Final
Focused Site Inspection Report
March 2009

Former Gopher Ordnance Works
Rosemount, Minnesota

United States Army Corps of Engineers - Omaha District

FINAL
FOCUSED SITE INSPECTION REPORT

FORMER GOPHER ORDNANCE WORKS
ROSEMOUNT, MINNESOTA

Submitted by

U.S. Army Corps of Engineers
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LIST OF ACRONYMS

AOCs ..... Areas of Concern
AUF ..... Area Use Factor
AVS ..... Acid Volatile Sulfide
BAF ..... Bioaccumulation Factor
Bay West ..... Bay West, Inc.
BCF ..... Bioconcentration Factor
bgs ..... below ground surface
BOD ..... Biological Oxygen Demand
CCME ..... Canadian Council of Ministers of the Environment
CERCLA ..... Comprehensive Environmental Response, Compensation, and Liability Act
CFR ..... Code of Federal Regulations
COPC ..... Contaminants of Potential Concern
CSF ..... Cancer Slope Factors
CSM ..... Conceptual Site Model
CWI ..... County Well Index
DCEM ..... Dakota County Environmental Management
DERP ..... Defense Environmental Restoration Program
DNT ..... Dinitrotoluene
^{o}F ..... degrees Fahrenheit
DoD ..... Department of Defense
DPA ..... Diphenylamine
DQO ..... Data Quality Objective
DRO ..... Diesel Range Organics
DuPont ..... E.I. DuPont de Nemours
DVD ..... Digital Versatile Disc
EDD ..... Electronic Data Deliverable
EPA ..... US Environmental Protection Agency
EPC ..... Exposure Point Concentration
ERA ..... Ecological Risk Assessment
ERAGS ..... Ecological Risk Assessment Guidance For Superfund
ERS ..... Environmental Remediation Services
FGOW ..... Former Gopher Ordnance Works
FID ..... Flame Ionization Detector
ft ..... feet
FUDS ..... Formerly Used Defense Site
GOCO ..... Government Owned and Contractor Operated
gpd ..... gallons per day
GRO ..... Gasoline Range Organics
GSA ..... General Services Administration
HBV ..... Health-Based Value
HHRA ..... Human Health Risk Assessment
HLA ..... Lifetime Health Advisory
HQ ..... Hazard Quotient
HRL ..... Health Risk Limit
IDW ..... Investigation Derived Waste
ILCR ..... Incremental Lifetime Cancer Risk
IUOE ..... Interational Union of Operating Engineers
K_d ..... Adsorption Coefficient
K_{oc} ..... Organic Carbon Partition Coefficient
K_{ow} ..... Octanol-Water Partition Coefficient
LHA ..... Lifetime Health Advisory
LOAEL ..... Lowest Observed Adverse Effect Level
MATC ..... Maximum Acceptable Toxicant Concentration
MCL ..... Maximum Contaminant Level
MDH ..... Minnesota Department of Health
MDL ..... Method Detection Limits
Mg/kg ..... Milligram per Kilogram
MPCA ..... Minnesota Pollution Control Agency
MSL ..... Mean Sea Level
MS/MSD ..... Matrix Spike/Matrix Spike Duplicate
NAWQC ..... National Ambient Water Quality Criteria
NCP ..... National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL ..... No Observed Adverse Effect Level
NPL ..... National Priorities List
NTS ..... Northeast Technical Services
PA ..... Preliminary Assessment
PAHs ..... Polynuclear Aromatic Hydrocarbons
PCB ..... Polychlorinated Biphenyl
PERC ..... Perchloroethylene
POL ..... Petroleum, Oil, and Lubricants
ppt ..... parts per thousand
PRG ..... Preliminary Remediation Goals
PRP ..... Potentially Responsible Party
QA/QC ..... Quality Assurance/Quality Control
QCD ..... Quitclaim Deed
RAGS ..... Risk Assessment Guidance for Superfund
RASI ..... Risk Assessment Information System
RBSE ..... Risk Based Site Evaluation
RCRA ..... Resource Conservation and Recovery Act
RfD ..... Reference Dose
RI ..... Remedial Investigation
RLs ..... Reporting Limits
RPD ..... Relative Percent Difference
SAP ..... Bay West Sampling and Analysis Plan (Bay West, 2007)
SEM ..... Simultaneously Extracted Metals
SI ..... Site Inspection
Site ..... Former Gopher Ordnance Works
SLV ..... Soil Leaching Value
SOS ..... Scope of Services
SQT ..... Sediment Quality Target
SRV ..... Soil Reference Value
STL ..... Severn Trent Laboratories
SVOC ..... Semi-Volatile Organic Compound
TCE ..... Trichloroethylene
TEF ..... Toxicity Equivalent Factor
TPH ..... Total Petroleum Hydrocarbons
UCL ..... Upper Confidence Limit
µg ..... microgram
USACE ..... US Army Corps of Engineers
USEPA ..... US Environmental Protection Agency
USGS ..... United States Geological Survey
USDA ..... United States Department of Agriculture
UMN ..... University of Minnesota
VOC ..... Volatile Organic Compounds
WD ..... War Department
WMA ..... Wildlife Management Areas

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EXECUTIVE SUMMARY

Bay West Inc. (Bay West) prepared a Draft Focused Site Inspection (SI) Report under its United States Army Corps of Engineers (USACE)-Omaha District Environmental Remediation Services (ERS) Contract W9128F-04-D-0004, Task Order #0021. The purpose of the Focused SI was to determine if a release and migration of hazardous substances to the groundwater, surface water, soil and/or sediment occurred as a result of activities performed in seven Areas of Concern (AOCs), and if a release has occurred, does it pose a potential risk to human health and the environment. The report was finalized by USACE-Omaha District in March 2009 and incorporated comments provided by the Northwest Division's Environmental and Munitions Center for Expertise (EM CX) Directorate.

This Focused SI Report summarizes the results of the field and laboratory work described in the July 2007 Final Sampling and Analysis Plan (SAP) (Bay West, 2007) for the seven AOCs at the Former Gopher Ordnance Works (FGOW) site (Site) located in Rosemount, Minnesota. The field portion of the Focused SI included a Land Survey of AOC 7, sampling for the media of concern in the AOCs and background sampling for chemical. Analytical samples were sent to Severn Trent Laboratories for chemical analysis. The Focused SI also included a screening-level Human Health Risk Assessment (HHRA) and screening-level Ecological Risk Assessment (ERA).

The FGOW facility was constructed and operated by the E.I. DuPont de Nemours Corporation (DuPont) under Contract W-ORD-642, between 1942 and 1945, for the production of oleum, smokeless cannon and rifle powder. According to the quarterly historical reports, FGOW began the production of nitrocellulose in January 1945 and began packing a finished product in March 1945. It continued operation through October 1945. Therefore, the production and packaging of powder only took place over a period of approximately eight months.

The FGOW facility was divided into four segments. Segment A contained the manufacturing operations and included all AOCs. Prior to 1942, Segment A was primarily agricultural and forest land. Following World War II, FGOW's Segment A was informally subdivided into roughly four parts with the northwest and southeast parts transferred from the Federal Government to the Regents of the University of Minnesota (UMN) by a Quitclaim Deed (QCD) dated October 9, 1947; the industrial area in the northeast part transferred from the Federal Government to the Regents of the UMN by a QCD dated March 19, 1948, and the southwest part returned to private ownership throughout 1947 (USACE, 2006a).

The USACE Preliminary Assessment (PA) Report (USACE 2006a) summarizes the production information available on past Department of Defense (DoD) operations. Once the property was transferred or returned to previous owners, over 60 years ago, there were few to no records available on activities that occurred since DoD operations. However, it is likely that land use practices after DoD operations ceased contributed to the release of potential hazardous substances detected in some of the AOCs. The areas and possible activities include AOC 1 (Coates Dump, agricultural use), AOC 5 (UMN storage and use of materials), AOC 6 (UMN disposal of waste), and AOC 7 (UMN use and lease of property). In addition, releases of potential hazardous substances may have occurred as a result of allowing the buildings to fall into disrepair after transfer of ownership.

Based on the results of the field work and the screening-level Risk Assessments, potential hazardous substances have been released impacting the groundwater, surface water, soil, and

sediment. These releases occurred as a result of activities performed in AOCs and there exist potential risks to human health and/or the environment. A brief summary of conclusions of the screening-level Risk Assessments is provided below.

Screening-Level HHRA. The screening-level HHRA qualitatively evaluated the potential risk to human receptors based on exposure to chemicals detected at the seven AOCs. The screening-level HHRA concluded the following:

- AOC 1-Northern Section: Based on the analytical results, AOC 1-Northern Section does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic and mercury in total soil. The maximum arsenic concentration was less than the maximum background arsenic concentration and the maximum mercury concentration exceeded the adjusted PRG but not the actual Region 9 PRG.

- AOC 1-Middle Section: Based on the analytical results, AOC 1-Middle Section does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic and mercury in total soil; and bis[2-ethylhexyl]phthalate in groundwater. The maximum arsenic concentration was less than the maximum background arsenic concentration and the maximum mercury concentration exceeded the adjusted PRG but not the actual Region 9 PRG. Regarding groundwater chemicals, bis(2-ethylhexyl)phthalate is frequently identified as a sampling or laboratory contaminant.

- AOC 1-Southern Section: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 1-Southern Section. The screening-level HHRA criteria that were exceeded are as follows: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene, along with arsenic in total soil; arsenic in sediment; and arsenic in surface water. Additional Site evaluation is recommended.

- AOC 2: Based on the analytical results, AOC 2 passed the screening comparison because no chemicals exceeded screening values. There were no positive detections in the soil or groundwater analytical results in this AOC.

- AOC 3: Based on the analytical results, AOC 3 passed the screening comparison because no chemicals exceeded screening values. There were no positive detections in the soil or groundwater analytical results in this AOC.

- AOC 4: Based on the analytical results, AOC 4 does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic in total soil. The maximum concentration of arsenic was less than the maximum background concentration of arsenic.

- AOC 5: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 5. The screening-level HHRA criteria that were exceeded are as follows: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, (all of the preceding chemicals are PAHs); dieldrin, and arsenic in total soil; no exceedances in groundwater. PAHs are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or

other organic substances. PAHs are usually found as a mixture containing two or more of these compounds, such as soot. As part of FGOW, this site was intended to store DNT. There is no evidence linking the presence of PAHs at the site to the short period of DuPont/DoD activities. Buildings at the site were turned over to UMN intact. It should be noted that the maximum arsenic concentration was less than the maximum background arsenic concentration. According to available information, there is no historical mention of FGOW use of dieldrin at AOC 5 and it was historically not available at the time of FGOW activities. Therefore, Dieldrin is likely a result of activities that occurred after FGOW operations. The bunkers are currently being used by the UMN for storage of a variety of materials including chemicals (such as fertilizers, paints, and petroleum products), machinery, scrap wood, and metal. No additional human health evaluation of AOC 5 with respect to DuPont/DoD activities is recommended.

- AOC 6: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 6. The screening-level HHRA criteria that were exceeded are as follows: PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene; and arsenic in total soil. No records were found to indicate the date the debris was deposited, but the Site may have been in use during demolition and dismantlement activities during and immediately following the operation of FGOW. It is also possible that some debris may have been placed at the Site more recently. Additional Site evaluation is recommended.

- AOC 7A: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 7A. The screening-level HHRA criteria that were exceeded are as follows: PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, fluoranthene, naphthalene, and phenanthrene; carbazole, Aroclor-1254, Aroclor-1260, arsenic, and lead in total soil. Additional Site evaluation is recommended.

- AOC 7B: Based on the analytical results, AOC 7B does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic in total soil; chloroform, benzo(k)fluoranthene, and bis(2-chloroisopropyl)ether in groundwater. The maximum arsenic concentration in soil did not exceed the maximum background concentration of arsenic. Chloroform did not exceed its MCL. Benzo(k)fluoranthene and bis(2-chloroisopropyl)ether were each detected once in groundwater and were not detected in the soil at AOC 7B.

- AOC 7C: Based on the analytical results, AOC 7C does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: benzo(a)pyrene and arsenic in total soil; and chloroform, benzo(a)anthracene, bis(2-ethylhexyl)phthalate, and chromium in groundwater. Benzo(a)pyrene was only detected once in soil, and that detection only marginally exceeded the screening level (65 µg/kg vs. 62 µg/kg). The maximum detection of arsenic in soil was less than the maximum background concentration. Chloroform and chromium do not exceed their respective MCLs. Bis(2-ethylhexyl)phthalate only marginally exceeds its MCL (6.6 µg/L vs. 6.0 µg/L). Benzo(a)anthracene was only detected once in groundwater.

- AOC 7D: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 7D. The screening-level HHRA criteria that were exceeded are as follows: PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene; pentachlorophenol, PCBs, arsenic, barium, and lead in total soil; chloroform, 2,4,6-trichlorophenol, and 2-methylnaphthalene in groundwater. The detections of chloroform do not exceed the MCL. Additional Site evaluation is recommended.

Screening-Level ERA. The screening-level ERA evaluated the potential risk to ecological receptors based on exposure to chemicals detected at the seven AOCs. The screening-level ERA concluded the following:

- AOC 1-Northern Section: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 1-Middle Section: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 1-Southern Section: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 2: The potential for ecological risk at AOC 2 cannot be ruled out completely due to uncertainties in the evaluation. 2,6-DNT was not detected, but the detection limit exceeds the ecological screening value. However, it should be noted that the screening criteria and detection limit are within an order of magnitude. Nitrocellulose was not detected above the MDLs, but the lack of screening criteria for this chemical means that the potential risk from nitrocellulose, if it is present below the detection limit, cannot be evaluated. While there is no established screening value for nitrocellulose, available data on human health effects and mammalian toxicity suggest that this chemical is virtually nontoxic (Ryon, 1986). While these uncertainties should be noted, it is unlikely that 2,6-DNT or nitrocellulose are present at AOC 2 at concentrations that pose unacceptable risk to ecological receptors. In addition, the site is tilled agricultural land. No additional ecological evaluation of this site is recommended.

- AOC 3: The potential for ecological risk at AOC 3 cannot be ruled out completely due to uncertainties in the evaluation. 2,6-DNT was not detected, but the detection limit exceeds the ecological screening value. However, it should be noted that the screening criteria and detection limit are within an order of magnitude. It is considered unlikely that 2,6-DNT is present at AOC 3 at concentrations that pose unacceptable ecological risk. Nitrocellulose was detected in each of the five surface soil samples analyzed; however, a lack of screening criterion for this chemical prohibits an evaluation of the potential risk from this chemical. However, as stated above, while there is no established screening value for nitrocellulose, available data on human health effects and mammalian toxicity suggest that this chemical is virtually nontoxic (Ryon, 1986). Additional ecological evaluation of this AOC is not recommended.

- AOC 4: The only chemical considered for potential further ecological evaluation after initial screening is selenium, with detected values and detection limits for non-detected samples that are within an order of magnitude of the ecological screening value. Selenium is not known to be associated with FGOW processes and at least half of the site is being managed for agricultural purposes, making the site of limited ecological value. Selenium is not recommended for additional ecological evaluation. Based upon the Screening-Level ERA, it is unlikely that there is unacceptable risk to ecological receptors at AOC 4, and no further ecological evaluation is recommended.

- AOC 5: Chemicals considered for potential further ecological evaluation after initial screening include: the pesticides 4,4'-DDT, aldrin and dieldrin; metals cadmium, lead and mercury; and PAHs benzo(a)anthracene, benzo(a)pyrene, chrysene and naphthalene. The pesticides are not considered to be likely DuPont/DoD-related chemicals, due to non-availability prior to 1948 and the likelihood that these chemicals are related to the decades of UMN agricultural use of the area. There is no evidence to suggest that cadmium or lead are related to DuPont/DoD use of AOC 5. There do not appear to be widespread levels of mercury that exceed screening or background levels. As part of FGOW, this site was intended to store DNT. There is no evidence to linking the presence of PAHs at the site to the short period of DuPont/DoD activities. Buildings at the site were turned over to UMN intact. Further ecological evaluation of the site is not recommended based on chemicals that are not related to DuPont/DoD activities and the marginal ecological value of the site itself due to structures and active human use of the area.

- AOC 6: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 7A-Northwest Quadrant: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 7B-Northeast Quadrant: Chemicals considered for further ecological evaluation after initial screening include the non-detected SVOCs: 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 4,6-dinitro-2-methylphenol, N-nitrosodimethylamine, and N-nitrosopyrrolidine. Because none of the preliminary chemicals recommended for additional ecological evaluation were actually detected, no further ecological evaluation of AOC 7B is recommended.

- AOC 7C-Southeast Quadrant: Chemicals considered for further ecological evaluation after initial screening include the non-detected SVOCs: 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 4,6-dinitro-2-methylphenol, N-nitrosodimethylamine, and N-nitrosopyrrolidine. Because none of the preliminary chemicals recommended for additional ecological evaluation were actually detected, no further ecological evaluation of AOC 7C is recommended.

- AOC 7D-Southwest Quadrant: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations

exceeded ecological screening values. Therefore, additional Site investigation is recommended.

Screening-level risk assessments are highly conservative evaluations. The next step in the risk assessment process would include the collection of additional Site specific data, a refinement of the list of chemicals under consideration for ecological evaluation based on more realistic exposure assumptions, considerations of background data, Site-specific factors that may influence chemical bioavailability, and comparisons of Site data to literature-based toxicity data in cases where screening criteria are lacking. This step would result in the identification of potential risk drivers at the Site, or a conclusion that no additional action or evaluation is warranted.

Because there are other Potential Responsible Parities (PRPs), in accordance with USACE ER 200-3-1, Formerly Used Defense Site (FUDS) Program Policy, once a release has been confirmed the next step is to transfer the project to the PRP District where they will identify all viable PRPs, determine allocation of responsibilities, and determine the lead regulatory agency before proceeding to the Remedial Investigation (RI) phase.

1.0 INTRODUCTION

Bay West has prepared this Draft Focused SI Report under its USACE-Omaha District ERS Contract W9128F-04-D-0004, Task Order #0021. The report was finalized by USACE-Omaha District and incorporated comments provided by the Northwest Division's Environmental and Munitions Center for Expertise (EM CX) Directorate.

The SI Report summarizes the results of the field and laboratory work described in the July 2007 Final SAP (Bay West, 2007) for six Areas of Concern (AOC 1 through 6) within the 1947 QCD Property and AOC 7, the Steam Plant Area and associated 26.7 Acres within the 1948 QCD Property at the Site located in Rosemount, Minnesota.

AOC 1 through AOC 6 were identified in the USACE *Preliminary Assessment Report Final 1947 Quitclaim Property* (PA Report), dated March 2006 (USACE, 2006a), for the FGOW and described in the USACE March 29, 2006 Scope of Services (SOS). On December 28, 2006, the USACE modified Bay West's Task Order to include AOC 7, namely the Steam Plant Area and associated 26.7 Acres. AOC 7 is described in the USACE December 2006 Revised SOS. As stated in the PA Report, the FGOW was divided into four segments. Segment A contains the manufacturing operations and includes all AOCs. Figure 1 is a Site Location Map that presents the boundaries of Segment A and the approximate locations of the AOCs included in this Focused SI. Figure 2 is an overlay of the AOC locations on an aerial photograph.

FGOW was a Government Owned and Contractor Operated (GOCO) facility on property formerly owned by the DoD and falls under the Defense Environmental Restoration Program (DERP) for FUDS. The Focused SI was conducted under the authority of the DERP. Compliant with the DERP statute, all actions undertaken shall comply with all applicable Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements.

1.1 Purpose

The purpose of this Focused SI was to obtain and analyze environmental samples, to investigate potential human and environmental exposure to potential hazardous substances attributed to past Site activities, and to perform a screening-level human and ecological risk assessment. The Focused SI has been developed in accordance with the following documents:

- USACE Requirements for the Preparation of Sampling and Analysis Plans, EM 200-1-3, February 2001 (USACE, 2001).
- U.S. Environmental Protection Agency (USEPA) Interim Final Guidance for Performing Site Inspections under CERCLA (EPA/540-R-92-021), September 1992 (USEPA, 1992a).
- USEPA Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, EPA/240/B-06/001, February 2006 (USEPA, 2006).

Additional references cited in this Focused SI are listed in the References section at the end of the document.

1.2 Report Organization

This Focused SI Report presents a Site description and historical information (Section 2.0). Section 2.0 also includes details on topography, climate, geology, and hydrology. Section 3.0

presents a summary of the Data Quality Objectives (DQOs) developed in the SAP. Section 4.0 presents the Focused SI procedures and analytical results. Section 5.0 presents a screening-level human health and ecological risk assessment and risk management discussion. Section 6.0 presents a summary and conclusions of the investigative activities and the screening-level risk assessment.

2.0 SITE DESCRIPTION AND HISTORY

The following Site description and background information was obtained from the PA Report (USACE, 2006a) and the USACE *History of Site & Sampling, Former Gopher Ordnance Works, MN, Steam Plant and Associated 26.7 Acres*, November 2006 (USACE 2006b).

2.1 Site Location and Facility History

FGOW was a GOCO facility. The facility was constructed and operated by the E.I. DuPont de Nemours Corporation (DuPont) under Contract W-ORD-642, between 1942 and 1945, for the production of oleum, smokeless cannon and rifle powder. According to the quarterly historical reports, FGOW began the production of nitrocellulose in January 1945 and began packing a finished product in March 1945. It continued operation through October 1945. Therefore, the production and packaging of powder only took place over a period of approximately eight months.

