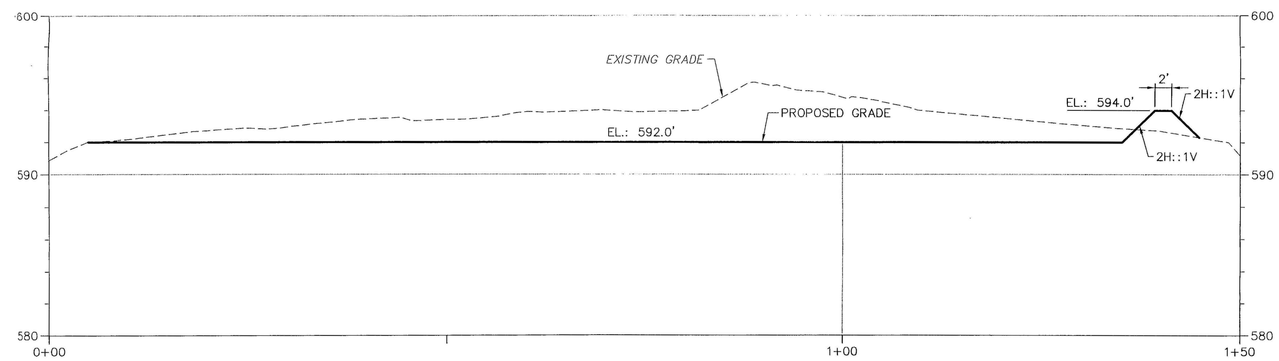
0 20 40

SCALE: 1" = 20'



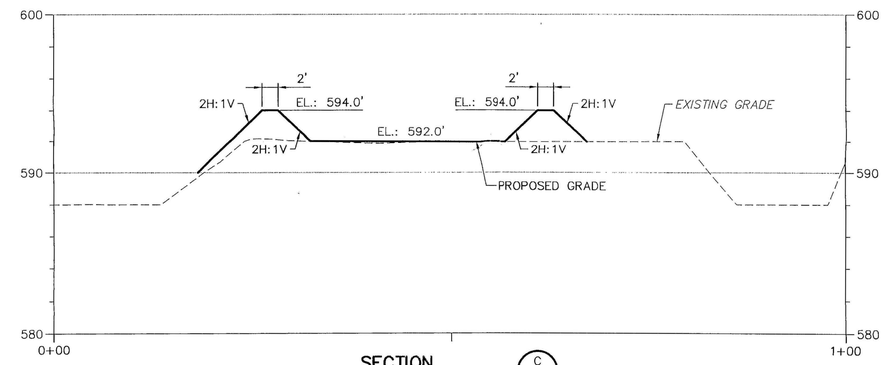
SECTION A

SCALE: HORIZ: 1" = 20'
VERT: 1" = 10'



SECTION B

SCALE: HORIZ: 1" = 10'
VERT: 1" = 5'



SECTION C

SCALE: HORIZ: 1" = 10'
VERT: 1" = 5'

0 10 20
HORIZONTAL SCALE: 1" = 10'

0 5 10
VERTICAL SCALE: 1" = 5'

DRAWN BY BH	DATE 7/27/11	ENGINEERED WETLAND B PROPOSED GRADING & SECTIONS PROPOSED REMEDIAL ACTION PLAN NS GREAT LAKES GREAT LAKES, ILLINOIS	CONTRACT NO. N62467-04-D-0055
CHECKED BY RLS	DATE 7/27/11		OWNER NO. 474
REVISED BY	DATE		APPROVED BY / DATE
SCALE AS NOTED		NAVFAC	DRAWING NO. C-5 / REV. 0

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