The FGOW facility was divided into four segments. Segment A contains the manufacturing operations and includes all AOCs. The other three segments are not discussed in this SI. Following World War II, FGOW's Segment A was informally subdivided into roughly four parts with the northwest and southeast parts transferred from the Federal Government to the Regents of the UMN by a QCD dated October 9, 1947; the industrial area in the northeast part transferred from the Federal Government to the Regents of the UMN by a QCD dated March 19, 1948, and the southwest part returned to private ownership throughout 1947 (USACE, 2006a). The seven AOCs are shown on Figures 1 and 2. Historical descriptions of the seven AOCs are included in the SAP and briefly outlined in Section 3.3.

2.2 Topography

The Soil Survey of Dakota County indicates that the northwestern and western parts of the county consist of complex moraines. The topography is hilly and irregular. There are many deep depressions that are poorly drained. A large area in the central and eastern parts of the county and parts of the extreme south are level to gently rolling outwash plains. A few short, steep escarpments separate terraces along the Mississippi River. Most of these areas are well drained; however, some areas in the central part of the county are poorly drained, and several have large peat bogs. The Vermillion River drains the central part of the county (United States Department of Agriculture [USDA], 1983).

FGOW sits on the Rosemount outwash plain, southeast of the St. Croix Moraine. As such, the soils consist of very permeable, mostly sands and gravels. The Dakota County Soil Survey indicates that the Waukegan-Wadena-Hawick soil group underlies most of FGOW. The Waukegan-Wadena-Hawick is described as level to very steep, well drained and excessively drained soils formed in silty and loamy sediments over sandy outwash, on outwash plains and terraces. Recent alluvium has been deposited along the Mississippi in the upper reach of Spring Lake and along the Vermillion River and its tributaries which received runoff from a disposal ditch at FGOW (USACE, 2006a).

2.3 Climate

According to the Dakota County soil survey, Dakota County is cold in winter and quite hot with occasional cool periods in summer. Precipitation during the winter frequently occurs as snowstorms; and during the warm months, it is mainly showers, often heavy, that occur when warm, moist air moves in from the south. In winter the average temperature is 16 degrees Fahrenheit (ºF), and the average daily minimum temperature is 7 ºF. In summer the average temperature is 70 ºF, and the average daily maximum temperature is 81 º F. The total annual precipitation, 21 inches, or 70 percent, usually falls in April through September. Average seasonal snowfall is 41 inches (USDA, 1983).

2.4 Geology and Hydrogeology

The geology and hydrogeology discussions were obtained from the PA Report (USACE, 2006a) and augmented with the *Geological Atlas C-6*, *Dakota County, MN* (UMN, 1990) along with well logs within Segment A obtained from the Minnesota County Well Index (CWI) at http://www.health.state.mn.us/divs/eh/cwi/.

2.4.1 Geology

The FGOW is located on the southeastern portion of the Twin Cities Basin within the Central Lowland Physiographic Province in northeastern Dakota County, Minnesota, on the south edge of the Minneapolis-St. Paul metropolitan area (USACE, 2006a).

The United States Geological Survey (USGS) 7.5 Minute Topographic Map (Figure 1) indicates that ground surface elevation in Segment A is approximately 890 feet (ft) above Mean Sea Level (MSL) in the southeast to 950 ft above MSL in the northwest. According to the Geologic Atlas, the elevation of the top of bedrock in the northwest corner of Segment A is approximately 800 ft above MSL and the top of bedrock elevation is between 850 and 900 ft above MSL in the southeast corner of Segment A. A buried bedrock valley is present in the northern half of the Segment A trending northeast between AOC 5 and AOC 6 with an approximate elevation of 750 ft above MSL at its deepest part.

Selected well and boring records within Segment A obtained from the CWI were also reviewed to determine the depth to bedrock. The unconsolidated deposits within Segment A range from: 3 to 25 ft below ground surface (bgs) near AOC 1; 111 ft bgs near AOC 2; 47 to 50 ft bgs near AOC 4; 161 to 195 ft bgs near AOC 5; 91 ft bgs between AOC6 and AOC 7; and 71 to 99 ft bgs near AOC 7. The St. Peter Sandstone (0 to 160 ft thick) appears to underlie most of the southern half of FGOW (AOC 1-Middle and Southern Sections, AOC 2, AOC 3-DA2, AOC 4). The underlying Prairie Du Chien (dolomite, up to 308 ft thick) appears to be the first bedrock unit to be encountered in most of the northern half of FGOW (AOC 5, AOC 6 and AOC 7). Copies of the afore-referenced well and boring logs are included in Appendix 1. Additional geology and bedrock information was obtained during the field portion of the Focused SI. This information is included in Section 4.3, Field and Analytical Results for Each AOC.

2.4.2 Hydrology

The overburden consists principally of glacial outwash deposits on the main FGOW facility, with some alluvium along the peripheral portions that include major river valleys (USACE, 2006a). At FGOW, the overburden is generally not considered a developable aquifer, except along the Vermillion River and by Spring Lake. There may be some potential for limited water

development (domestic, agricultural or livestock wells) in the outwash deposits along the northern portion of the main FGOW facility, and to the west toward Rosemount. At the main FGOW facility, groundwater elevation in the overburden is from approximately 890 ft above MSL at the southwest corner to about 840 ft above MSL on the northeast corner. The typical depth to ground water is between 50 and 100 ft bgs in the FGOW area.

The bedrock aquifers are the principal source for groundwater in the immediate area of FGOW. Of those, the principal shallow bedrock aquifer is the Prairie Du Chien-Jordan Formation. The elevation of the potentiometric surface in the Prairie Du Chien-Jordan aquifer is about 890 ft above MSL in the southwest corner of the main facility to about 830 ft above MSL in the northeast corner, with the levels declining to the northeast.

According to the quaternary hydrology map in the Geologic Atlas, the water table aquifer in the unconsolidated deposits is approximately 900 ft above MSL in the western portion of Segment A to 825 ft above MSL in the northeast, near AOC 7. Groundwater contours indicate that groundwater flow in the unconsolidated deposits trends east – northeast, towards Spring Lake/Mississippi River.[1] The map also identifies areas where the unconsolidated aquifer may be confined or yield little water. The potentiometric contours in the Prairie Du Chien-Jordan bedrock show that groundwater is approximately 880 ft above MSL in the southwest to 840 ft above MSL in the northeast within Segment A. Groundwater contours indicate that groundwater flow in the bedrock aquifer trends to the northeast, towards Spring Lake/Mississippi River.

Well and boring records from the CWI did not contain information on wells completed in the unconsolidated deposits. Well and boring records did indicate static groundwater levels in the bedrock wells as follows: 8.8 to 35 ft bgs near AOC 1; 101 ft bgs near AOC 2; 52 ft bgs in AOC 4; 75 ft bgs in AOC 5; 70 ft bgs between AOC 6 and AOC 7; 80 and 85 ft bgs near AOC 7. Copies of these well logs are included in Appendix 1. Additional hydrologic information was obtained during the field portion of the Focused SI. This information is included in Section 4.3, Field and Analytical Results for Each AOC.

2.5 Historical Information and Current Use

Seven AOCs were evaluated in the Focused SI. Historical Site information was obtained from References USACE, 2006a and USACE, 2006b. Limited analytical data were available relative to the seven AOCs to indicate the presence or absence of contamination. A detailed historical summary for each of the seven AOCs, along with the potential hazardous substances were described in the SAP and are briefly described below. The location of each AOC is shown on Figure 2. AOCs 1 through 7 are shown in greater detail on Figures 3 through 9, respectively.

In 2006, legislation was enacted that set aside 2,822 acres of land owned by UMN (located inside the south boundary of former Segment A) to be jointly managed by UMN and the Minnesota Department of Natural Resources. This area is known as Vermillion Highlands and a portion of the land is included in the study area of this report, including the Middle and Southern parts of AOC 1, all of AOC 2, and AOC 3-DA2. According to a June 2008 Draft of a Concept Master Plan for the Vermillion Highlands,[2] portions of the property are to be managed for

[1] The direction of the groundwater was confirmed during groundwater sampling for chloroform from the Rosemount Research Center's Burn Pit and reported in the EPA Superfund Record of Decision: University of Minnesota (Rosemount Research Center); EPS ID: MND 980613780, OU 02, 03; Rosemount, MN; 06/29/1990.

[2] http://www.umorepark.umn.edu/sites/c9e0e563-70e4-43e4-8a5e-b620e3ae848e/uploads/Vermillion_Highlands_concept_master_plan.pdf

agricultural research while other areas are designated for recreation and as wildlife management areas (WMA). The Vermillion Highlands Research Recreation & WMA Hunting Information website[3] described that limited seasonal hunting and trapping is allowed on large portions of the area. In accordance with the legislation, the property will be deeded by UMN to the State in 2032.

2.5.1 AOC 1, Waste Disposal Ditch, Primary and Secondary Settling Ponds

This AOC begins at 160th Street with the Waste Disposal Ditch and continues south to the outfall of the Secondary Settling Pond (Figures 1 and 3). According to the drainage schematics provided by Dakota County, "process" water was collected in the Laminex Woodbox Sewer system from the nitrocellulose production areas, solvent areas, and the smokeless powder manufacturing areas. The Sewer had its outfall at the northern tip of AOC 1-Northern Section. In addition, treated effluent from the sanitary lines also flowed through the Wastewater Treatment Plant and then into the Laminex lines less than 0.5 miles northeast of the Laminex Woodbox Sewer outfall. AOC 1 is divided into three sections: Northern, Middle, and Southern. The waste disposal ditch in general followed the natural drainage contours of the area and was man-made in some areas, with sides up to 20 ft high in the area south of 170th Street (Photograph 1 through 4, Appendix 2).

The Northern Section is located north of 170th Street on private property. Based on existing topography, the northern half of the waste ditch in this section appears to have been filled in. There is a section of ditch between the Northern and Middle segments that is not included in the AOC investigation. This section, just south of 160th Street, is located on private property and another segment (from 170th Street north to the segment on private property) is on the Regents of the UMN property and is not included in this AOC or Focused SI work since that particular property has not been reviewed through a Preliminary Assessment. The Focused SI did not include investigation of the fill area since the fill placement would have blocked the flow to treated water into the Settling Basins so fill was likely to have occurred after DuPont/DoD operations.

The Middle Section begins at 170th Street (where the Coates Dump is located), trends southward and includes the primary settling basin and drainage ditch up to approximately the secondary settling basin. Solid waste deposited in the Coates Dump at the head of the drainage ditch would have made the ditch unusable as a waste water disposal ditch.[4] Therefore, the landfill waste would likely have been disposed of after DuPont/DoD operations had terminated. The former Coates Dump is a landfill that may have been used by the public (USACE, 2006a). The current property owners may also have used this as a disposal area. According to discussions with UMN representatives during the February 21, 2007 Site visit , at the request of the MPCA, UMN placed a cover over the landfill area. The Primary Settling Basin is present approximately 600 ft down gradient of the former dump (Photograph 2, Appendix 2). The ditch enters the settling basin at its northeast corner. A berm, possibly an old weir structure, is located in the ditch at the outfall/toe end of the basin (Photograph 3, Appendix 2).

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[3] http://www.dnr.state.mn.us/wmas/vermillion_highlands.html

[4] According to an undated history of the Coates Dump site (DK-08) obtained form the Minnesota Department of Health, at some time the Minnesota Pollution Control Agency indicated that "[…] the dump commenced in 1948 as an open unregulated dump. Information from the Dakota County Dept. of Environmental Management indicate nixed-municipal wastes were dumped on the site for many years. The believed that wastes at the site consisted of the University of Minnesota mixed waste, possible army waste, some industrial waste and hazardous waste."

The Focused SI did not include investigation of the former Coates Dump since the dump activities occurred after DuPont/DoD activities. However, previous studies did identify the presence of a perchloroethylene (PERC), and trichloroethylene (TCE) groundwater contaminant plume resulting from the former dump activities (USACE, 2006a).

The Southern Section includes the Secondary Settling Basin (Photograph 4, Appendix 2), a secondary acid neutralization plant, contact mixing basin, chemical storehouse, and a still well. A dam/weir structure is present at the outlet of the basin. During the Bay West Site visits surface water was only observed in AOC 1-Southern Section below the former dam/weir structure (Photograph 5, Appendix 2).

During DuPont/DoD activities at FGOW, underground Laminex Woodbox Sewer system was designed to collect 100,000,000-gallons-per-day (gpd) of process water. The process water came from the acid/oleum production areas as well as the nitrocellulose production facilities where large amounts of fresh water were used to break down cotton fibers, neutralize acid and remove impurities from the nitrated cotton. This process water was released into the Waste Disposal Ditch along the east boundary of the FGOW. The Laminex Woodbox sewers, located on property transferred to the Regents of the UMN in 1948, are not part of this AOC or Focused SI work. Two acid neutralization systems were installed at FGOW: the first was located to treat the process water from the acid manufacturing area; and the second was located at the outfall of the secondary settling basin.

The sanitary sewers were designed to collect 300,000 gpd of wastewater from laundries and personal hygiene facilities as well as shop maintenance operations and also carried sewage to the wastewater treatment facility located in the northeast part of FGOW. After chlorination and dilution to meet the state's Biological Oxygen Demand (BOD) standard, the treated wastewater was released into the Laminex Woodbox Sewer system and then into the Waste Disposal Ditch.

Current Use: The waste disposal ditch, settling ponds and surrounding areas are now used for agricultural, wildlife management and recreational purposes with interspersed regions of mixed pine and hardwood forest and grassland. Remnants of the dam/weir structure and some of the buildings associated with the secondary settling basin including the chemical storehouse building and still-well can be observed in the Southern Section. The ditch is vegetated and is dry with the exception of seasonal rain events during which it is a pathway for surface runoff (USACE, 2006a). As stated above, surface water was only observed in AOC 1-Southern Section between the former dam/weir structure and the east border of AOC 1 - Southern Section.

Historical Analytical Data and Potential Media of Concern: DuPont production operations in the northeast part of FGOW's Segment A may have potentially contributed the following substances to the Waste Disposal Ditch: nitrocellulose; dinitrotoluene (DNT); diphenylamine (DPA); industrial solvents and degreasers; petroleum, oil, and lubricants (POLs); mercury; polynuclear aromatic hydrocarbons (PAHs); metals; oleum; sulfuric acid; and nitric acid (USACE, 2006a). Mercury may have been present as an impurity in the coal burned at the FGOW Steam Plant. However, documentation also exists showing that from 1974 to the present, UMN has applied wastewater biosolids[5] to areas within the boundaries of FGOW. The UMN, Dakota County

[5] According to a 2001 article in the *Journal of Environmental Quality*, UMN has been applying wastewater biosolids (sewage sludge) to a test plot at Rosemount Research Center since 1974. Sampling routinely was conducted to

Environmental Management (DCEM) and the MPCA collected soil samples in the settling basins in 2003 (Peer Engineering, 2003). Mercury, chromium, 2,4-DNT, 2,6-DNT and o-nitrotoluene were detected. DCEM collected groundwater samples in 1992 in association with the Coates Dump. Metals, PERC, and TCE were detected. Since solid waste disposal activities in the Coates Dump blocked the Waste Disposal Ditch that was used by FGOW, these activities occurred after FGOW operations ceased in late-1945, and include possible UMN and public disposal that may have contributed the following potential hazardous substances VOCs, SVOCs,[6] and metals.

Media of potential concern include surface and subsurface soil, groundwater, sediment, and surface water.

2.5.2 AOC 2, Shipping/Storage Buildings

This AOC is bounded by 170th Street, Patrol Road (which follows the perimeter of the FGOW facilities), and Blaine Avenue (Figures 1 and 4). This AOC was privately farmed prior to acquisition by the War Department (WD).

Ninety-six shipping houses, each approximately 54 ft by 64 ft in size, were laid out in rows and used during operations at FGOW. Forty-eight of the buildings were built to hold 500,000 pounds of powder and the other forty-eight buildings were built to hold 250,000 pounds of powder. During production operations at FGOW, zinc containers holding between 100 and 140 pounds of finished cannon powder were stored in these buildings to await shipment. Historical schematic drawings show that the buildings were constructed on piers over a gravel bed and that the floors of the buildings were made from creosote-treated lumber. There are no known reports of spills or leaks of product at these locations but according to TM 9-2900, Military Explosives, leaky powder cans were to be expected. In addition, an inspection report dated April 23, 1947, indicates that small quantities of smokeless powder were observed in and around these buildings, particularly in the floor joints (USACE 2006a). The buildings are no longer present but the former building locations are still visible in the 2003 aerial photographs.

Current Use: Shortly following the closure of FGOW, AOC 2 was returned to and remains agricultural land (Photograph 6 and 7, Appendix 2) that appears to be cultivated by the UMN or their tenants.

Historical Analytical Data and Potential Media of Concern: DuPont/DoD production operations at FGOW may have potentially contributed the following substances at the Shipping and Storage Buildings: nitrocellulose, DNT, and DPA (USACE, 2006a). Historical sampling has not been conducted in this AOC.

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measure and evaluate the metal content remaining in the surface soil as well as plant uptake of metals at and around the site. The article points out that UMN's plowing of the test area where biosolids have been applied may inadvertently cause the metal particles to become airborne and spread over surrounding areas.

[6] A semi-volatile organic compound (SVOC) include: pesticides, polychlorinated biphenyls (PCBs), polynuclear aromatics hydrocarbons (PAHs) (that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances), plasticizers, wood preservatives, and other pollutants. SVOCs could encompass thousands of organic chemicals, but the field has been narrowed to more commonly known environmental contaminants that are potentially adverse to public safety.

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Media of potential concern include surface and subsurface soil, and groundwater.

2.5.3 AOC 3, Miscellaneous Drainage Areas

Several drainage areas or depressions that apparently held drainage/runoff water from various storage and shipment building areas were identified in the PA Report. The following two drainage areas were evaluated in the Focused SI:

1) AOC 3-DA1 south and adjacent to AOC 5 (Figures 1 and 5A) (Photograph 8, Appendix 2)
2) AOC 3-DA2 south of 170th Street, between the AOC 2 and AOC 4 (Figures 1 and 5B)

No structures were placed in these drainage areas as part of FGOW operations. The drainage areas were part of privately owned farms prior to acquisition by the WD.

Current Use: The areas are now surrounded mainly by agricultural land belonging either to private owners or the Regents of the UMN. Vegetation observed during the PA Site reconnaissance was noted to be healthy in both areas with no signs of distress. Bay West did not observe surface water in either of the two drainage areas during the Site visits.

Historical Analytical Data and Potential Media of Concern: Shipping cases accidentally dropped either inside or outside the shipping/storage houses may have potentially contributed the following substances at the Miscellaneous Drainage Areas: nitrocellulose, DNT and DPA (USACE, 2006a). Historical sampling has not been conducted in these areas.

Media of potential concern include surface and subsurface soil, and groundwater.

2.5.4 AOC 4, Sanitary Buildings

AOC 4 is in the southwest part of FGOW (between 170th Street and Patrol Road) (Figures1 and 6). Documentation of activities at this AOC was not found during the PA. The following buildings were identified in the SAP:

- 107-T Time Office
- 108-T Sanitary Building
- 109-T Sanitary House
- 110-T Boiler House
- 200-T Toilets (sixty-five small rectangular structures)

This AOC was privately farmed prior to acquisition by the WD. A short time following the closure of FGOW, the Site was returned to private ownership. No records were found to identify when the buildings were demolished.

Current Use: The northern half of this area is currently grass/agriculture land while the remainder supports dense trees and shrubs and some tall grasses.

Historical Analytical Data and Potential Media of Concern: DuPont operations may have generated either PAHs from coal or POLs from the liquid fuel used in the boiler house. No documentation was found to show the type of fuel (coal or heating oil) the boiler house used to

generate heat (USACE, 2006a). Metals may also have been released as a result of historical DuPont/DoD activities. Historical sampling has not been conducted in this area.

Media of potential concern include surface and subsurface soil, and groundwater.

2.5.5 AOC 5, Dinitrotoluene Storage Bunkers

AOC 5 is located in the western part of FGOW, east of Patrol Road and south of 160th Street (Figures 1 and 7). The bunkers were intended to store DNT, but FGOW production records do not indicate that DNT was ever stored in the bunkers and there are no FGOW operations records that document spills or leaks of DNT at this AOC (USACE, 2006a). In April 1944, the property where these bunkers stand was leased to Raymond Laboratories, Inc. of St. Paul, MN for the purpose of storing explosives. No records were found to indicate how long these bunkers were used or what type of explosives may have been stored in the bunkers. A letter from the Office of Real Property Disposal to the UMN dated September 13, 1946, indicates that the buildings were used to store DNT and DPA. An inspection report dated April 23, 1947, indicates that a small quantity of smokeless powder was observed in the floor drain of one of these buildings, while small quantities of DNT were observed in the floor drain of two of the buildings.

This area was privately farmed prior to acquisition by the WD.

Current Use: Seven of the eight original bunkers are still present and appear to be in use by the UMN for storage of a variety of materials including chemicals (such as fertilizers, paints, and petroleum products), machinery, scrap wood, and metal. Five of the bunkers have been rehabilitated by UMN, with new metal roofs and siding. All that remains of the other two bunkers are the concrete floors and sides; these bunkers contain the scrap wood and metal.

During the initial Site visit, Bay West took several photographs of AOC 5. A few of these photos are included in Appendix 2 (Photographs 10 through 12). Photographs 10 and 12 are of the storage bunkers, while Photograph 11 shows a drainage area that continues on into AOC3-DA1 (Photograph 8). Bay West also entered storage bunker 607. The concrete walls and floor appear to be in good condition with minimal cracking. Some oil was noted on the floor, possibly from machinery stored/recent activities conducted within the building. The interior of the building had a strong mothball odor.

Historical Analytical Data and Potential Media of Concern: DuPont/DoD production activities at FGOW or Raymond Laboratories, Inc. storage operations may have potentially contributed the following substances at the DNT Storage Bunkers: DNT, and DPA (USACE, 2006a). UMN practices could have resulted in a release of VOCs, SVOCs, herbicides and metals. Historical sampling has not been conducted in this area.

Media of potential concern include surface and subsurface soil, and groundwater.

2.5.6 AOC 6, 154th Street Disturbed Area

Three disturbed areas were identified in the PA Report. The disturbed areas are visible in 1945 aerial photographs. These areas were privately farmed prior to acquisition by the WD. Two of the smaller areas, located south of 154th Street, appear to be borrow areas. The PA Report concluded that these two smaller areas require no further investigation (USACE, 2006a). Therefore, they are not included in this AOC.

The area between Patrol Road and 155th Street is a football-field-size depression containing large amounts of surface and buried construction debris (Figures 1 and 8). Debris including rebar, concrete, and asphalt were visible on the ground surface. Although no records were found to indicate the date the debris was deposited, the Site may have been in use during demolition and dismantlement activities during and immediately following the operation of FGOW. It is also possible that some debris may have been placed at the Site more recently (USACE, 2006a).

Current Use: The 154th Street Disturbed Area is now overgrown with weeds, brush, and trees, and is surrounded by agriculture fields. There was no sign of distressed vegetation at the Site. Photograph 13 (Appendix 2) shows the 154th Street Disturbed Area.

Historical Analytical Data and Potential Media of Concern: According to the PA Report, DuPont/DoD activities at FGOW may have potentially contributed the following substances at the 154th Street Disturbed Area: PAHs, and metals (USACE, 2006a). The UMN and/or their tenants may have contributed various types of debris after FGOW property was transferred to the UMN. Historical sampling has not been conducted in this area.

Media of potential concern include surface and subsurface soil, and groundwater.

2.5.7 AOC 7, Steam Plant and Associated 26.7 Acres

AOC 7 is located in the northeast corner of FGOW, east of Blaine Street (Figures 1 and 9). In addition to the Steam Plant Building 401A, other FGOW-facility support structures were also located on the 26.7-acres. Construction of the FGOW facility began in 1942. Records indicate that the Steam Plant became operational in mid-1943. Production operations finally began in January 1945, but production only occurred on lines A, B, and C with final operations ending in September 1945. Lines D, E, and F were never completed or made operational. Dismantlement and decontamination of FGOW facilities were conducted in 1945 and 1946.

The 26.7-acre Site surrounding the Steam Plant was conveyed from the Federal government to the Regents of the UMN in a QCD dated March 17, 1948, along with other industrial properties to the west and south of this 26.7-acre parcel. The title to the property reverted from the Regents of the UMN to the National Industrial Reserve Division of the General Services Administration (GSA) on June 27, 1951 and then returned to the UMN from the Federal Government on March 9, 1961. No records were found to describe the use of the property by the UMN after 1961.

There are many buildings and features within AOC 7. For the purposes of this Focused SI, AOC 7 was subdivided into four quadrants (AOC 7A, AOC 7B, AOC 7C, AOC 7D) to facilitate the investigation activities and to more accurately represent operations and potential exposure areas (Figure 9). Additional detail on historical features and current use, historical analytical data and potential media of concern for each quadrant is described below.

Historical Features and Current Use:

AOC 7A – Northwest Quadrant: AOC 7A is located in the northwest quadrant of AOC 7 and is detailed on Figure 9A. The main historical features and/or buildings in this area included the following:

- 402-A Water Reservoir including:
    - 412-A Pump House (attached to the south side of Bldg 402-A)
    - Transformer Pads, south of Bldg 412-A
    - Water Inlet House (attached to the north side of Bldg 402-A)
- 53-TC47 Boiler House

The north quarter (approximate) of AOC 7A is currently farmland. The remainder is currently not used and remnants of the collapsed buildings (water reservoir, pump house, and water inlet house) are present. The Boiler House is no longer present. Photograph 14 (Appendix 2) shows concrete pads on the south side of the Pump House which may have been the location of transformers. Photograph 15 (Appendix 2) shows the Water Inlet House, which has since collapsed due to disrepair and/or vandalism as reported by UMN on-site representatives.

AOC7B – Northeast Quadrant: AOC 7B is located in the northeast quadrant of AOC 7 and is detailed on Figure 9B. The main historical features and/or buildings in this area included the following:

- 406-A Salt Dissolving Pit
- 151-TC3 Field Office
- 52-TC4 Storage
- Dry Chemical Storehouse
- Drainage ditch adjacent to the rail line passing by the Dry Chemical Storehouse

No historical features are currently visible in this area and as shown on Photograph 16 (Appendix 2) AOC 7B is well graded. Currently, this area does not appear to be managed by the UMN for any agricultural or wildlife activities.

According to discussions with UMN representatives during the February 21, 2007 Site visit, the International Union of Operating Engineers (IUOE) Local 49 extensively reworked subsurface soils in AOC 7B as part of their training.[7] The topsoil was removed and stockpiled on the south side of AOC 7C and AOC 7D. Excavations may have extended down as far as 30 ft bgs. All of the underground utilities, including culverts used to transport wastewater, were reportedly removed. The culverts are currently being stored in AOC 7D, south of Building 401-A.

AOC 7C – Southeast Quadrant: AOC 7C is located in the southeast quadrant of AOC 7 and is detailed on Figure 9C. The main historical features and/or buildings in this area included the following:

- Coal Storage
- Crusher House Conveyor Houses/Towers

[7] Local 49's training and apprenticeship program began in 1978 at the Rosemount, MN, facility to provide training for journeyman and apprentice alike. The training center was reported to have moved from Rosemount to a new site in the fall of 2006, but the website http://www.unions.org still lists the address of the IUOE Local 49 in the area north of AOC7B.

- 55-T Field Office
- 54-TC25 Toilet
- Drainage Ditch. The surface water drainage ditch network provided storm water drainage for approximately 150 acres of the east-central portion of Segment A including surface water runoff from the nitrocellulose processing area. This network runs through AOC 7C and AOC 7D.

In addition to the historical features, stockpiled topsoil reportedly removed from AOC 7B is also present in the southwest corner of AOC 7C and the south side of AOC 7D. The Focused SI did not include investigation of the stockpiled soil since the placement occurred after DuPont/DoD operations. The stockpiled soil appears to be well vegetated, thereby minimizing potential soil runoff.

This area does not appear to be currently managed by the UMN for any agricultural of wildlife activities. The only historical features currently remaining in this area are remnants of the coal conveyor towers and field office. Photograph 17 (Appendix 2) shows the location of the former Coal Storage Area. According to discussions with UMN representatives during the February 21, 2007 Site visit, the 49th Operating Engineers Union may have extensively reworked the subsurface soils in this area. Photograph 18 (Appendix 2) shows a culvert located in the northeast corner of AOC 7C. Water collected in this area during a rain event. Otherwise surface water was not observed in the ditches and culverts.

AOC 7D-Southwest Quadrant: AOC 7D is located in the southwest quadrant of AOC 7 and is detailed on Figure 9D. The main historical features and/or buildings in this area were the following:

- 401-A Steam Plant A (also referred to as Power House).
    - 401-AA Flash Mixer
    - 401-AA1 Precipitators
- Drainage Ditch. See AOC 7C for discussion
- 405-A Electrical Substation (Transformer pads)
- Fuel Oil Tanks
- 410-A Ash Disposal Pit and Sump
- Secondary Containment Reservoir
- Soft Water Tank (Water Tower)

In addition to the historical features, stockpiled topsoil reportedly removed from AOC 7B is also present in the southwest corner of AOC 7C and the south side of AOC 7D. The Focused SI did not include investigation of the stockpiled soil since the placement occurred after DuPont/DoD operations.

This area is does not appear to be currently managed by the UMN for any agricultural or wildlife activities. Features currently remaining in this area include the ditches and remnants of the foundations and towers with the exception of the secondary containment reservoir and water tower. Photographs 19 through 23 (Appendix 2) show selected features in AOC 7D. Photograph 19 is of the stockpiled soil on the south side of the AOC 7D. Photograph 20 shows

the former location of Building 401-A and the culverts from AOC 7B. Photograph 21 shows the former Fuel Oil Tank location east of Building 401-A. Photograph 22 shows the former Ash Disposal Pit. Photograph 23 shows concrete pads that may have been the location of transformers.

Historical Analytical Data and Potential Media of Concern
Industrial activities in AOC 7 that may have contributed to a release of PCBs, solvents and degreasers, POLs, and heavy metals included building repair and painting, boiler and electrical equipment repair. A release of these substances could also have occurred as part of the Federal Government or University of Minnesota dismantling activities or from post-DuPont/DoD activities such as the small arms practice rounds encountered during the field work (see section 4.3.7) or other activities occurring since the end of March 1961. In addition, a portion of the waste disposal ditch, described in Section 2.5.1, also passed through parts of AOC 7. Therefore, DNT, DPA[8] and other substances associated with the flow of waste water could be present in the waste disposal ditches.

In the UMN's 2005 *Winter Retrospect: Research Takes Flight at Rosemount*,[9] the last paragraph states that "Amid architectural remnants of the old ordnance plant, signs of new life abound, including an 11-mile riding trail, a truck-driving range for Dakota County Technical College, a law-enforcement bomb detonation area and firing range [emphasis added], and a small airport." Therefore, DNT detected in the Primary Settling Basin may have come from sources other than the production of smokeless powder.

The following is a breakdown of potential site contaminants and media of concern by area:

AOC 7A – Northwest Quadrant: Operations at FGOW may have potentially contributed the following substances at AOC 7A: polychlorinated biphenyls (PCBs), industrial solvents and degreasers, POLs, and heavy metals. Historical sampling has not been conducted in this area.

Media of potential concern in AOC 7A include surface and subsurface soil, and groundwater.

AOC 7B – Northeast Quadrant: Operations at FGOW may have potentially contributed the following substances at AOC 7B: industrial solvents and degreasers, POLs, and heavy metals. Historical sampling has not been conducted in this area.

Media of potential concern in AOC 7B include surface and subsurface soil, and groundwater.

AOC 7C – Southeast Quadrant: Operations at FGOW may have potentially contributed the following substances at AOC 7C: nitrocellulose, DNT, DPA, industrial solvents and degreasers, POLs, mercury, heavy metals, oleum, nitric and sulfuric acids, and semi-volatile organic compounds (SVOCs). Historical sampling has not been conducted in this area.

Media of potential concern in AOC 7C include surface and subsurface soil, and groundwater.

[8] DPA is not only an inhibitor for explosives but is also used in fungicides, plant growth regulators and insecticides
[9] http://www.it.umn.edu/news/inventing/2005_Winter/retrospect.html

AOC 7D – Southwest Quadrant: Operations at FGOW may have potentially contributed the following substances at AOC 7D: nitrocellulose, DNT, DPA, industrial solvents and degreasers, POLs, mercury, SVOCs, heavy metals, oleum, sulfuric and nitric acids, and PCBs.

The History of Site & Sampling (USACE, 2006b) summarized historical sampling conducted in or near AOC 7D. Analyses of soil samples collected from the stockpiled soil indicated the presence of metals. However, the metal concentrations were below regulatory levels. Analyses of soil samples collected near the former transformers indicated the presence of PCBs. However, the PCB concentrations were below regulatory levels. Analyses of soil samples collected within the underground water holding tank located to the west of building 401A identified the presence of metals, naphthalene, SVOCs, PCBs, asbestos and diesel range organics (DROs) above regulatory levels.

Media of potential concern in AOC 7D include surface and subsurface soil, and groundwater.

3.0 DATA QUALITY OBJECTIVES

3.1 Initial Site Conceptual Site Model

A Conceptual Site Model (CSM) is a description of a Site and its environment that is based on existing knowledge. It describes sources and receptors, and the inter-actions that link these. The CSM illustrates all complete exposure pathways, current and future. An initial CSM was developed for the Site and can be found in the SAP. The results of the Focused SI were used to prepare a revised CSM. The revised CSM for human health and ecological evaluations is presented in Section 5.

3.2 Data Quality Objectives and Action Levels

The DQOs and action levels are presented in the SAP and briefly summarized below.

Principal Study Question: Has a release and migration of potential hazardous substances to the groundwater, surface water, soil and/or sediment occurred as a result of activities performed in the seven AOCs? If a release has occurred, does it pose a potential risk to human health and the environment?

Decision Statement(s): Determine whether an AOC can be removed from further consideration or whether additional studies are necessary to determine the nature and extent of contamination and risks to human health and the environment.

Types and Sources of Information Needed to Resolve Decisions: To resolve the decision statement(s), soil, groundwater, sediment, and surface water samples will be collected and analyzed for chemicals.

Information Needed to Establish the Action Level: In accordance with the MPCA RBSE Manual, COPC analytical results will be compared to the background levels and regulatory screening criteria, if available. Preliminary regulatory screening criteria, presented in SAP, includes the following:

- Soil Criteria:
    - MPCA Tier 1 (Residential/Unrestricted Land Use) Soil Reference Values (SRVs).
    - USEPA Region 9 Preliminary Remediation Goals (PRGs).
- Soil-to-Groundwater Screening Criteria:
    - MPCA Tier 1 Soil Leaching Values (SLVs).
- Groundwater Criteria:
    - MDH Health Risk Limits (HRL).
    - If no HRLs established, use USEPA Maximum Contaminant Levels (MCLs), Health-Based Values (HBVs), or Lifetime Health Advisory (HLA) limits as specified in the MPCA Drinking Water Criteria tables.
    - USEPA Region 9 PRGs.
- Surface Water Criteria:

  - MPCA Tier 1 Surface Water Screening Criteria based on Minnesota Rules Chapter 7050.

- Sediment Criteria:
  - Sediment Quality Targets (SQTs), Table 14, provided by the MPCA on February 22, 2007, available at: http://www.pca.state.mn.us/water/sediments/sqt-tables.pdf

Appendix 4 of the SAP summarized the target parameters, methods, Reporting Limits (RLs), and regulatory screening criteria. Section 4.3 presents a comparison of the analytical results to the screening criteria presented in the Appendix 4 SAP tables. As stated in the SAP, preliminary screening criteria will be further developed and refined during the Risk Assessment process. Therefore, Sections 5.1.2 and 5.2.1.2 of this SI provide additional screening criteria based upon EPA Region 9 Preliminary Remediation Goals (PRGs) and discussion of the source and use of all of the screening values used in the human health and ecological screening-level risk assessments.

Develop a Decision Rule ("if..then".. statement):

- If contaminants are detected in the soil and exceed the regulatory screening criteria then a release of a potential hazardous substance has occurred.
- If contaminants are detected in the groundwater and exceed the screening criteria then a release of a potential hazardous substance has occurred.
- If contaminants are detected in the sediment and exceed the regulatory screening criteria then a release of a potential hazardous substance has occurred.
- If contaminants are detected in the surface water and exceed the regulatory screening criteria then a release of a potential hazardous substance has occurred.

If analytical results show that a release has occurred and exceed the regulatory screening criteria, additional actions may be necessary. A complete discussion of exceedances is included in Sections 4.0 and 5.0.

4.0 FOCUSED SITE INSPECTION

The field portion of the Focused SI included the Land Survey of AOC 7, sampling of media of concern in each AOC and background sampling for the chemicals identified in the SAP. Prior to performing the sampling activities Bay West obtained access agreements from the land owners.

Samples were sent to Severn Trent Laboratories (STL) for chemical analysis. Laboratory analytical reports and Electronic Data Deliverables (EDDs) are included as a Digital Versatile Disc (DVD) in Appendix 3. The results of the analytical data are summarized in laboratory summary tables (Tables 1 through 24 included under the Tables tab of this report) and discussed in Section 4.3. Table 25 presents a description of the environment encountered at each sample location. Tables 26 and 27 summarize volatile organic compound (VOC) Field Blank analysis, Blind Duplicate Identification Cross Reference, and Matrix Spike/Matrix Spike Duplicate (MS/MSD) sample identification numbers. The blind duplicates identification numbers in the summary Tables 1 through 24 have been changed to actual sample locations and DUP added for clarification. In accordance with the SAP, data verification was performed on 100% of the analytical and data packages. Data validation was performed on 10% of the analytical data packages. Data verification and validation summaries are included in Appendix 4. Data flags are presented in Table 1 and are included in the analytical summary tables (Tables 2-25).

4.1 Land Survey of AOC 7

Bay West contracted with EVS, Inc. to complete the land survey of the Steam Plant and associated 26.7 acres. The survey results were provided to USACE under separate cover on July 3, 2007. The survey results were used to update the AOC 7 figures.

4.2 Sampling Procedures

The Focused SI sample locations were developed to address the DQOs specified in Section 3.0. This includes identifying the potential hazardous substances present, determining whether potential hazardous substances are being released to the environment, and determining whether potential hazardous substances have impacted specific targets. The detailed sampling rationale/design for each AOC is presented in the SAP and summarized in Section 4.3. Sample methods for the different media are described in Sections 4.2.1 through 4.2.4.

Immediately after collection of the sample, chemical preservative, if needed, was added. In addition, each sample container was packed for shipment and the Chain-of-Custody was completed in accordance with the SAP. Non-dedicated sampling equipment was decontaminated in accordance with SAP prior to moving to the next sampling location. Soil, groundwater, surface water and sediment samples were collected for laboratory analysis from the locations shown on Figures 3 through 10. Sample locations and analytical results are discussed in greater detail in Section 4.3.

4.2.1 Soil Sampling

Procedures used in the collection of surface, subsurface, and composite soil samples are described in this section.

Surface Soil Samples: Surface soil samples were collected from 0-0.5 ft bgs using dedicated sampling equipment (disposable scoops and zip-lock baggies). All VOC, SVOCs, PAHs, DRO

and nitrocellulose samples were collected as discrete aliquots from the middle of the interval without homogenization, using a stainless steel spoon or disposable syringe. Sample containers designated for discrete samples were filled so that minimal headspace was present in the containers. All remaining samples were collected from homogenized soil over the depth interval.

Subsurface Soil Samples: Soil borings using direct-push technology were completed by Northeast Technical Services (NTS) using a vehicle-mounted Geoprobe ® sampling unit. Direct-push borings were performed to 1) define the characteristics of the unconsolidated sediments below the Site; 2) characterize the relationship between the subsurface stratigraphy to aid in the evaluation of potential pathways of contamination; 3) allow for the collection of soil samples at discrete intervals for physical identification, field analysis, and chemical analysis; and 4) allow for the collection of groundwater samples for analytical laboratory chemical analyses (Section 4.2.2).

All direct push-soil samples were logged by a Bay West geologist in the field on the USACE Drilling Log Form. Copies of the completed drilling logs are included in Appendix 5. Soil samples for lithologic logging were collected continuously for the first 10 ft and then every 5 ft for the remaining depth of each boring. Samples for laboratory analysis were retrieved with a macro-core sampler. The probe rods and sampling units were advanced by the static weight of the carrier vehicle and hydraulic hammer percussion. Sample cores were collected with removable clear plastic liners. Upon retrieval of the sampling device, the percentage of recovery was recorded and the contained soil core was split in half lengthwise using a stainless steel knife. Samples designated for laboratory analysis were collected from the core using disposable syringes or bottles were filled directly. The syringe was either used to retrieve an isolated section(s) of the soil core or was run lengthwise down the core to collect a sample representative of the entire core interval.

All soil samples were screened for organic vapors using a Flame Ionization Detector (FID). Headspace analysis was performed in general accordance with the MPCA Fact Sheet 3.22 *"Soil Sample Collection and Analysis Procedures"* and the Geology Supplement to the SOS. Headspace readings are included on the boring logs in Appendix 5. The FID was calibrated prior to each days drilling activities using a methane standard.

Subsurface soil samples were collected at depths no greater than 10 ft bgs, unless otherwise specified. In general, if one subsurface sample was targeted for collection from a boring, the sample was collected from 2 to 4 ft bgs. If more than one subsurface soil sample was collected from a boring, the samples were collected from 2 to 4 ft bgs and 8 to 10 ft bgs.

All VOC, SVOCs, PAHs, DRO, and nitrocellulose samples were collected as discrete aliquots from the middle of the interval, without homogenization, using a stainless steel spoon, disposable syringe, or the bottle was filled directly. Sample containers designated for discrete samples were filled so that minimal headspace was present in the containers. All remaining samples were collected from homogenized soil over the depth interval in disposable zip-lock baggies.

After each sample was collected, the soil core sampling equipment was washed in an alconox/water mixture and rinsed with water. Plastic liners were discarded and a new liner was used for the collection of the next sample.

Unless groundwater samples were collected (Section 4.2.2), direct-push borings were abandoned upon completion of the boring in accordance with the Minnesota Department of Health (MDH) well code by placing a bentonite grout slurry seal from the bottom of the borehole to grade.

Composite Sampling: The first step of the compositing process involved the assembly of the bottles containing the discrete samples to be composited (Note: At this point, samples for VOC, SVOCs, PAHs, DRO, and nitrocellulose analysis had been previously collected. These samples were not collected from composited or homogenized sample volumes). Next, an equal quantity of each discrete sample was placed into a disposable zip-lock bag. The soil placed into the bag was mixed thoroughly until the single composite sample had a consistent physical appearance. Upon completion of the compositing process, the sample jars were filled from the zip-lock bag.

4.2.2 Direct-push Groundwater Sampling

Groundwater samples were collected at locations shown on Figures 3 through 10, and described in Section 4.3. Groundwater samples were collected from the water table when encountered within 100 ft bgs. If groundwater was present, after the completion of the direct-push borings described above, a four-foot-long screen was advanced to the bottom of the bore hole and the groundwater was allowed to stabilize. Prior to sample collection, an electric water level indicator was lowered into the direct-push rod to record the depth to groundwater. Factory fresh tubing with a stainless steel check value on its end was lowered into the screen and the groundwater was pumped manually for sample collection. Groundwater samples for metals analysis were field filtered.

Upon completion of the water sampling, the direct-push borings were abandoned in accordance with the MDH well code by placing a bentonite grout slurry seal from the bottom of the borehole to grade.

4.2.3 Surface Water and Sediment Sampling

Surface water samples and sediment samples were collected for laboratory analysis at locations shown on Figure 3C, and described in Section 4.3.1. Surface water and sediment samples were co-located.

Surface Water: Surface water samples were collected first to minimize sediment entrainment in the water sample. If more than one sample was collected from a water body, the furthest down-gradient surface water sample was collected first. Surface water samples were obtained using dedicated equipment and factory-fresh disposable sampling equipment. One of the following procedures was used depending on the characteristics of the water body.

Direct Fill: Collection of surface water samples using the direct fill hand-held bottle method was accomplished by submerging the appropriate sample container with the cap in-place into the body of water. The container was then slowly and continuously filled using the cap to regulate the rate of sample entry into the container. The sample container was filled, such that a minimum of bubbling (and volatilization) occurred. Every effort was made to not disturb the sediments and minimize sediment entrainment in the water sample. The sample container was retrieved from the water body with minimal disturbance to the sample.

Dipper and Pond: Collection of surface water samples using the dipper and pond method was accomplished by slowly submerging the sampler device into the water so that the open end of

the device is facing upstream. Every effort was made to not disturb the sediments and minimize sediment entrainment in the water sample. The sampler device was retrieved from the water body with minimal disturbance to the sample, which was then transferred into appropriate sample containers.

Sediment Sampling: After collection of the water sample, sediment samples were collected 0 to 4 inches bgs with a drop core. Organic debris (leaf litter, sticks, etc.) were removed prior to placing sample into laboratory containers. Non-dedicated sampling equipment was decontaminated between each sample location.

4.2.4 Test Pit Excavations and Soil Sampling

Test pits were conducted using an excavator to collect surface soil and subsurface soil samples in AOC 6. In most instances, test pit excavations extended to native soils. Excavations did not extend greater than 5 ft in depth. Test pit observations were recorded on an HTRW Boring Log Form and are included in Appendix 5.

Soil samples were collected for laboratory analysis at locations shown on Figure 8, and described in Section 4.3.6. Soil samples were collected as described in the soil sampling procedures in Section 4.2.1. All surface soil samples were collected from 0 to 0.5 ft bgs from the sidewalls of the test pits. Subsurface soil samples were collected directly from the excavator bucket. Samples were collected in fill material, if encountered.

4.3 Field and Analytical Results for Each AOC

A brief discussion of the geologic and hydrologic conditions encountered, sampling locations and purpose, and analytical results for each AOC is provided in this section. A complete discussion on exceedance of screening criteria is presented in Section 5.0, Screening Level Risk Assessment. All tables referenced are located behind the Tables tab associated with this report.

4.3.1 AOC 1, Waste Ditch and Settling Ponds

Soil and groundwater samples collected from AOC 1 were analyzed for VOCs, SVOCs, Resource Conservation and Recovery Act (RCRA) metals, DNT, and nitrocellulose; surface water samples were analyzed for VOCs, PAHs SIM, RCRA metals (6020), DNT, and nitrocellulose; and sediment samples were analyzed for VOCs, PAHs SIM, RCRA metals, DNT, and nitrocellulose. Additional discussion on sample locations and selected analytical results for each section is provided below.

AOC 1-Northern Section: Soil encountered in boring AOC1N-GP1 consisted of approximately 4 ft of silt and sand underlain by medium to coarse, poorly-graded sand to 54 ft bgs (the termination of the boring). Groundwater was encountered at approximately 50 ft bgs.

Two surface soil, two subsurface soil, and one groundwater samples were collected from one grab sample and one push-probe boring. Table 2 presents a summary of the soil analytical results and Table 5 presents a summary of the groundwater analytical results. See Figure 3A for sample locations and selected analytical results. Results are briefly summarized below:

- One surface soil sample, two subsurface soil samples, and one groundwater sample were collected from one direct-push boring (AOC1N-GP1) in the middle of this section. This

sample location was selected to provide information on chemicals that may have been transported into and deposited in this area. Metals, 1 SVOC [Bis(2-Ethylhexyl)phthalate], 5 VOCs, and nitrocellulose were detected in the soil. Bis(2-Ethylhexyl)phthalate, 2,4-DNT , and 3 VOCs were detected in the groundwater. It should be note that bis(2-Ethylhexl)phthalate is frequently identified as a sampling or laboratory contaminant.

- One surface soil grab sample (AOC1N-SS-SS1) was collected at the southern end of the this section in the waste ditch to provide information on chemicals that may have been transported out of this area and as a baseline to determine potential impacts that may have occurred down-stream from the Coates Dump. Explosives (2,4-DNT and 2,6-DNT), metals, 8 VOCs, and nitrocellulose were detected in the soil. SVOCs were not detected. However, the MDLs for SVOCs were elevated due to sample matrix interferences.

Middle Section: Soil encountered in AOC 1M generally consisted of 10 ft of silt and sand underlain by medium to course poorly-graded sand to the termination of the boring (AOC1M-GP1-36 ft bgs; AOC1M-GP2-44 ft bgs; AOC1M-GP3-20 ft bgs). Groundwater was encountered at approximately 31 ft bgs in AOC1M-GP1; 36 ft bgs in AOC1M-GP2; and 14 ft bgs in AOC1M-GP3.

A total of five surface soil, six subsurface soil, and three groundwater samples were collected from two grab samples and three push-probe borings. Table 3 presents a summary of the soil analytical results and Table 5 presents a summary of the groundwater analytical results. See Figure 3B for sample locations and selected analytical results. Results are briefly summarized below.

- One surface soil grab sample (AOC1M-SS-SS1) was collected at the southern end of the Coates Dump in the waste ditch to provide information on chemicals that may have been deposited as a result of surface water runoff from the Coates Dump. Metals, 3 SVOCs, 2 VOCs and nitrocellulose were detected in the soil.
- Primary Settling Basin. Two direct-push borings and one surface soil sample for the collection of three surface soil samples, four subsurface soil samples, and two groundwater samples were placed in the primary settling basin.
    - AOC1M-GP1 was placed at the head of the primary settling basin to provide information on chemicals that may have settled out immediately upon entering the basin area. Metals, 2,4-DNT, 5 SVOCs, 8 VOCs and nitrocellulose were detected in the soil. Barium and bis(2-Ethylhexyl)phthalate were detected in the groundwater at this location. Bis(2-Ethylhexyl)phthalate is frequently identified as a sampling or laboratory contaminant.
    - AOC1M-GP2 was placed at the toe of the primary settling basin to provide information on chemicals that may have migrated further downstream, prior to exiting the basin area. Metals, 2,4-DNT, 5 SVOCs, 6 VOCs, and nitrocellulose were detected in the soil. Barium was detected in the groundwater at concentrations below background.
    - AOC1M-SS2. The second surface soil sample was targeted for the drainage/waste ditch south of the dam/weir structure from the primary settling basin to provide information on chemicals that may have been transported further downstream. Metals, 2,4-DNT, 3 SVOCs, 3 VOCs, and nitrocellulose were detected in the soil.
- A third direct-push boring (AOC1M-GP3) was placed in the southern portion of the drainage/waste ditch in this section to provide information on chemicals that may have been

transported further downstream. Metals, 2,4-DNT, 3 SVOCs, 3 VOCs, and nitrocellulose were detected in the soil. Barium was in detected in the groundwater at concentrations below background. Acetone, trichloroethene and nitrocellulose were also detected in the groundwater. Acetone is frequently identified a common laboratory contaminant.

Southern Section: Soil encountered in AOC1S generally consisted of 10 ft of silty clay and sand. The borings were terminated at 10 ft bgs. Groundwater was encountered at approximately 6 ft bgs.

A total of five surface soil, four subsurface soil, and two groundwater samples were collected from two grab samples and three push-probe borings. Two surface water and two sediment samples were also collected. Table 4 presents a summary of the soil analytical results, Table 5 presents a summary of the groundwater analytical results, Table 6 presents a summary of the sediment analytical results and Table 7 presents a summary of the surface water analytical results. See Figure 3C for sample locations and selected analytical results. Results are briefly summarized below.

- Secondary Settling Basin. Two direct push borings were placed within the secondary settling basin for the collection of two surface soil samples, four subsurface soil samples, and two groundwater samples.
    - AOC1S-GP1 was placed at the head of the secondary settling basin to provide information on chemicals that may have settled out immediately upon entering the basin area. Metals, 3 SVOCs, 3 VOCs, and nitrocellulose were detected in the soil. Barium and bis(2-Ethylhexyl)phthalate were detected in the groundwater at this location. Bis(2-Ethylhexyl)phthalate is frequently identified as a sampling or a laboratory contaminant.
    - AOC1S-GP2 was placed at the toe of the primary settling basin to provide information on chemicals that may have migrated further downstream, prior to exiting the basin area. Metals, 4 SVOCs, 4 VOCs, and nitrocellulose were detected in the soil. Barium was detected in the groundwater at concentrations near or below background concentrations.
- Three additional surface soil grab samples were also collected:
    - Contact/mixing basin. Surface soil sample AOC1S-SS-SS1 was collected in the location of the former contact/mixing basin. Metals, 1 SVOC, 6 VOCs and nitrocellulose were detected in the soil.
    - Former chemical storehouse building. Surface soil sample AOC1S-SS-SS2 was collected near the former chemical storehouse building. Metals, 14 SVOC, 5 VOCs and nitrocellulose were detected in the soil.
    - Former still-well. Surface soil sample AOC1S-SS-SS3 was collected near the former still-well. Metals, 8 SVOCs, 5 VOCs and nitrocellulose were detected in the soil.
- Two sediment samples were co-located with two surface water samples collected below the dam/weir structure. The surface water and sediment samples were targeted for the center most point at the inflow (head) and outflow (toe) of the water body to provide information on chemicals that may have settled out in these areas and determine if contaminants may have migrated further downstream.
    - Surface water sample (AOC1S-W-S1) and sediment sample (AOC1S SED-SED1) were collected within approximately 4 ft of the dam/weir structure

(Appendix 2, Photographs 24 and 25). Metals, 16 SVOCs, 6 VOCs and nitrocellulose were detected in the sediment. Metals, 10 SVOCs, 1 VOCs and nitrocellulose were detected in the surface water.

- o Surface water sample (AOC1S-W-S2) and sediment sample (AOC1S-SED-SED2) were collected in a small stream (Appendix 2, Photograph 26) down-gradient of the dam/weir structure and the first surface water and sediment sample location. Metals, 16 SVOCs, 2 VOCs and nitrocellulose were detected in the sediment. Metals, 1 SVOC, and nitrocellulose were detected in the surface water.

It should be noted that arsenic was detected in media samples across the entire FGOW Site. Arsenic is a naturally occurring substance that can be found in any of these media and has been found in the background samples (see Section 4.3.8). Arsenic is not known to be related to gunpowder production. However, possible historical uses of arsenic, which may have occurred after DuPont/DoD operations, include pesticides, fertilizers, and 'dips' to protect livestock from ticks and other pests.

4.3.2 AOC 2, Shipping/Storage Buildings

Soil encountered in AOC 2 generally consisted of 3 to 4 ft of silty clay underlain by poorly-graded sand to the termination depth of the borings (AOC2-GP1 at 36 ft bgs; AOC2- GP2 at 59 ft bgs). Groundwater was encountered at approximately 32 ft bgs in AOC2-GP1 and at approximately 55 ft bgs in AOC2-GP2.

Soil and groundwater samples collected from AOC 2 were analyzed for DNT, DPA, and nitrocellulose. A total of two surface soil, four subsurface soil, and one groundwater samples were collected from two push-probe borings. Tables 8 and 9 present a summary of the soil and groundwater analytical results, respectively. See Figure 4 for sample locations and analytical results.

Two direct push borings were placed within AOC 2 for the collection of two surface soil samples, four subsurface soil samples, and two groundwater samples. Results are briefly summarized below.

- AOC2-GP1 was placed in a drainage area within AOC 2 to provide information on chemicals that may have been released as a result of historical Site activities conducted in AOC 2. Contaminants were not detected above the RLs in the soil or groundwater samples.
- AOC2-GP2 was placed within the approximate perimeter of a former shipping/storage building to provide information on chemicals that may have been released from materials stored within the building. Contaminants were not detected above the RLs in the soil or groundwater samples.

4.3.3 AOC 3, Miscellaneous Drainage Areas

Soil and groundwater samples collected from AOC 3 were analyzed for DNT, DPA, and nitrocellulose. A total of five surface soil, one subsurface soil, and two groundwater samples were collected from three grab samples and two push-probe borings. Tables 10 and 11 present a summary of the soil and groundwater analytical results, respectively. See Figure 5A and Figure 5B for sample locations and analytical results. Results are briefly summarized below.

AOC 3-DA1: This drainage area is located south of AOC 5. Soil encountered in AOC 3-DA1-GP1 generally consisted of 6.5 ft of silt underlain by poorly-graded sand to the termination depth of 52 ft bgs. Groundwater was encountered at approximately 50 ft bgs.

Samples were collected in this area to provide information on chemicals that may have migrated into or out of this drainage area from AOC 5. With the exception of low levels of nitrocellulose in the surfaces soil samples (AOC3-SS-SS1 and AOC3-SS-GP1) and the 2-4 ft interval (AOC3-S-GP1), contaminants were not detected above the RLs in the soil or groundwater.

AOC 3-DA2: This drainage area is located between AOC 2 and AOC 4. Soil encountered in AOC 3-DA2-GP1 generally consisted of 5 ft of silt underlain by poorly-graded sand to the termination depth of 55 ft bgs. Groundwater was encountered at approximately 49 ft bgs.

Samples were collected to provide information on chemicals that may have migrated into this drainage area. With the exception of low levels of nitrocellulose in the surfaces soil samples (AOC3-SS-SS1, AOC3-SS-SS2 and AOC3-SS-GP1), contaminants were not detected above the RLs in the soil or groundwater.

4.3.4 AOC 4, Sanitary Buildings

Soil encountered in AOC 4 generally consisted of 2 ft of silt or silty sand underlain by poorly-graded sand to the refusal depth of 52 ft bgs (AOC4-GP1) and 53 ft bgs (AOC4-GP2). Bedrock, indicative of the St. Peter Sandstone was encountered at 53 ft bgs in AOC4-GP2. Groundwater was not encountered in the AOC 4 borings. Coal pieces were noted on the ground surface near the former boiler house during implementation of the Focused SI work.

Soil samples collected from AOC 4 were analyzed for PAHs, DRO, gasoline range organics (GRO), and RCRA metals. A total of four surface soil and four subsurface soil samples were collected from two grab sample and two push-probe borings. Groundwater was not encountered in the push-probe borings so groundwater samples were not obtained for analysis. Table 12 presents a summary of the soil analytical results. See Figure 6 for sample locations and selected analytical results.

Sample locations were selected to provide information on chemicals that may have been released near the historical buildings/features or migrated into drainage areas as a result of historical Site activities. Metals, DRO, GRO and 5 SVOCs were detected in the soil.

4.3.5 AOC 5, Dinitrotoluene Storage Bunkers

Soil encountered in AOC 5 generally consisted of 2-4 ft of silt underlain by poorly-graded sand to the termination depth of the borings with the following exceptions:

- A 1.5 to 2 foot silt layer was encountered between 4 and 7 ft bgs in borings AOC5-GP8, AOC5-GP9, and AOC5-GP11.
- AOC5-GP5 and AOC5-GP7 were extended to a refusal depth of 48 ft and 44 ft bgs, respectively. The borings were terminated due to the presence of a dense gravel layer and/or bedrock. Perched groundwater was encountered in AOC5-GP7 at 41 ft bgs where a clay layer was present at 40-44 ft bgs. The remaining borings were terminated at 10 ft bgs.

Soil and groundwater samples collected from AOC 5 were analyzed for DNT, DPA, nitrocellulose, RCRA metals, PAHs, DRO, and GRO. Soils were additionally analyzed for

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organochlorine pesticides to evaluate possible releases from activities that occurred after DuPont/DoD operations. A total of 12 surface soil, 24 subsurface soil, and one groundwater samples were collected from 12 push-probe borings. Tables 13 and 14 present a summary of the soil and groundwater analytical results, respectively. See Figure 7 for sample locations and selected analytical results.

Sample locations were targeted near or adjacent to the entrance of each DNT storage bunker and in potential surface water drainage areas to provide information on chemicals that may have been released as a result of historical Site activities. One surface soil sample and one subsurface soil sample was collected for chemical analysis from each of the twelve direct-push locations in this AOC. Metals, DRO, GRO, 15 PAHs, 2,4-DNT, and nitrocellulose were detected in the soil. 2,4-DNT was only detected in one soil sample (FGOW-AOC5-SS-GP9).

Groundwater was only encountered in one of the deep borings (AOC5-GP7). This was a slowly recharging perched groundwater system and it took several days of water collection to collect adequate sample volume for analysis. There were no detections above the MDLs and/or screening criteria in the groundwater. DRO, GRO and 2 SVOCs were detected in the groundwater sample. Barium was detected in the groundwater sample at levels near or below background concentrations. DNT and DPA were not detected in the groundwater sample.

4.3.6 AOC 6, 154th Street Disturbed Area

Six test pits were excavated in AOC 6. Test pit and sample locations were adjusted in the field to bias the samples locations towards visible fill material, lower areas, or possible depositional areas. Photographs 27 through 57 document the test trench activities. Soil samples were analyzed for RCRA metals and PAHs. A total of six surface soil and six subsurface soil samples were collected from six test pits. Table 15 presents a summary of the soil analytical results. See Figure 8 for sample locations and selected analytical results. Results are briefly summarized below.

- AOC6-TP1 was excavated to 3 ft bgs. There were no visible signs of fill material. Samples were collected for analysis in the topsoil (0-6 inches) and the underlying poorly-graded sand (3 ft). Metals and 12 PAHs were detected in the surface soil sample from this location. Metals were detected but PAHs were not detected above the RLs in the subsurface soil sample from this location.
- AOC6-TP2 was excavated to 4 ft bgs. Fill material consisting of metal bike frame, wire, concrete, and PVC plastic was present up to 2 ft bgs. Poorly-graded sand was encountered below the fill. Samples were collected for analysis in the fill (0-6 inches) and the underlying poorly-graded sand (2 ft). Metals and 11 PAHs were detected in the soil at this location.
- AOC6-TP3 was excavated to 5 ft bgs. The trench was terminated at 5 ft due to possible asbestos-containing material. Fill material consisting of concrete, bricks, possible asbestos-containing material, transite siding, rags, and metal were present to the termination depth. Two samples (0-6 inches and 5 ft) were collected for analysis in the fill material. Metals and 15 PAHs were detected in the soil at this location.
- AOC6-TP4 was excavated to 4 ft bgs. There were no visible signs of fill material. Samples were collected for analysis in the topsoil (0-6 inches) and the underlying poorly-graded sand (4 ft). Metals and 13 PAHs were detected in the surface soil sample from this location. .

Metals were detected but PAHs were not detected above the RLs in the subsurface soil sample from this location.

- AOC6-TP5 was an elongated trench (approximately 40 ft) due to the presence of rubble less than 1 ft bgs. Therefore, the trackhoe continued to move until excavation could continue to a greater depth. The main trench was excavated to 5 ft bgs. The trench was terminated at 5 ft due to possible asbestos-containing material. Fill material consisting of concrete, bricks, possible asbestos-containing material, asphalt shingles, pottery, burn material, and transite siding were present to the termination depth. Two samples (0-6 inches and 5 ft) were collected for analysis in the fill material. Metals and 15 PAHs were detected in the soil at this location.
- AOC6-TP6 was excavated to 3 ft bgs. Fill material consisting of concrete, cow bones, and barbed wire present up to 1 ft bgs. Samples were collected for analysis in the fill (0-6 inches) and the underlying poorly-graded sand (2 ft). Metals and 13 PAHs were detected in the soil at this location.

4.3.7 AOC 7, Steam Plant and Associated 26.7 Acres

As previously discussed, for the purposes of this Focused SI, AOC 7 has been subdivided into four quadrants as shown on Figure 9. Additional discussion on sample locations, analytical parameters and selected analytical results for each section is provided below.

AOC 7A-Northwest Quadrant: Soil encountered in the seven borings placed in AOC 7A generally consisted of 2 to 5 ft of sandy fill underlain by poorly-graded sand to the termination depth of the borings. Two- to 3-ft silt layers were noted in AOC7A-GP2 and AOC7A-GP7 between 3 and 9 ft bgs. A clay layer was noted in GP3 at 7-8 ft bgs. The deep borings (AOC7A-GP2 and AOC7A-GP6), targeted for groundwater sample collection, were extended to a refusal depth of 53 and 60 ft bgs, respectively. These borings encountered a thick gravel layer in the poorly-graded sand that prevented the push-probe from extending further. Groundwater was not encountered in these borings. The remainder of the borings were each terminated at 10 ft bgs.

Soil samples collected from AOC 7A were analyzed for PCBs, VOCs, SVOCs, and/or RCRA metals. A total of 13 surface soil and seven subsurface soil samples were collected from five grab samples and seven push-probe borings. Table 16 presents a summary of the soil analytical results. See Figure 9A for sample locations and selected analytical results. Results are briefly summarized below.

- Former Transformer Pads, South of the Building 412-A: AOC7A-GP5, AOC7A-GP6, AOC7A-SS-SS1, AOC7A-SS-SS2, AOC7A-SS-SS3, and AOC7A-SS-SS4 were located near the Former Transformer Pads and samples were analyzed for PCBs, Metals, VOCs, and SVOCs. Metals, PCBs, 17 SVOCs, and 10 VOCs were detected in soil.
- Water inlet house on the north side of Building 402-A: AOC7A-GP1, AOC7A-GP2 were located adjacent to the water inlet house and analyzed for Metals, VOCs, and SVOCs. Metals, 18 SVOCs, and 9 VOCs were detected in soil.
- Building 53-TC47. AOC7A-GP4 was located adjacent near this former building and analyzed for VOCs, and SVOCs. Metals, 13 SVOCs, and 6 VOCs were detected in soil .
- Building 402A. Borings AOC7A-GP3 and AOC7A-GP7 were located adjacent to the southwest and southeast corner building, respectively. Samples were analyzed for VOCs,

and SVOCs. Metals, 17 SVOCs, and 6 VOCs were detected in AOC7A-GP3. Metals and 6 VOCs were detected in AOC7A-GP7.

On August 15, 2007, during the collection of the soil samples in the former transformer pad area, munition debris (expended small arm cartridge cases) were encountered scattered on the ground surface (Photographs 58 and 59, Appendix 2). On August 16, 2007, USACE requested additional photographs be taken. The field staff returned to the area and noted that a majority of the expended small arm cartridge cases had been removed from this area,. However, upon looking further, additional expended small arm cartridge cases remained in this area. From appearance/condition of this munition debris, an Omaha District Ordnance and Explosives (OE) Technician concluded that the munition debris had been deposited after the property was transferred to the UMN in 1961.

AOC 7B-Northeast Quadrant: Soil encountered in the three borings placed in AOC 7B generally consisted of 6 to 16 ft of silty sand fill underlain by poorly-graded sand to the termination depth of 68 ft bgs. Groundwater was encountered in these borings at approximately 63 to 68 ft bgs.

Soil and groundwater samples collected from AOC7B were analyzed for DROs, VOCs, SVOCs, and/or RCRA metals. A total of three surface soil, four subsurface soil, and three groundwater samples were collected from three push-probe borings. Tables 17 and 18 present a summary of the soil and groundwater analytical results, respectively. See Figure 9B for sample locations and selected analytical results. Metals and 9 VOCs were detected in the soil. Barium and chromium, 7 SVOCs, 6 VOCs were detected in the groundwater.

AOC 7C-Southeast Quadrant: Soil encountered in the seven borings placed in AOC 7C generally consisted of 3 to 12 ft of silty sand underlain by poorly-graded sand to the termination depth of 65 to 68 ft bgs. Groundwater was encountered in two of the three deep borings at approximately 63 (AOC7C-GP3) and 66 ft bgs (AOC7C-GP6).

Soil and groundwater samples were analyzed for VOCs, SVOCs, RCRA metals, DNT, DPA, and/or nitrocellulose. A total of 15 surface soil, seven subsurface soil, and two groundwater samples were collected from eight grab samples and seven push-probe soil borings. Tables 19 and 20 present a summary of the soil and groundwater analytical results, respectively. See Figure 9C for sample locations and selected analytical results. Metals, 11 SVOCs, 4 VOCs, and nitrocellulose were detected in the soil. Barium, chromium, 8 SVOCs, 6 VOCs, and nitrocellulose were detected in the groundwater.

AOC 7D-Southwest Quadrant: Soil encountered in the nine borings placed in AOC 7D generally consisted of 2 to 10 ft of silt, silty sand and fill underlain by poorly-graded sand to the termination depth of 68 ft bgs (AOC7D-GP1, AOC7D-GP2, AOC7D-GP5, AOC7D-GP8). Boring AOC7D-GP2 encountered a well-graded sand layer at 6-12 ft bgs. Groundwater was encountered in the deep borings between approximately 61 and 64 ft bgs.

Soil and groundwater samples were analyzed for VOCs, SVOCs, RCRA metals, DNT, nitrocellulose, PCBs, and/or DRO. A total of 13 surface soil, 13 subsurface soil, and four groundwater samples were collected from four grab samples and nine push-probe soil borings. Tables 21 and 22 present a summary of the soil and groundwater analytical results, respectively. See Figure 9D for sample locations and selected analytical results. Results are briefly summarized below.

- Former transformer pads (within 405-A Electrical Substation): PCBs, Metals, 17 SVOCs, 6 VOCs, and nitrocellulose were detected in the surface and subsurface soil in this area (AOC7D-SS-SS3, AOC7D-SS-SS4, AOC7D-GP7 and AOC7D-GP8). A groundwater sample was collected from AOC7D-GP8. Barium and 4 VOCs were detected.
- Secondary Containment Reservoir: AOC7D-GP3 was placed adjacent to this area. DRO, Metals, 18 SVOCs, and 1 VOCs were detected in the soils.
- Drainage Ditch: AOC7D-GP2, AOC7D-SS-GP6, AOC7D-GP9, AOC7D-SS-SS1 and AOC7D-SS-SS2, were place along the drainage ditch. DRO, Metals, 14 SVOCs, 9 VOCs and nitrocellulose were detected in the soil. A groundwater sample was collected from AOC7D-GP2. Barium and 4 VOCs were detected.
- 401-AA Flash Mixer, 401-AA1 Precipitators Building: AOC7D-GP1 was placed adjacent to this area. Metals, 7 SVOCs, and 8 VOCs were detected in the soil. DRO, barium, bis(2-Ethylhexyl)phthalate, and 4 VOCs were detected in the groundwater. Bis(2-Ethylhexyl)phthalate may be a sampling or laboratory contaminant.
- 410-A Ash Disposal Pit and Sump: AOC7D-GP5 was placed adjacent to this area. DRO, Metals, 18 SVOCs, 12 VOCs, and nitrocellulose were detected in the soil. Barium, 2 SVOCs, and 6 VOCs were detected in the groundwater.
- Former Fuel Oil Tanks: AOC7D-S-GP4 was placed outside of the concrete wall that contained the former fuel oil tank. DRO, metals, 1 SVOC and 6 VOCs were detected in the soil.

4.3.8 Background Samples

Soil sample locations were selected to represent unbiased background locations. Photographs of selected background borings are included in Appendix 2 (Photographs 60-65). Samples were targeted for agricultural areas, wooded areas, and ditches that do not appear to be runoff areas associated with FGOW operations. Table 25 presents a description of the type of environment present at each background sample location.

Groundwater samples were collected from two of the direct-push sample locations in areas thought to be up-gradient of the Site. Groundwater samples were not collected from direct-push borings placed in suspected drainage areas.

Background soil and groundwater samples were analyzed for RCRA metals. A total of 14 surface soil, 14 subsurface soil, and two groundwater samples were collected from 14 push-probe soil borings. Tables 23 and 24 present a summary of the soil and groundwater analytical results, respectively. See Figure 10 for sample locations and a summary of the analytical results.

Arsenic, barium, cadmium, chromium, lead, and mercury were detected in a majority of the background soil samples. Selenium and silver were not detected above the RLs in soils. Barium was the only metal detected in the groundwater above the RLs.

4.4 Investigation Derived Wastes

Two drums of investigation-derived waste (IDW) consisting of soil cuttings from the geo-probe borings were collected and are currently stored in a secured area in AOC 7A until analytical results and disposal options have been evaluated. Procedures to be utilized for the collection,

storage, characterization and proper disposal of all IDW are described in SAP. Disposal will be consistent with applicable Federal, State, and local regulations or guidance. Bay West will obtain approval from USACE PM on all decisions regarding IDW disposition.

5.0 SCREENING LEVEL RISK ASSESSMENT

5.1 Screening-Level Human Health Risk Assessment

The purpose of this screening-level HHRA is to examine the potential for chemicals detected in environmental media to pose unacceptable risks to human receptors. This screening-level HHRA was conducted by comparing maximum AOC Site chemical concentrations directly to screening criteria in the USEPA Region 9 Preliminary Remediation Goals (PRGs) (USEPA, 2004) (see Section 5.1.2 below for more detailed description).

Total soil (i.e., includes soil analytical results from all depths), groundwater, surface water, and sediment samples were collected from one or more of the seven AOCs investigated within this Focused SI and evaluated in this screening-level HHRA. This evaluation was conducted as a preliminary screening to qualitatively assess the potential for adverse health effects upon exposure to total soil, groundwater, surface water, and sediment where applicable.

The screening-level HHRA was conducted in accordance with the following guidance document:

- Risk Assessment Guidance for Superfund (RAGS), Part A, Human Health Evaluation Manual (USEPA, 1989)

The HHRA summary tables and figures referenced in this section are presented in Appendix 6.

5.1.1 Exposure Assessment

The two primary elements of the exposure assessment are identifying the appropriate receptor group or groups and selecting appropriate exposure point concentrations (EPC). The potential human receptors and EPCs are outlined below.

Potential Human Receptors
For the purposes of the risk-screening portion of this screening-level HHRA, the most conservative screening criteria were selected regardless of current or potential future use. The human health risk-based screening criteria used in this screening-level HHRA assume that human exposure to the chemicals is long-term (chronic) and occurs in a residential site setting through a defined set of common exposure pathways (i.e., ingestion, dermal contact, and inhalation). A residential exposure scenario is generally considered the most conservative human exposure scenario and is appropriate for a screening-level HHRA. The long term/residential exposure scenario is incorporated in the screening-level HHRA through the use of residential-based screening criteria (refer to Section 5.1.2). These conservative assumptions in the initial screening are applied to assess whether an unacceptable risk may be present and further investigation and/or evaluation is warranted. However, the seven AOCs are not likely to be developed for future residential use so human exposure will not be long-term.

If it is determined that additional evaluation beyond the screening-level HHRA is required, human exposure scenarios that best fit actual property use will be selected for any future evaluations. It is assumed that future land use will remain similar to current land use (i.e., industrial and/or agricultural/wildlife management) at the seven AOCs. Based on information available regarding the physical features, site setting, site historical activities, and current and expected land uses, three potential human receptors are considered suitable for the seven AOCs. These include the following:

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- Recreational Users
- Casual Trespassers in Secured Areas
- Agricultural/Commercial/Industrial Workers (short-term worker exposure scenarios)

Potential human exposure pathways associated with these scenarios may include one or more of the following:

- Ingestion, dermal contact, and inhalation exposures to chemicals in soil
- Groundwater ingestion exposures
- Terrestrial food chain exposures due to surface soil chemicals
- Dermal contact and ingestion exposures to chemicals in surface water and sediment that have migrated to surface water with groundwater and/or surface run-off

However, it should be noted that only the primary exposure pathways of ingestion, dermal contact, and inhalation exposures are considered in this initial risk screening. Should further evaluation be required, the remaining exposure pathway would be included. Current and potential future exposure scenarios for the AOCs at FGOW are summarized in the conceptual site models in Appendix 6 of this screening-level HHRA.

Exposure Point Concentrations

The EPC is a conservative estimate of the average chemical concentration in an environmental medium. The EPC is determined for each individual exposure area within an AOC. An exposure area is the area throughout which a receptor moves and encounters an environmental medium for the duration of the exposure. Typically, the 95% Upper Confidence Limit (UCL) of the mean is used as the average chemical concentration when quantifying potential risk. However, at the screening phase limited data and/or undefined exposure area boundaries may preclude the use of a 95% UCL, and the maximum detected concentration may be more appropriate. For this screening-level HHRA, the highest detected chemical concentrations of those chemicals detected in the environmental media sampled at each AOC are considered the EPCs based on the rationale described below.

Soil data were collected at all seven AOCs. For the initial evaluation of soil data the maximum detected concentration was used as the EPC. This approach adds to the protectiveness of the risk characterization since only limited characterization of potential AOC-related chemicals has been conducted. For this initial screening, soil data from samples collected at all depths were evaluated. Analytical data from soil samples collected several feet below ground surface where human exposure is not likely to occur cannot be eliminated from the risk characterization process. This is because of the possibility that these areas could be exposed in the future due to excavation, construction, or other activities. As such, the soil data from each AOC are evaluated as a total soil data set (i.e., includes soil analytical results from all depths). Therefore, given that this is an initial screening and the uncertainty associated with the boundaries of potential exposure areas, the maximum detected concentrations of soil chemicals were used as EPCs.

Groundwater data were collected at AOCs 1, 2, 3, 5, and 7. These data were collected from direct-push boring sample locations using peristaltic pumps and dedicated silicon tubing. Groundwater samples for metals analysis were field filtered. The maximum number of groundwater samples collected for an AOC was six (AOC 1). Therefore, given the limited

knowledge of exposure areas and small sample set sizes, the maximum detected concentrations of groundwater chemicals were used as EPCs.

Surface water and sediment data were collected only at AOC 1. Two surface water and two sediment samples were collected at AOC 1. Therefore, given the limited knowledge of exposure areas and small sample set sizes, the maximum detected concentrations of surface water and sediment chemicals were used as EPCs.

5.1.2 Health-Based Screening Levels

This section presents the criteria used in the screening evaluation of potential human health risks. The chemicals screened were detected during the field sampling and analytical phase of the field activities that were conducted at the seven AOCs as part of the Focused SI.

The maximum detected concentration at each AOC was compared to the USEPA Region 9 PRG. For non-carcinogens, the Region 9 PRG was divided by 10 in order to account for potential additive effects of multiple chemicals. The maximum detected soil and groundwater inorganic concentrations were also compared to background or naturally-occurring levels from samples collected from unbiased background locations at the FGOW during the Focused SI. MPCA Soil Reference Values (SRVs) and MDH HRLs were not used for screening but were included in the tables for comparison purposes only. Each of the aforementioned criteria is discussed in the paragraphs that follow.

USEPA Region 9 PRGs
The USEPA Region 9 PRGs are often used as tools for determining preliminary chemicals of potential concern (COPCs) for human health risk assessments as part of evaluating and cleaning up contaminated sites. They are risk based concentrations derived from standardized equations (representing ingestion, dermal contact, and inhalation exposure pathways), combining exposure information assumptions and USEPA toxicity data. The PRGs contained in the Region 9 PRG Table are generic; they are calculated without site-specific information. Region 9 PRGs should be viewed as USEPA guidelines, not legally enforceable standards. The PRGs for potentially carcinogenic chemicals are based on a target Incremental Lifetime Cancer Risk (ILCR) of $1x10^{-6}$. The PRGs for non-carcinogens are based on a target hazard quotient of 1.0. For potential carcinogens, the toxicity criteria applicable to the derivation of PRG values are oral and inhalation cancer slope factors (CSFs); for non-carcinogens, they are chronic oral and inhalation reference doses (RfDs). These toxicity criteria are subject to change as more updated information and results from the most recent toxicological/epidemiological studies become available. The PRG table is updated periodically to reflect such changes. It should be noted that the most recent update of the Region 9 PRGs was in October 2004. (USEPA, 2004)

Since there are no Region 9 PRGs specifically for surface water or sediment, the detected chemicals in surface water were compared to corresponding tap water PRGs multiplied by a factor of ten and the detected chemicals in sediment were compared to corresponding residential soil PRGs multiplied by a factor of ten. This methodology is utilized to allow for matrix differences between sediment and soil, as well as surface water and tap water. This provides professionally acceptable and conservative human health-based screening criteria for screening chemicals for surface water and sediment in the absence of any other human health screening criteria. It has been successfully utilized in other USEPA Regions, including but not limited to Regions 3, 4, 7, and 8.

Blank Concentrations
If a chemical is detected in both the environmental sample and a blank sample, it may not be retained as a COPC in accordance with RAGS (USEPA, 1989) depending on the concentration of the chemical in the media. Therefore, for the validated data, blank data were compared with results from environmental samples. If the blanks contained detectable results for common laboratory contaminants (i.e., acetone, 2-butanone, methylene chloride, toluene, and phthalate esters), environmental sample results were considered as positive results only if they exceed 10 times the maximum amount detected in the associated blank (USEPA, 1989). If the chemical detected in the blank(s) is not a common laboratory contaminant, environmental sample results were considered as positive results only if they exceed five times the maximum amount detected in the associated blank(s) (USEPA, 1989). Furthermore, the elimination of an environmental sample result would directly correlate to a reduction in the prevalence of the contaminant in that media. Associated blanks for the seven AOCs included trip blanks, which are analyzed for VOCs only.

The aforementioned methodologies for evaluating blanks are usually implemented during third party analytical data validation prior to the selection of COPCs in a baseline risk assessment. It should be noted that data validation was performed on 10% of the data. Therefore, in order to err on the side of conservatism, only data in which the qualifier contained a "U" (undetected at the limit of detection) or "u" (undetected due to presence of analyte in method blank - concentrations in samples not significantly different from background) were treated as not detected. All other analytical results were considered as positive results regardless how they were qualified.

Background or Naturally-Occurring Levels
Generally, a comparison to naturally-occurring levels applies only to inorganic analytes, because the majority of organic chemicals are not naturally occurring. Background samples were collected from areas that were not known to be influenced by Site activities. For this screening-level HHRA, sample concentrations for inorganics in soil and groundwater were compared to maximum detected concentrations of the corresponding background data sets. However, it should be noted that background data are presented in the screening tables for comparison purposes only and are discussed further in the risk management section of the report.

5.1.3 State Values Included for Comparison

MPCA Tier 1 SRVs
Tier 1 SRVs are risk-based soil concentrations based on unrestricted land use that reflect the most common direct exposure pathways to help determine when additional investigation and/or remediation is necessary. Unrestricted land use SRVs allow for both adult and child receptors and combined direct exposure pathways (i.e., incidental soil/dust ingestion, dermal contact, and inhalation of vapors and suspended particulates). MPCA assumes that the Tier 1 SRVs will provide a reasonably conservative, protective exposure scenario for most sites. As per MPCA RBSE Guidance, each chemical-specific SRV corresponds to an individual target risk limit of 1 x 10^{-5} for carcinogens and a 0.2 HQ for non-carcinogens. The most recent update to the Tier 1 SRVs was in May 2007.

Since there are no MPCA human health-based screening criteria available specifically for sediment, the detected chemicals in sediment were compared to the corresponding Tier 1 SRV

multiplied by a factor of ten. As previously discussed, a similar process was followed with the Region 9 PRGs.

In the case of carcinogenic PAHs, MPCA RBSE Guidance states that benzo(a)pyrene equivalent concentrations (BaP equivalents) should be calculated by multiplying the site-specific carcinogenic PAH data results by relative potency factors cited in MPCA RBSE Guidance and then comparing to the BaP equivalent standard of 2,000 µg/kg. For this comparison, rather than altering site-specific data results, individual screening values were calculated for each carcinogenic PAH by dividing the BaP equivalent standard (2,000 µg/kg) by the relative potency factors cited in MPCA RBSE Guidance. This methodology provides a sound tool comparable with calculating BaP equivalents from site data.

MDH HRLs
MDH HRLs are health-risk-based values based on a long-term drinking water consumption scenario. The HRL is used as a reference point for comparison to Site groundwater quality. If no HRLs are established, MCLs, HBVs, or Lifetime Health Advisory (LHA) limits are used as specified in the MPCA Drinking Water Criteria tables. The most recent update to the HRLs was in November 2007. It should be noted that carcinogenic PAHs detected in groundwater were handled in the same manner as described above for soil and sediment.

5.1.4 Risk Screening

A total of five environmental media (surface soil, subsurface soil, groundwater, surface water, and sediment) were investigated at one or more of the seven AOCs included in the Focused SI and evaluated in this screening-level HHRA. Surface and subsurface soil samples were collected from all seven AOCs. Groundwater samples were collected from AOCs 1, 2, 3, 5, and 7. Surface water and sediment samples were collected from AOC 1. Subsurface samples are those soil samples from depths of approximately 6 inches to approximately 10-feet bgs. Screening was conducted for all soil analytical results (regardless of depth) to maintain a conservative approach. Not all available data were included in the risk evaluation. DRO and GRO data were not evaluated because these data do not apply to a specific compound. Although DRO and GRO data can be useful in locating sources of contamination, they are not as informative when evaluated quantitatively in a human health risk evaluation. DRO and/or GRO data were available for AOC 4 soil, AOC 5 soil and groundwater, AOC 7B soil and groundwater, and AOC 7D soil and groundwater. Investigation activities are discussed in greater detail in Section 4.0. Analytical data acquired at the sites were summarized in tabular format and discussed in Section 4.0.

It should be noted that analytical results of re-extractions performed on applicable samples were included in the laboratory analytical results and subsequently some of the data sets. Had all data been validated, these re-extractions would have been incorporated into the original sample or rejected. Therefore, best professional judgment was used in incorporating or rejecting the re-extraction/re-analysis results with the corresponding original sample. This is an acceptable approach for the screening-level risk assessment. Generally, the re-extractions were rejected in favor of the original sample because surrogate recoveries of both original and re-extracted samples were outside control limits or the sample was re-extracted outside hold time. However, in certain circumstances, re-extraction/re-analysis results were incorporated into the original sample. For example, if a sample was diluted and re-analyzed, those results present above the

linear calibration curve and flagged with an "E" (estimated) were replaced with the result from the re-analysis. This was done to achieve the lowest possible reporting limits. If surrogate recoveries of the original sample were outside control limits and the re-analysis was extracted within hold time with surrogate recoveries in control, the original sample was rejected in favor of the re-extraction.

Appendix 6 presents the screening of chemicals for each environmental medium investigated at AOCs 1 through 7 and evaluated in this human health risk evaluation based on comparisons of residential-based screening criteria to the maximum detected concentration. Soil chemicals were screened based on comparisons of the maximum detected concentration with USEPA Region 9 PRGs for residential soil. Groundwater chemicals were screened based on comparisons of the maximum detected concentration with USEPA Region 9 PRGs for tap water (groundwater). Surface water chemicals were screened against 10 times the tap water PRG. Sediment chemicals were screened against the residential soil PRG (multiplied by a factor of 10). If screening criteria were not available, the chemical was discussed in the risk management section of the report. Information is presented in these tables only for those chemicals detected at least once in the medium of interest.

If multiple chemicals are present, the cumulative risk must be evaluated. Therefore, the following actions were taken. In order to account for cumulative risk from multiple non-carcinogenic chemicals in a medium, the non-carcinogenic PRGs were divided by ten (yielding a hazard index of 0.1). Arsenic and total chromium are known to have both non-carcinogenic and carcinogenic properties. Soil saturation/ceiling limits were not divided by ten or number of non-carcinogenic chemicals since they are not risk-based values.

The following paragraphs present the rationale for screening of site chemicals. The sections are organized first by site, then by media investigated at the Site. Brief descriptions of the rational for sample collection are provided below. Please refer to Sections 2.5 and 4.3 of this report for more detailed descriptions of the historical uses and field sampling rational at each AOC. The discussion presented below is limited to those compounds/analytes that exceeded screening criteria . Specific information concerning those compounds/analytes that did not exceed screening criteria is provided in Appendix 6. Sample locations, analytical results, and corresponding figures have been presented in Section 4.0 of this Focused SI Report.

5.1.4.1 AOC 1, Waste Ditch and Settling Ponds

AOC 1-Northern Section

Total Soil: Soil samples collected at AOC 1 - Northern Section were analyzed for VOCs, SVOCs, DNT, metals, and nitrocellulose. Samples were collected as to provide information on chemicals that may have been transported into and deposited in this area and as a baseline to determine potential impacts that may have occurred down-stream from the Coates Dump. The screening table for total soil at AOC 1 - Northern Section is presented in Appendix 6.

VOCs, SVOCs , DNT, metals, and nitrocellulose were detected in AOC 1 - Northern Section soil. As shown on Appendix 6, Table 1, arsenic and mercury were detected above their

residential soil PRGs. Nitrocellulose has no screening criteria.[10] It should be noted that the maximum arsenic concentration was less than the maximum background arsenic concentration. The maximum detection of mercury exceeded its adjusted PRG but not the actual U.S. EPA Region 9 PRG.

AOC 1-Middle Section

Total Soil: Soil samples collected at AOC 1 - Middle Section were analyzed for VOCs, SVOCs, DNT, metals, and nitrocellulose. Samples were collected to provide information on chemicals that may have been deposited as a result of surface water runoff from the Coates Dump, as well as waste water discharged into the waste disposal ditches. The screening table for total soil at AOC 1 - Middle Section is presented in Appendix 6.

VOCs, SVOCs, DNT, metals, and nitrocellulose were detected in AOC 1 - Middle Section soil. As shown on Appendix 6, Table 2, arsenic and mercury were detected above their residential soil PRGs. Nitrocellulose has no screening criteria. It should be noted that the maximum arsenic concentration was less than the maximum background arsenic concentration. The maximum detection of mercury exceeded the adjusted Region 9 PRG but not the actual Region 9 PRG.

Groundwater: Three out of the six AOC 1 groundwater samples were collected from AOC 1-Middle Section. Therefore, all of the AOC 1 groundwater sample results are presented in the AOC 1M discussion. Groundwater samples collected at AOC 1 were analyzed for VOCs, SVOCs, DNT, metals, and nitrocellulose. The screening table for groundwater at AOC 1 is presented in Appendix 6.

VOCs, one SVOC, DNT, metals, and nitrocellulose were detected in AOC 1 groundwater. As shown on Appendix 6, Table 3, bis(2-ethylhexyl)phthalate was detected above its tap water PRGs. Nitrocellulose has no screening criteria...

As noted above, bis(2-ethylhexyl)phthalate exceeded screening criteria. However, bis(2-ethylhexyl)phthalate is frequently identified as a sampling or laboratory contaminant.[11]

AOC 1-Southern Section

Total Soil: Soil samples collected at AOC 1 - Southern Section were analyzed for VOCs, SVOCs, DNT, metals, and nitrocellulose. Samples were collected to provide information on chemicals in the basin area, contact/mixing basin, former chemical storehouse building, former still-well, and waste disposal ditch. The screening table is presented in Appendix 6.

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[10] Per *Textbook of Military Medicine, Part III, Volume 2 Occupational Health: The Soldier and the Industrial Base, Chapter 9Military Energetic Materials: Explosives and Propellants (1993),* nitrocellulose "…has a very low potential as a hazard to human health. As an insoluble polymer, nitrocellulose is not absorbed in the gut, and in fact does not appear to be absorbed by any route. The only effects of ingestion are due to the bulk of fiber, which may occlude the intestinal lumen, and are no different than effects of nonnitrated cellulose. Nitrocellulose is not irritating to the skin, and no mutagenic activity has been detected."

[11] Phthalates are common plasticizers often found in laboratory and sampling equipment. They are also common laboratory contaminants that are seen in environmental samples.

VOCs, SVOCs , DNT, metals, and nitrocellulose were detected in AOC 1 - Southern Section soil. As shown in Appendix 6, Table 4, the following exceeded their respective residential soil PRGs: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene; and arsenic. Nitrocellulose has no screening criteria. The maximum arsenic value only marginally exceeded the upper background concentration for arsenic.

Surface Water: Surface water samples collected at AOC 1 - Southern Section were analyzed for VOCs, PAHs, DNT, metals, and nitrocellulose. The surface water and sediment samples were targeted for the center most point at the inflow (head) and outflow (toe) of the water body to provide information on chemicals that may have settled out in these areas and determine if chemicals may have migrated further downstream. The screening table for surface water at AOC 1 - Southern Section is presented in Appendix 6.

One VOC, multiple PAHs and metals , as well as nitrocellulose, were detected in AOC 1 - Southern Section surface water. As shown in Appendix 6, Table 5, arsenic exceeded corresponding tap water PRGs multiplied by a factor of 10. Nitrocellulose has no screening criteria.

Sediment: Sediment samples collected at AOC 1 - Southern Section were analyzed for VOCs, PAHs, DNT, metals, and nitrocellulose. The sediment samples were co-located with the surface water samples and collected as described above. The screening table for sediment at AOC 1 - Southern Section is presented in Appendix 6.

VOCs, PAHs, metals, and nitrocellulose were detected in AOC 1 - Southern Section sediment. As shown in Appendix 6, Table 6, arsenic exceeded the residential soil PRG multiplied by a factor of 10. Nitrocellulose has no screening criteria.

5.1.4.2 AOC 2, Shipping/Storage Buildings

Soil and groundwater samples were collected at AOC 2 and analyzed for DNT, DPA, and nitrocellulose. Samples were collected to provide information on chemicals that may have been released as a result of historical activities conducted in AOC 2. There were no positive detections of any of the analytes in the soil or groundwater analytical results. As such, there were no exceedances of screening criteria for AOC 2. AOC 2 data are presented in Section 4.3.2 of the Focused SI Report.

5.1.4.3 AOC 3, Miscellaneous Drainage Areas

Soil and groundwater samples were collected at AOC 3 and analyzed for DNT, DPA, and nitrocellulose. Samples were collected to provide information on chemicals that may have migrated into or out of the drainage areas. There were no positive detections of any of the analytes in the soil or groundwater analytical results. As such, there were no exceedances of screening criteria for AOC 3. AOC 3 data are presented in Section 4.3.2 of the Focused SI Report.

5.1.4.4 AOC 4, Sanitary Buildings

Total Soil: Soil samples collected at AOC 4 were analyzed for PAHs, TPH, and metals. Sample locations were selected to provide information on chemicals that may have been released near

the historical buildings/features or migrated into drainage areas as a result of historical activities. The screening table for total soil at AOC 4 is presented in Appendix 6.

PAHs, TPH, and metals were detected in AOC 4 soil. As shown in Appendix 6, Table 7, arsenic exceeded its residential soil PRG. It should be noted that the maximum arsenic soil concentration was less than the maximum background soil arsenic concentration.

5.1.4.5 AOC 5, Dinitrotoluene Storage Bunkers

Total Soil: Soil samples collected at AOC 5 were analyzed for PAHs, DPA, pesticides, DNT, metals, and nitrocellulose. Sample locations were targeted near or adjacent to the entrance of each DNT storage bunker and in potential surface water drainage areas to provide information on chemicals that may have been released as a result of historical activities. The screening table for total soil at AOC 5 is presented in Appendix 6.

Multiple PAHs, multiple pesticides, DNT, and metals were detected in AOC 5 soil; DPA was not detected. As shown in Appendix 6, Table 8, the following exceeded their respective residential soil PRGs: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene; the pesticide dieldrin; and arsenic. It should be noted that the maximum arsenic concentration was less than the maximum background arsenic concentration.

According to available information, there is no historical mention of FGOW use of dieldrin at AOC 5 and since it was not produced until 1948,[12] it was not available at the time of FGOW activities. Therefore, dieldrin is the result of activities that occurred after FGOW operations. The bunkers are currently being used by the UMN for storage of a variety of materials including chemicals (such as fertilizers, paints, and petroleum products), machinery, scrap wood, and metal.

As part of FGOW, this site was intended to store DNT. There is no evidence to link the presence of PAHs at the site to the short period of DuPont/DoD activities. Buildings at the site were turned over to UMN intact.

Groundwater: Groundwater samples collected at AOC 5 were analyzed for PAHs, DPA, DNT, metals, and nitrocellulose. The screening table for groundwater at AOC 5 is presented in Appendix 6.

PAHs and metals were detected in AOC 5 groundwater. As shown in Appendix 6, Table 9, none of the detected compounds exceeded tap water PRGs. Therefore, no screening criteria were exceeded for AOC 5 groundwater.

[12] "Cyclodienes--The cyclodienes appeared after World War II: chlordane, 1945, aldrin and dieldrin, 1948; heptachlor, 1949; endrin, 1951; mirex, 1954; endosulfan, 1956; and chlordecone (Kepone®), 1958." *An Introduction to Insecticides, 4th Edition*, George W. Ware and David M. Whitacre; University of Minnesota

5.1.4.6 AOC 6, 154th Street Disturbed Area

Total Soil: Soil samples collected at AOC 6 were analyzed for PAHs and metals. Samples were collected at locations biased towards visible fill material, lower areas, or possible depositional areas. The screening table for total soil at AOC 6 is presented in Appendix 6.

PAHs and metals were detected in AOC 6 soil. As shown on Appendix 6, Table 10, the following exceeded their respective residential soil PRGs: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene; and the metal arsenic.

5.1.4.7 AOC 7, Steam Plant and Associated 26.7 Acres

AOC 7A-Northwest Quadrant

Total Soil: Soil samples collected at AOC 7A were analyzed for VOCs, SVOCs, PCBs, and metals. Samples were collected to provide information on chemicals in the following areas: former transformer pads (south of the Building 412-A), remnants of the water inlet house on the north side of remnants of Building 402-A, former Building 53-TC47, and the southwest and southeast corner near Building 402A. A screening table for total soil at AOC 7A is presented in Appendix 6.

VOCs, SVOCs, PCBs, and metals were detected in AOC 7A soil. As shown in Appendix 6, Table 11, the following exceeded their respective residential soil PRGs: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, carbazole, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene; fluoranthene, naphthalene, and phenanthrene: the PCBs Aroclor-1254, Aroclor-1260; and the metals arsenic and lead. It should be noted that the PAH, PCB, and lead exceedances were primarily in the area of the former transformer pads. It should also be noted that the maximum arsenic concentration was less than the maximum background arsenic concentration. .

AOC 7B-Northeast Quadrant

Total Soil: Soil samples collected at AOC 7B were analyzed for VOCs, SVOCs, DNT, and metals. Samples were collected to provide information on chemicals that may have been released as a result of historical activities. The screening table for total soil at AOC 7B is presented in Appendix 6.

VOCs and metals were detected in AOC 7B soil. As shown on Appendix 6, Table 12, only arsenic exceeded its respective residential soil PRG. It should be noted that the maximum arsenic concentration was less than the maximum background arsenic concentration.

Groundwater: Groundwater samples collected at AOC 7B were analyzed for VOCs, SVOCs, and metals. The screening table for groundwater at AOC 7B is presented in Appendix 6.

VOCs, SVOCs, and metals were detected in AOC 7B groundwater. As shown on Appendix 6, Table 13, the VOC chloroform and the PAHs benzo(k)fluoranthene, and bis(2-chloroisopropyl)ether exceeded their respective tap water PRGs. Note that chloroform does not exceed its MCL.

AOC 7C-Southeast Quadrant

Total Soil: Soil samples collected at AOC 7C were analyzed for VOCs, SVOCs, DPA, DNT, metals, and nitrocellulose. Samples were collected to provide information on chemicals that may have been released as a result of historical activities. The screening table for total soil at AOC 7C is presented in Appendix 6.

VOCs, SVOCs, metals, and nitrocellulose were detected in AOC 7C soil. As shown in Appendix 6, Table 14, the PAH benzo(a)pyrene and the metal arsenic exceeded their residential soil PRGs. Nitrocellulose has no screening criteria.

Groundwater: Groundwater samples collected at AOC 7C were analyzed for VOCs, SVOCs, DPA, DNT, metals, and nitrocellulose. The screening table groundwater at AOC 7C is presented in Appendix 6.

VOCs, SVOCs, two metals, and nitrocellulose were detected in AOC 7C groundwater. As shown on Appendix 6, Table 15, the VOC chloroform, the PAH benzo(a)anthracene, and the phthalate bis(2-ethylhexyl)phthalate, and the metal chromium exceeded their respective tap water PRGs. The compounds 4-Nitrophenol and nitrocellulose do not have screening criteria. Chromium exceeds only the adjusted PRG, not the actual Region 9 PRG. In addition, the PRG chosen for screening was the value for Chromium VI, which is very conservative, since Chromium III is the more prevalent form and is far less toxic than Chromium VI.

AOC 7D-Southwest Quadrant

Total Soil: Soil samples collected at AOC 7D were analyzed for VOCs, SVOCs, DPA, PCBs, DNT, metals, and nitrocellulose. Samples were collected to provide information on chemicals in the following areas: Former Transformer Pads (within 405-A Electrical Substation), former Secondary Containment Reservoir, drainage ditch, remnants of former 401-AA Flash Mixer/401-AA1 Precipitators building, 410-A Ash Disposal Pit and Sump, and the Former Fuel Oil Tanks. The screening table for total soil at AOC 7D is presented in Appendix 6.

VOCs, SVOCs, PCBs, metals, and nitrocellulose were detected in AOC 7D soil. As shown on Appendix 6, Table 16, the following exceeded their respective residential soil PRGs: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene; the SVOC pentachlorophenol; the PCBs Aroclor-1254 and Aroclor-1260; and the metals arsenic, barium, and lead. It should be noted that the PCB and lead exceedances occurred in the former transformer pads area (within 405-A Electrical Substation). The 3-methylphenol & 4-methylphenol mixture and nitrocellulose have no screening criteria.

Groundwater: Groundwater samples collected at AOC 7D were analyzed for VOCs, SVOCs, DPA, PCBs, DNT, metals, and nitrocellulose. The screening table for groundwater at AOC 7D is presented in Appendix 6.

VOCs, SVOCs, and metals were detected in AOC 7D groundwater. As shown in Appendix 6, Table 17, the VOC chloroform, and SVOCs 2,4,6-trichlorophenol and 2-methylnaphthalene exceeded their respective tap water PRGs. Chloroform does not exceed its MCL.

5.1.5 Characterization of Uncertainty

Uncertainties are encountered throughout the risk screening process. This section discusses the sources of uncertainty inherent in the following elements of the screening-level HHRA performed for AOCs 1 through 7:

- Sampling and analysis (reliability and uncertainties)
- Screening of chemicals (the application of the health-based screening value and the inherent assumptions used in its derivation)
- Exposure assessment (use of maximum chemical concentration for EPCs and highest exposure receptors)
- Limited chemical database for the AOCs
- Conservative measures incorporated in the screening-level HHRA

Uncertainties associated with this screening-level HHRA are discussed in the following sub-sections.

5.1.5.1 Sampling and Analysis

The development of a risk assessment depends on the reliability of, and uncertainties associated with, the analytical data available to the risk assessor. These, in turn, are dependent on the operating procedures and techniques applied to the collection of environmental samples in the field and their subsequent analyses in the laboratory. To minimize the uncertainties associated with sampling and analysis at the seven AOCs included in the Focused SI, MPCA approved sampling and analytical methods were employed. Samples were collected from locations specified in the approved Work Plan along with the necessary QA/QC samples.

Analytical data are limited by the precision and accuracy of the methods of analysis that are reflected by the relative percent difference (RPD) of duplicate analyses and the percent recovery of spikes, respectively. In addition, the statistical methods used to compile and analyze the data (e.g., detection frequencies) are subject to the overall uncertainty in data measurement. Furthermore, chemical concentrations in environmental media fluctuate over time and with respect to sampling location. Analytical data must be sufficient to consider the temporal and spatial characteristics of chemicals at the Site with respect to exposure.

There is uncertainty associated with performing data validation on only 10% of the data collected for the seven AOCs. Therefore, in order to err on the side of conservatism, all data regardless of the assigned qualifier (with the exception of “U” or “u” qualified data) were considered positive results. As a result, it is likely that data frequencies of some common and uncommon laboratory contaminants would have been reduced had data been qualified non-detect based on blank contamination. Treating these data as positive results likely over-estimates potential risk.

As previously stated, analytical results of re-extractions performed on applicable samples were included in the laboratory analytical results and subsequently some of the data sets, since only 10% of the data was validated. Had all data been validated, these re-extractions would have been incorporated into the original sample or rejected. Typically, it is not appropriate to include the analytical results of re-extractions/re-analyses as separate environmental analytical results in a risk assessment. Therefore, best professional judgment was used in incorporating or

rejecting the re-extraction/re-analysis results with the corresponding original sample. Generally, the re-extractions were rejected in favor of the original sample because surrogate recoveries of both original and re-extracted samples were outside control limits or the sample was re-extracted outside hold time. However, in certain circumstances, re-extraction/re-analysis results were incorporated into the original sample. For example, if a sample was diluted and re-analyzed, those results present above the linear calibration curve and flagged with an "E" (estimated) were replaced with the result from the re-analysis. This was done to achieve the lowest possible reporting limits. If surrogate recoveries of the original sample were outside control limits and the re-analysis was extracted within hold time with surrogate recoveries in control, the original sample was rejected in favor of the re-extraction. These actions may have resulted in an over- or under-estimation of potential risk.

5.1.5.2 Screening of Chemicals

Soil chemicals were screened based on comparisons of the maximum detected concentration with PRGs for residential soil (soil). Groundwater chemicals were screened based on comparisons of the maximum detected concentration with PRGs for tap water (groundwater) Surface water chemicals were compared to 10 times the tap water PRG. Sediment chemicals were compared to10 times the residential soil PRG.

PRGs were derived using conservative, USEPA-promulgated default values, and the most recent toxicological criteria available. This adds additional conservatism to the chemical screening process.

RfDs and CSFs have been combined with "standard" exposure scenarios to calculate the PRG. Actual exposure scenarios and parameters may differ from those used to calculate the PRG.

Nitrocellulose was detected at several of the AOCs. It does not have screening criteria with which it can be evaluated. A literature search was conducted to determine potential adverse human health effects from direct contact exposure to nitrocellulose. While there is no established screening value for nitrocellulose, available data on human health effects and mammalian toxicity suggest that this chemical is virtually nontoxic (Ryon, 1986).

Although future residential development is unlikely, a conservative approach to this risk screening was applied. The list of chemicals that exceed residential screening values for soil, groundwater, surface water, and sediment is considered conservative for the FGOW. Conservative chemical screening in the human health risk screening protects public health.

5.1.5.3 Exposure Assessment

In performing exposure assessments, uncertainties arise from two main sources. First, uncertainties arise in estimating the fate of a compound in the environment, including estimating release and transport in a particular environmental medium. Second, uncertainties arise in the estimation of chemical intakes resulting from contact by a receptor with a particular medium.

To estimate an intake, certain assumptions must be made about exposure events, exposure durations, and the corresponding assimilation of chemicals by the receptor. The highest exposure receptors (i.e., residents) were assumed in this screening-level HHRA through the use of residential screening criteria. The residential exposure scenario incorporates the most conservative exposure factors, which have been generated by the scientific community and are

not site-specific. It is assumed that all potential receptors remain on or near the Site throughout the exposure periods and that their exposures to chemicals from the Site are all uniform. These assumptions incorporate a great deal of conservatism into the risk screening process.

The use of the maximum chemical concentration as the EPC was designed to avoid underestimating daily intakes at the screening-level phase of the HHRA given the uncertainty associated with exposure areas and in the case of groundwater, surface water, and sediment, small data sets. The use of maximum values as the concentration term reduces the potential for underestimating exposure at the screening-level phase.

5.1.5.4 Limited Chemical Database

Analytical parameters were selected and analyzed at the AOCs based on suspected past activities. This may result in underestimation of potential risk from unknown chemicals because full analytical suites were not included in the sample analyses.

5.1.5.5 Conservative Measures Incorporated into the Screening-Level HHRA

Several conservative measures are incorporated into the screening-level HHRA in order to minimize the potential to underestimate risk to human receptors. The following items summarize interpretations of data that add levels of conservatism to the results of the risk screening:

- Although none of the seven AOCs are likely to be developed for future residential use and much of the area will remain either agricultural and/or managed wildlife, the human health risk-based screening criteria used in this screening-level HHRA assume a residential exposure scenario, which is generally considered the most conservative human exposure scenario.
- Since only limited characterization of potential AOC-related chemicals has been conducted, the maximum detected concentration of each chemical was selected as the EPC for this screening-level HHRA. This approach adds to the protectiveness of the risk characterization.
- Third party data validation was performed on only 10% of the data. Therefore, in order to err on the side of conservatism, only data in which the qualifier contained a “U” (undetected at the limit of detection) or “u” (undetected due to presence of analyte in method blank - concentrations in samples not significantly different from background) were treated as not detected. All other analytical results were considered as positive results regardless how they were qualified.
- To account for cumulative risk from multiple non-carcinogenic chemicals in a medium, the non-carcinogenic PRGs were divided by ten (yielding a hazard index of 0.1).

5.1.6 Results of the Screening-Level HHRA

The screening-level HHRA qualitatively evaluated the potential risk to human receptors based on exposure to chemicals detected at seven AOCs identified at the FGOW. The strengths and weaknesses of the screening-level HHRA are discussed in Section 5.1. The results are summarized as follows:

- AOC 1-Northern Section: Based on the analytical results, AOC 1-Northern Section does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic and mercury in total soil. The maximum arsenic concentration was less than the maximum background arsenic concentration and the maximum mercury concentration exceeded the adjusted PRG but not the actual Region 9 PRG.
- AOC 1-Middle Section: Based on the analytical results, AOC 1-Middle Section does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic and mercury in total soil; and bis[2-ethylhexyl]phthalate in groundwater. The maximum arsenic concentration was less than the maximum background arsenic concentration and the maximum mercury concentration exceeded the adjusted PRG but not the actual Region 9 PRG. Regarding groundwater chemicals, bis(2-ethylhexyl)phthalate is frequently identified as a sampling or laboratory contaminant.
- AOC 1-Southern Section: Based on the analytical results, some screening-level HHRA criteria were exceeded in AOC 1-Southern Section. The screening-level HHRA criteria that were exceeded are as follows: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene, along with arsenic in total soil; arsenic in sediment; and arsenic in surface water. Additional Site evaluation is recommended.
- AOC 2: Based on the analytical results, AOC 2 passed the screening comparison because no chemicals exceeded screening values. There were no positive detections in the soil or groundwater analytical results in this AOC.
- AOC 3: Based on the analytical results, AOC 3 passed the screening comparison because no chemicals exceeded screening values. There were no positive detections in the soil or groundwater analytical results in this AOC.
- AOC 4: Based on the analytical results, AOC 4 does not appear to pose an unacceptable risk to human receptors. Arsenic in total soil exceeded its screening criteria at this AOC. However, the maximum concentration of arsenic was less than the maximum background concentration of arsenic.
- AOC 5: Based on the analytical results, some screening-level HHRA criteria were exceeded in AOC 5. The screening-level HHRA criteria that were exceeded are as follows: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene; the pesticide dieldrin, and the metal arsenic in total soil; no exceedances in groundwater. PAHs are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances. PAHs are usually found as a mixture containing two or more of these compounds, such as soot. As part of FGOW, this site was intended to store DNT. There is no evidence linking the presence of PAHs at the site to the short period of DuPont/DoD activities. Buildings at the site were turned over to UMN intact. It should be noted that the maximum arsenic concentration was less than the maximum background arsenic concentration. According to available information, there is no historical mention of FGOW use of dieldrin at AOC 5 and it was historically not available at the time of FGOW activities. Therefore, dieldrin is a result of activities that occurred after FGOW operations. The bunkers are currently being used by the UMN for storage of a variety of materials including chemicals (such as fertilizers, paints, and petroleum products),

machinery, scrap wood, and metal. No additional human health evaluation of AOC 5 with respect to DuPont/DoD activities is recommended.

- AOC 6: Based on the analytical results, some screening-level HHRA criteria were exceeded in AOC 6. The screening-level HHRA criteria that were exceeded are as follows: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene; and arsenic in total soil. No records were found to indicate the date the debris was deposited, but the Site may have been in use during demolition and dismantlement activities during and immediately following the operation of FGOW. It is also possible that some debris may have been placed at the Site more recently. Additional Site evaluation is recommended.
- AOC 7A: Based on the analytical results, some screening-level HHRA criteria were exceeded in AOC 7A. The screening-level HHRA criteria that were exceeded are as follows: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, carbazole, fluoranthene, naphthalene, and phenanthrene; the PCBs Aroclor-1254, Aroclor-1260; and the metals arsenic and lead in total soil. Additional Site evaluation is recommended.
- AOC 7B: Based on the analytical results, AOC 7B does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic in total soil; chloroform, benzo(k)fluoranthene, and bis(2-chloroisopropyl)ether in groundwater. The maximum arsenic concentration in soil did not exceed the maximum background concentration of arsenic. Chloroform did not exceed its MCL. Benzo(k)fluoranthene and bis(2-chloroisopropyl)ether were each detected once in groundwater and were not detected in the soil at AOC 7B. There does not appear to be a need for additional evaluation of site soil. There is no evidence that groundwater contains extensive chemical detections and ground in the area has been extensively reworked subsequent to DuPont/DoD activities. Additional human health evaluation with respect to DuPont/DoD activities is not recommended.
- AOC 7C: Based on the analytical results, AOC 7C does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: benzo(a)pyrene and arsenic in total soil; and chloroform, benzo(a)anthracene, bis(2-ethylhexyl)phthalate, and chromium in groundwater. Benzo(a)pyrene was only detected once in soil, and that detection only marginally exceeded the screening level (65 µg/kg vs. 62 µg/kg). The maximum detection of arsenic in soil was less than the maximum background concentration. Chloroform and chromium do not exceed their respective MCLs. Bis(2-ethylhexyl)phthalate only marginally exceeds its MCL (6.6 µg/L vs. 6.0 µg/L). Benzo(a)anthracene was only detected once in groundwater. Additional human health evaluation with respect to DuPont/DoD activities is not recommended.
- AOC 7D: Based on the analytical results, some screening-level HHRA criteria were exceeded in AOC 7D. The screening-level HHRA criteria that were exceeded are as follows: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene; pentachlorophenol; PCBs; and the metals arsenic, barium, and lead in total soil; chloroform, 2,4,6-trichlorophenol and 2-methylnaphthalene in groundwater. The detections of chloroform do not exceed its MCL. Additional Site evaluation is recommended.

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It should be noted that the presence of PCBs and PAHs may have resulted from historical DuPont/DoD activities in these AOCs. However, PAHs and pesticides are known to be ubiquitous in nature and may be the result of historical activities after DuPont/DoD operations ceased. The detections of arsenic may be related to application of pesticides.

5.2 Screening-Level Ecological Risk Assessment

This section presents a Screening-Level Ecological Risk Assessment (ERA) for each of the seven AOCs. The Screening-Level ERA is consistent with the methods specified in the FSAP and follows guidelines set forth in Steps 1 and 2 of the USEPA guidance, *Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997). Section 5.2.1 describes the methodology used for the Screening-Level ERA, and Sections 5.2.2 through 5.2.8 present results of Screening-Level ERAs for each AOC.

The ERA summary tables and figures referenced in this section are presented in Appendix 7.

5.2.1 Screening-Level ERA Methodology

The USEPA ERA guidance consists of eight steps. The first two steps in this eight-step process represent the Screening-Level ERA:

- Screening-Level Problem Formulation and Ecological Effects Evaluation (Step 1).
- Screening-Level Exposure Estimate and Risk Calculation (Step 2).

These steps are described in the following sections.

5.2.1.1 Screening-Level Problem Formulation

Screening-Level Problem Formulation is the first step (Step 1) of the ERA process and establishes the goals, scope, and focus of the Screening-Level ERA. Major components of Screening-Level Problem Formulation include the following:

- Environmental Setting
- Historical Analytical Data
- Conceptual Model: A description of how chemicals associated with the AOC may come into contact with ecological receptors
    - Contaminant Fate and Transport Mechanisms
    - Exposure Routes and Pathways
    - Selection of Receptors

These major components of the Screening-Level Problem Formulation are described in detail below. This step of the ERA process is intended to answer two main questions: (1) Do complete exposure pathways exist at the Site? and (2) Are sufficient data available to conduct the Screening-Level ERA?

Environmental Setting
The environmental setting is a general description of the Site history and Site features, with emphasis on the habitats and ecological receptors known or likely to be present on or near the AOC. Information on the history of each AOC provides an indication of the types of chemicals possibly used by DuPont/DoD expected on the AOC and the media in which they were likely to

be present. The physical features of each AOC, including geological (e.g., soils), hydrogeological (e.g., surface water and groundwater flow patterns), and climatologic (e.g., precipitation) parameters, were important in determining how chemicals from source areas could be transported to ecological habitats. These descriptions are included in Section 2.0 of this report and were based on existing information and mapping. Available information regarding the habitat types and ecological receptors known or likely to be present on the Site were developed based on historical information and were modified based on information obtained during the Site work and are summarized in AOC-specific sections that follow.

Historical Analytical Data and Analytical Data Obtained for the Focused SI Work
Summaries of historical analytical chemistry data for media at the AOC are included in Section 2.5.

The historical analytical data and analytical data obtained for the Focused SI work for ecologically relevant media were compiled and evaluated. The data compilation followed the approach indicated in Section 5.1 – Screening-Level Human Health Risk Assessment. The evaluation considered such factors as sample size, sample location, analytical parameters, QA/QC samples, and reporting limits to determine if the available data were adequate to conduct the Screening-Level ERA. Not all available data were included in the risk evaluation. DRO and GRO data were not evaluated because these data do not apply to a specific compound. Although DRO and GRO data can be useful in locating sources of contamination, they are not as informative when evaluated quantitatively in an ecological risk evaluation. DRO and/or GRO data were available for AOC 4 surface soil, AOC 5 surface soil, AOC 7B surface soil, and AOC 7D surface soil.

Conceptual Model
The conceptual model was designed to relate potentially exposed receptor populations with potential contaminant source areas based on the physical nature of the AOCs and potential exposure pathways. Important components of the conceptual model were the identification of potential sources of contaminants, transport pathways, exposure media, potential exposure routes, and potential receptor groups. Actual or potential exposures of ecological receptors associated with a given AOC were determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has four components: (1) a source of chemicals that can be released to the environment; (2) a release and transport mechanism to move the chemicals from the source to an exposure point; (3) an exposure point where ecological receptors could contact the affected media; and (4) an exposure route whereby chemicals can be taken up by ecological receptors.

The main objective of the conceptual model in Step 1 of the ERA process was to identify any complete exposure pathways present at an AOC. The AOC-specific Screening-Level ERAs will describe conceptual models that relate directly to the AOCs under consideration. A variety of potential source areas were represented by the seven AOCs under consideration.

Contaminant Fate and Transport Mechanisms: A characterization of known or potential contaminant sources and the likely transport mechanisms (if any) to ecological habitats based on the fate properties of the source-related chemicals. The mechanisms of toxicity for these chemicals were also considered.

In the absence of measured values of chemicals within biotic media, the transport and partitioning of chemicals into particular environmental compartments, and their ultimate fate in

those compartments, was predicted from key physical-chemical characteristics. The physical-chemical characteristics that were most relevant for exposure modeling in this assessment include water solubility, adsorption to solids, and octanol-water partitioning. These characteristics are defined below.

The water solubility of a compound influences its partitioning to aqueous media. Highly water-soluble chemicals, such as most VOCs, have a tendency to remain dissolved in the water column rather than partitioning to sediment (Howard, 1991). Compounds with high water solubility also generally exhibit a lower tendency to bioconcentrate in aquatic organisms and a greater likelihood of biodegradation, at least over the short term (Howard, 1991).

Adsorption is a measure of a compound's affinity for binding to solids, such as soil or sediment particles. Adsorption is expressed in terms of partitioning, either adsorption coefficient (K_d) (a unitless expression of the equilibrium concentration in the solid phase versus the water phase) or as organic carbon partition coefficient (K_{oc}) (K_d normalized to the organic carbon content of the solid phase; again unitless) (Howard, 1991). For a given organic chemical, the higher the K_{oc} or K_d, the greater the tendency for that chemical to adhere strongly to soil or sediment particles. K_{oc} values can be measured directly or can be estimated from either water solubility or the octanol-water partition coefficient using one of several available regression equations (Howard, 1991).

Octanol-water partitioning indicates whether a compound is hydrophilic or hydrophobic. The Octanol-water partition coefficient (K_{ow}) expresses the relative partitioning of a compound between octanol (lipids) and water. A high affinity for lipids equates to a high K_{ow} and vice versa. As discussed above, K_{ow} has been shown to correlate well with Bioconcentration Factors (BCFs) in aquatic organisms, adsorption to soil or sediment particles, and the potential to bioaccumulate in the food chain (Howard, 1991).

Exposure Routes and Pathways: An evaluation of potential exposure routes and a determination of the existence of any potentially complete exposure pathways.

Endpoints and Risk Hypotheses: Assessment and measurement endpoints to be evaluated in the Screening-Level ERA were selected for potentially complete exposure pathways identified in the conceptual model. Testable hypotheses were established regarding the relationship among the assessment endpoints and their predicted responses when exposed to chemicals.

Transport pathways describe the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media. The primary mechanisms for contaminant transport from potential source areas at the AOCs include the following:

- Overland transport of chemicals with surface soil via surface runoff to downgradient surface soil, surface water and sediment.
- Leaching of chemicals from surface soil and/or subsurface soil by infiltrating precipitation and transport to surface water and sediment with groundwater.
- Uptake by biota from surface soil, surface water, and/or sediment and trophic transfer to upper trophic level receptors.

An exposure pathway links a source of contamination with one or more receptors through exposure to one or more ecologically relevant media. Exposure, and thus potential risk, can only occur if complete exposure pathways exist. An exposure route describes the specific

mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. The most common exposure routes are dermal contact, direct uptake, ingestion, and inhalation.

Terrestrial vegetation may be exposed to chemicals present in surface soils through their root surfaces during water and nutrient uptake. Unrooted, floating aquatic plants, rooted submerged aquatic plants, and algae may be exposed to chemicals directly from the water or for rooted plants from sediments.

Terrestrial and aquatic invertebrates may be exposed to chemicals in surface soil, sediment, or surface water through dermal adsorption and ingestion. Much of the toxicological data available for terrestrial and aquatic invertebrates are based on in-situ studies that represent both pathways. Therefore, both pathways are considered together in this Screening-Level ERA. Invertebrates also present a link between surface soil, surface water, and/or sediment and upper trophic level receptors through food web transfer. As such, they are typically included as prey items for upper trophic level dietary exposures.

Birds and mammals may be exposed to chemicals through: (1) the inhalation of gaseous chemicals or chemicals adhered to particulate matter; (2) the incidental ingestion of contaminated abiotic media (e.g., soil or sediment) during feeding or cleaning activities; (3) the ingestion of contaminated water; (4) the ingestion of contaminated plant and/or animal tissues for chemicals that have entered food webs; and/or (5) dermal contact with contaminated abiotic media. Their relative importance depends in part on the chemical being evaluated. For chemicals having the potential to bioaccumulate (e.g., PCBs), the greatest exposure to wildlife is likely to be from the ingestion of prey. For chemicals having a limited potential to bioaccumulate (e.g., aluminum), the exposure of wildlife to chemicals is likely to be greatest through the direct ingestion of abiotic media, such as soil or sediment.

Direct ingestion of drinking water was only considered if the salinity of a drinking water source is less than 15 parts per thousand (ppt), the approximate toxic threshold for wildlife receptors (Humphreys, 1988). AOC 1 was the only AOC with surface water present. This water was fresh water and was evaluated as a potential habitat for aquatic receptors and as a potential drinking water source for upper trophic level receptors.

Certain potential exposure pathways and/or routes were not evaluated in the Screening-Level ERA. Though potentially complete, these pathways were considered insignificant relative to other pathways due to low potential for exposure and low levels of relevant contaminants. For example, dermal exposures were not identified as significant relative to ingestion exposures for upper trophic level receptors and were not evaluated in the Screening-Level ERA. This approach is supported by evidence outlined in Suter II et al. (2000) and USEPA (2000b), including the general fate properties (e.g. low affinity for dermal uptake) of the majority of compounds detected in surface soil, the low potential exposure frequency and duration, and the protection offered by feathers, fur, and scales to avian, mammalian, and reptilian receptors, respectively. In addition, literature reviews indicate that dermal exposures to wildlife from classes of chemicals known or suspected to be of concern via dermal adsorption (VOCs, organophosphate pesticides, petroleum compounds) are often overestimated in laboratory studies (where feathers/fur are removed) and do not represent realistic exposure scenarios (USEPA, 2000b). Furthermore, in developing soil screening-levels for 24 important compounds identified from National Priorities List (NPL) sites, USEPA calculated that the contribution of dermal exposures to the total dose received by terrestrial receptors to be 0.5 percent or less

and therefore omitted the dermal pathway from in their exposure estimates (USEPA, 2000b). Incidental ingestion of soil or sediment during feeding and preening activities is, however, considered in the risk estimates for upper trophic level receptors. Direct contact exposures were also considered for lower trophic level receptors (e.g., terrestrial and aquatic invertebrates).

Inhalation of gaseous chemicals and chemicals adhered to particulate matter (e.g., soil) were also excluded from evaluation in this Screening-Level ERA as the inhalation pathway is considered insignificant relative to ingestion pathways. As described above for dermal exposures, this approach is consistent with Suter II et al. (2000) and USEPA (1997 and 2000b), which recognize the relatively small contribution of the inhalation pathway to exposure estimates. For example, USEPA (2000b) estimates the expected contribution of exposure to dust particles and VOCs via inhalation to be 0.01% and 0.5% or less, respectively relative to ingestion. Vegetative groundcover and litter layers further minimize suspension of dust and the potential for exposure.

Endpoints and Risk Hypotheses. The screening-level problem formulation included the selection of ecological endpoints. Endpoints in the Screening-Level ERA define ecological attributes that are to be protected (assessment endpoints) and a measurable characteristic of those attributes (measurement endpoints) that can be used to gauge the degree of impact that has or may occur (USEPA, 1992, 1997, and 1998). Assessment endpoints most often relate to attributes of biological populations or communities, and are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by chemicals attributable to the site (USEPA, 1997). Assessment endpoints contain an entity (e.g., red-tailed hawk) and an attribute of that entity (e.g., survival rate). Individual assessment endpoints usually encompass a group of species or populations (the receptor) with some common characteristic, such as specific exposure route or contaminant sensitivity, with the receptor then used to represent the assessment endpoint in the risk evaluation. The considerations for selecting assessment and measurement endpoints are summarized in USEPA (1992 and 1997) and discussed in detail in Suter II (1989, 1990, and 1993). Risk hypotheses are testable hypotheses about the relationship among the assessment endpoints and their predicted responses when exposed to contaminants.

Assessment and measurement endpoints may involve ecological components from any level of biological organization, from individual organisms to the ecosystem (USEPA, 1992). Effects on individuals are important for some receptors, such as rare and endangered species, but population and community-level effects are typically more relevant to ecosystems. Population and community-level effects are usually difficult to evaluate directly without long-term and extensive study. However, measurement endpoint evaluations at the individual level, such as an evaluation of the effects of chemical exposure on reproduction, can be used to predict effects on an assessment endpoint at the population or community-level. In addition, use of criteria values designed to protect the vast majority (e.g., 95 percent) of the components of a community (e.g., National Ambient Water Quality Criteria [NAWQC] for the Protection of Aquatic Life) can be useful in evaluating potential community and/or population-level effects.

The most appropriate generic assessment endpoint for Screening-Level ERAs is the maintenance of receptor populations. Therefore, the specific objective of the Screening-Level ERA was to determine if exposure to site-related chemicals present in surface water, sediment, and/or surface soil are likely to result in declines in ecological receptor populations. Declines in populations could result in a shift in community structure and possible elimination of resident

species. Measurement endpoints are used in Screening-Level ERAs because it is often difficult or impossible to directly assess whether the environmental value that is to be protected (the assessment endpoint) is being impacted. For example, an assessment endpoint may involve a decline in a particular population or a shift in the structure of a community. While these things might be quantifiable, the necessary studies would generally be time-consuming and difficult to interpret. However, measurement endpoints indicative of observed adverse effects on individuals are relatively easy to measure in toxicity studies and can be related to the assessment endpoint. For example, contaminant concentrations that lead to decreased reproductive success or increased mortality of individuals in toxicity tests could, if found in the environment, result in shifts in population structure, potentially altering the community composition associated with a site.

Risk hypotheses are testable hypotheses about the relationship among the assessment endpoints and their predicted responses when exposed to chemicals. Although USEPA (1997) prescribes that risk hypotheses be developed in Step 3 (screening level risk assessment problem formulation), it is generally useful to develop preliminary risk hypotheses as part of the screening-level problem formulation.

Preliminary assessment endpoints, risk hypotheses, and measurement endpoints for the AOCs addressed in this document are presented in Appendix 7, Table 1.

Selection of Receptors.
Receptor species were selected at each AOC based on the environmental setting and the selected assessment endpoints.

Because of the complexity of natural systems, it is generally not possible to directly assess the potential impacts to all ecological receptors present within an area. Therefore, receptor species (e.g., red-tailed hawk) or species groups (e.g., terrestrial invertebrates) are often selected as surrogates to evaluate potential risks to larger components of the ecological community (guilds; e.g., insectivorous birds) represented in the assessment endpoints (e.g., survival and reproduction of insectivorous birds). Selection criteria typically include those species about which the following statements apply:

- Are known to occur, or are likely to occur, at the Site.
- Have a particular ecological, economic, or aesthetic value.
- Are representative of taxonomic groups, life history traits, and/or trophic levels in the habitats present at the Site for which complete exposure pathways are likely to exist.
- Can, because of toxicological sensitivity or potential exposure magnitude, be expected to represent potentially sensitive populations at the Site.
- Have sufficient ecotoxicological information available on which to base an evaluation.

Lower trophic level species were evaluated based on those taxonomic groupings (e.g., terrestrial and aquatic plants and invertebrates) for which screening values have been developed. These groupings and screening values are used in most Screening-Level ERAs. As such, specific receptor species of lower trophic level biota were not chosen because of limited species-specific information available. These receptors were instead dealt with on a community level via a comparison to media-specific screening values.

The upper trophic level receptor species listed below were selected for dietary exposure modeling based on the criteria listed above, the general guidelines presented in USEPA (1992), the environmental setting (e.g., habitats), and the assessment endpoints selected at each AOC.

Terrestrial species:

- Avian omnivore - American robin (*Turdus migratorius*)
- Mammalian herbivore - Meadow vole (*Microtus pennsylvanicus*)
- Avian herbivore - Mourning dove (*Zenaida macroura*)
- Mammalian carnivore - Red fox (*Vulpes vulpes*)
- Avian carnivore - Red-tailed Hawk (*Buteo jamaicensis*)
- Mammalian insectivore - Short-tailed shrew (*Blarina carolinensis*)
- Mammalian omnivore - White-footed mouse (*Peromyscus maniculatus nubiterrae*)

Semi-aquatic species:

- Mammalian omnivore - Raccoon (*Procyon lotor*)

Screening-Level Problem Formulation Decision Point
The screening-level problem formulation was intended to answer two main questions: (1) Do complete exposure pathways exist at the AOC? and (2) Are sufficient data available to conduct the Screening-Level ERA? Complete exposure pathways from a source area are likely to exist if all of the following are present:

- Habitat that supports ecological receptor populations (note that ecological habitat may be absent due to chemical contamination or habitat alteration).
- Contaminant transport pathways to ecologically relevant media. Although a site may contain no or marginal ecological habitat, it will be assessed if site-related chemicals have the potential to migrate to areas containing more extensive or more viable habitat. A site of this nature may contribute to overall contamination in the watershed in which it exists.
- Complete exposure routes.

If no complete exposure pathways existed at an AOC, the ERA process would terminate at Step 1 - Screening-Level Problem Formulation with a conclusion of negligible risk. This was not the case for any of the AOCs under consideration in this document. In all cases, one or more complete exposure pathways were known or likely to exist, and the ERA process continued to Step 2 - Screening-Level Ecological Effects Evaluation, which included the Screening-Level Exposure Estimation, and Screening-Level Risk Calculation. Only pathways that were determined to be complete were evaluated.

5.2.1.2 Screening-Level Ecological Effects Evaluation

The purpose of the screening-level ecological effects evaluation is the establishment of chemical exposure levels (screening values) that represent conservative thresholds for adverse ecological effects. One set of screening values is typically developed for each of the selected assessment endpoints. Two types of screening values (media-specific screening values and ingestion-based screening values) were developed. Media-specific screening values were developed for ecologically relevant media at each AOC (e.g., surface soil). Sources of

toxicological benchmarks that were used to develop the media-specific screening values are listed below.

Soil Screening Values (in order of preference):

- USEPA Ecological Soil Screening Levels (Eco-SSLs) (USEPA, 2005a-f, 2006, 2007a-e) available at http://www.epa.gov/ecotox/ecossl/
- USEPA Region 5 Ecological Screening Levels (USEPA, 2003) available at http://www.epa.gov/reg5rcra/ca/ESL.pdf
- Benchmarks obtained from the Risk Assessment Information System (RAIS) Ecological Screening Benchmark Tool available at http://rais.ornl.gov/cgi-bin/eco/eco_search

Surface Water Screening Values (in order of preference):

- MPCA Tier I Screening benchmarks for surface water (MPCA, 2006) available at http://www.pca.state.mn.us/cleanup/riskbasedoc.html
- Benchmarks obtained from the RAIS Ecological Screening Benchmark Tool available at http://rais.ornl.gov/cgi-bin/eco/eco_search

Sediment Screening Values (in order of preference):

- Sediment Quality Targets (SQTs) for Minnesota (MPCA, 2007) available at http://www.pca.state.mn.us/water/dediments/sqt-tables.pdf.
- USEPA Region 5 Ecological Screening Levels (USEPA, 2003) available at http://www.epa.gov/reg5rcra/ca/ESL.pdf
- Benchmarks obtained from the Risk Assessment Information System (RAIS) Ecological Screening Benchmark Tool available at http://rais.ornl.gov/cgi-bin/eco/eco_search

Appendix 7, Table 2 lists the screening values selected by medium. Additional information regarding the sources for screening values follows:

- USEPA Ecological Soil Screening Levels (Eco-SSL): The Eco-SSL guidance provides a set of risk-based soil screening levels for several soil contaminants that are frequently of ecological concern for terrestrial plants and animals at hazardous waste sites. The most conservative of values derived for terrestrial plants, terrestrial invertebrates, mammals, and avian receptors was selected.
- USEPA Region 5 Ecological Screening Levels (ESL): USEPA Region 5 ESLs for RCRA Appendix 9 hazardous chemicals are initial screening levels with which the Site chemical concentrations can be compared.
- MPCA Tier I Screening Benchmark for Surface Waters: The MPCA Remediation Program has produced a Surface Water Pathway Evaluation User's Guide with surface water screening value tables to be used for preliminary site assessments. Tier I values were used.
- Sediment Quality Targets for the Protection of Sediment-Dwelling Organisms in Minnesota: The MPCA has published guidance for the use and application of SQTs for the protection of sediment-dwelling organisms. Sources cited include the following:
    - Freshwater consensus-based sediment quality guidelines (MacDonald et al., 2000)

  - New York State Department of Environmental Conservation (NYSDEC) sediment guidance (NYSDEC, 1999)
  - Canadian environmental quality guidelines (Canadian Council of Ministers of the Environment [CCME], 1999)

- Risk Assessment Information System (RAIS) Ecological Screening Benchmark Tool: This resource summarizes benchmarks from a variety of sources. The most conservative of available values was selected. Those sources cited on Appendix 7, Table 2 include the following:
  - Soils: Dutch Target and Intervention Values (Swartjes, 1999).
  - Sediment: USEPA Region 6 ecological screening benchmarks (TNRCC, 2001)

Ingestion-based screening values for dietary exposures were derived for each receptor species and chemical evaluated for food web exposures. Toxicological information from the literature for wildlife species most closely related to the receptor species was used if available. This information was supplemented by laboratory studies of non-wildlife species (e.g., laboratory mice) when necessary. Chronic No Observed Adverse Effect Levels (NOAELs) based on growth or reproduction were preferentially used as ingestion-based screening values for upper trophic level receptors. NOAELs represent the highest dose of a chemical at which an effect being measured in a toxicity test does not occur. If several chronic toxicity studies were available from the literature for a given chemical, the most appropriate study was selected for each receptor species based on study design, study methodology, study duration, study endpoint, and test species. When chronic NOAEL values were unavailable, estimates were derived or extrapolated from chronic Lowest Observed Adverse Effect Levels (LOAELs) or acute values (LD50). LOAELs represent the lowest dose of a chemical at which an effect being measured in a toxicity test occurs, while an LD50 represents the dose of a chemical at which half of the organisms being tested die. An uncertainty factor of 10 was used to convert a reported LOAEL to a NOAEL, while an uncertainty factor of 100 was used to convert the acute LD50 to a chronic NOAEL (i.e., the LD50 was multiplied by 0.01 to obtain the chronic NOAEL). Appendix 7, Tables 3 and 4 provide ingestion-based screening values for birds and mammals, respectively.

Not all chemicals analyzed in ecologically relevant media were evaluated for food web exposures. The specific chemicals evaluated for food web exposures were limited to those identified as important bioaccumulative chemicals in Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs (USEPA, 2000a). These chemicals and their respective log K_{ow} values are provided on Appendix 7, Table 5.

5.2.1.3 Screening-Level Exposure Estimation

This portion of the Screening-Level ERA involves the identification of the data to be used to represent concentrations of chemicals to which ecological receptors may be exposed to in various media and the derivation of exposure point concentrations from those data (typically the maximum detected concentration). Exposure assumptions, exposure models, and model input parameters are also presented and discussed.

Selection Criteria for Analytical Data
Available analytical data for ecologically relevant media were selected for use in the Screening-Level ERA based on the following set of selection criteria:

- Maximum reporting limits were conservatively used to estimate exposure for non-detected chemicals.
- In some instances, duplicate samples were collected in the field. The maximum concentration of each chemical in the original or duplicate sample was used as a conservative estimate of chemical concentrations at a particular sampling point.

Exposure Point Concentrations – Abiotic Media

Maximum detected concentrations in abiotic media (e.g., surface soil) were used to conservatively estimate potential chemical exposures for the ecological receptors selected to represent the assessment endpoints. For conservatism, the maximum detection limit for chemicals that were analyzed but not detected was compared to the medium-specific screening value and (where applicable) used for food web exposure modeling. This was done to ensure that detection limits were similar to, or less than, chemical concentrations at which potential adverse effects to ecological receptors may occur.

Exposure Point Concentrations – Prey Items

Exposures for upper trophic level receptor species via the food web were determined by estimating the chemical-specific concentrations in each dietary component using uptake and food web models. Ingestion of abiotic media, if appropriate, was also included when calculating the total level of exposure. As indicated previously, maximum measured concentrations in abiotic media were used in all calculations to provide a conservative assessment. Tissue concentrations were modeled for terrestrial plants (food item for American robin, meadow vole, mourning dove, short-tailed shrew, and white-footed mouse), soil invertebrates (food item for American robin, meadow vole, red fox, short-tailed shrew, white-footed mouse, and red-tailed hawk), small mammals (food item for red-tailed hawk and red fox), amphibians (food item for raccoon), aquatic plants (food item for raccoon), and aquatic invertebrates (food item for raccoon). Maximum media concentrations from each AOC were used as exposure point concentrations for incidental ingestion by upper trophic level receptors. The methods and models used to derive these estimates are described below.

The uptake of chemicals from the abiotic media into terrestrial and aquatic food items was based (where available) on conservative (e.g., maximum or 90th percentile) BCFs or bioaccumulation factors (BAFs) from the literature. A BCF indicates the degree to which a chemical may concentrate in organisms coincident with the concentration of the chemical in the surrounding media. They are calculated by dividing the concentration of a chemical in the tissue of organisms by the concentration in the surrounding media. BAF values consider both direct exposures to the surrounding media, as well as uptake from dietary exposures. As such, BAFs were given preference over BCFs when estimating prey item tissue concentrations. Default factors of 1.0 were used only when data are unavailable for chemicals in the literature. The methods and models used to derive these estimates are described below.

Terrestrial Plants: Tissue concentrations in the aboveground vegetative portion of terrestrial plants were estimated by multiplying the maximum measured soil concentration for each chemical by chemical-specific soil-to-plant BCFs obtained from the literature. The BCF values used were based on root uptake from soil and on the ratio between dry-weight soil and dry-weight plant tissue. Literature values based on the ratio between dry-weight soil and wet-weight plant tissue were converted to a dry-weight basis by dividing the wet-weight BCF by the estimated solids content for terrestrial plants (15 percent [0.15]; Sample et al., 1997).

BCFs for terrestrial plants are those reported in Baes et al. (1984) or Bechtel Jacobs (1998a) for inorganic chemicals. For non-ionic organic chemicals, BCFs were obtained from chemical-specific regressions of plant uptake data compiled by USEPA as part of the Eco-SSL effort (USEPA, 2005f). Significant regressions (i.e., those with a slope significantly different than 0 and R^2 value > 0.2) were used to estimate bioaccumulation. If a significant regression was not found for a specific chemical, the median BAF was used to estimate bioaccumulation. In the absence of chemical-specific empirical data on plant uptake, "an inter-chemical extrapolation approach which related log K_{ow} to log BAF can be used" (USEPA, 2005f).

The soil-to-plant BCFs used in the Screening-Level ERA are summarized in Appendix 7, Table 6.

Earthworms. Tissue concentrations in soil invertebrates (earthworms are the standard surrogate) were estimated by multiplying the maximum measured soil concentration for each chemical by chemical-specific BCFs or BAFs obtained from the literature. BCFs are calculated by dividing the concentration of a chemical in the tissues of an organism by the concentration of that same chemical in the surrounding environmental medium (in this case, soil) without accounting for uptake via the diet. BAFs consider both direct exposure to soil and exposure via the diet. Since earthworms consume soil, BAFs are more appropriate values and were used in the food web models when available. BAFs based on depurated analyses (soil was purged from the gut of the earthworm prior to analysis) were given preference over undepurated analyses when selecting BAF values since direct ingestion of soil is accounted for separately in the food web model.

The BCF/BAF values used in this Screening-Level ERA are based on the ratio between dry-weight soil and dry-weight earthworm tissue. Literature values based on the ratio between dry-weight soil and wet-weight earthworm tissue were converted to a dry-weight basis by dividing the wet-weight BCF/BAF by the estimated solids content for earthworms (16 percent [0.16]; USEPA, 1993). For inorganic chemicals without available measured BCFs/BAFs, an earthworm BAF of 1.0 was assumed.

Small Mammals. Whole-body tissue concentrations in small mammals (short-tailed shrew, meadow vole, and white-footed mouse) were estimated using one of two methodologies. For chemicals with literature-based soil-to-small mammal BAFs, the small mammal tissue concentration was obtained by multiplying the maximum measured surface soil concentration for each chemical by a chemical-specific soil-to-small mammal BAF. The BAF values used are based on the ratio between dry-weight soil and whole-body dry-weight tissue. Literature values based on the ratio between dry-weight soil and wet-weight tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for small mammals (32 percent [0.32]; USEPA, 1993). BAFs for shrews were those reported in Sample et al. (1998b) for insectivores (or for general small mammals if insectivore values were unavailable), for voles were those reported for herbivores, and for mice were those reported for omnivores. The soil-to-small mammal BAFs used in the Screening-Level ERA are shown in Appendix 7, Table 7.

For those chemicals without soil-to-small mammal BAF values, an alternate approach was used to estimate whole-body tissue concentrations. Because most chemical exposure for small mammal species is via the diet, it was assumed that the concentration of each chemical in the small mammal's tissues is equal to the chemical concentration in its diet, that is, a diet to whole-

body BAF (wet-weight basis) of one was assumed. Resulting tissue concentrations (wet-weight) were converted to dry weight using an estimated solids content of 32 percent (see above).

The use of a diet to whole-body BAF of one is likely to result in a conservative estimate of chemical concentrations for chemicals that are not known to biomagnify in terrestrial food chains (e.g., aluminum). For chemicals that are known to biomagnify (e.g., PCBs), a diet to whole-body BAF value of one will likely result in a realistic estimate of tissue concentrations based on reported literature values. For example, a maximum BAF (wet weight) value of 1.0 was reported by Simmons and McKee (1992) for PCBs based on laboratory studies with white-footed mice. Menzie et al. (1992) reported BAF values (wet-weight) for dichlorodiphenyltrichloroethane (4,4'-DDT) of 0.3 for voles and 0.2 for short-tailed shrews. Reported BAF (wet-weight) values for dioxin are only slightly above one (1.4) for the deer mouse (USEPA 1990).

Aquatic Plants. Tissue concentrations in the vegetative portion of aquatic plants (i.e., rooted wetland vegetation) were estimated using the same methodologies as described above for terrestrial plants except that maximum sediment (not soil) concentrations were used in the calculation. Conservative sediment-to-aquatic plant BAFs used in the Screening-Level ERA are summarized in Appendix 7, Table 8.

Amphibians. Tissue concentrations in whole-body frogs were estimated by multiplying the maximum measured sediment concentration for each chemical by chemical-specific sediment-to-fish BAFs. Sediment-to-fish BAFs were used to estimate frog tissue concentrations due to a lack of literature-based BAFs designed specifically for the sediment-to-frog pathway. The use of sediment-to-fish BAFs represents a source of uncertainty since they may provide an uncertain estimate of sediment-to-frog bioaccumulation. A summary of the sediment-to-frog BAFs used in the Screening-Level ERA is provided in Appendix 7, Table 8.

Aquatic Invertebrates. Tissue concentrations in aquatic invertebrates were estimated by multiplying the maximum measured sediment concentration for each chemical by chemical-specific sediment-to-invertebrate BCFs or BAFs obtained from the literature. The BCF/BAF values are based on the ratio between dry-weight sediment and dry-weight invertebrate tissue. Because BAFs consider both direct exposure to sediment and exposure via the diet, BAFs are more appropriate values and were used in the food web models when available. BAFs based on depurated analyses (sediment was purged from the gut of the organism prior to analysis) were given preference over undepurated analyses when selecting BAF values since direct ingestion of sediment is accounted for separately in the food web model.

Literature values based on the ratio between dry-weight sediment and wet-weight invertebrate tissue were converted to a dry-weight basis by dividing the wet-weight BCF/BAF by the estimated solids content for aquatic invertebrates (21 percent [0.21]; USEPA 1993). For chemicals without available measured literature BCF/BAF values, a BCF/BAF of 1.0 was assumed. The sediment-to-invertebrate BCFs/BAFs used in the Screening-Level ERA are summarized in Appendix 7, Table 9.

Dietary Intakes

Dietary intakes for each upper trophic level receptor species were calculated using the following formula modified from USEPA (1993):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [WIR)(WC_x)]][AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg body weight/day)
FIR	=	Food ingestion rate (kg/day, dry-weight)
FC_{xi}	=	Concentration of chemical x in food item i (milligram per kilogram [mg/kg], dry weight)
PDF_i	=	Proportion of diet composed of food item i (dry weight basis)
SC_x	=	Concentration of chemical x in surface soil/sediment (mg/kg, dry weight)
PDS	=	Proportion of diet composed of surface soil/sediment (dry weight basis)
WIR	=	Water ingestion rate (L/day)
WC_x	=	Concentration of chemical x in water (mg/L)
BW	=	Body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

Exposure parameters for upper trophic level receptors are provided in Appendix 7, Table 10, and dietary compositions are provided on Appendix 7, Table 11.

5.2.1.4 Screening-Level Risk Calculation

The screening-level risk calculation is the final step in a Screening-Level ERA (Step 2). In this step, the maximum exposure concentrations (abiotic media) or exposure doses (upper trophic level receptor species) are compared with the corresponding screening values to derive screening risk estimates. The outcome of this step is a list of chemicals exceeding ecological screening values for each medium-pathway-receptor combination evaluated or a conclusion of negligible risk. It should be noted that the Screening-Level ERA is a highly conservative evaluation that often results in a substantial list of chemicals that exceed screening values. The next step in the ERA process (Step 3) refines this list to focus any additional action or evaluation at a site on chemicals indicated to drive risk to ecological receptors. The uncertainty involved in Steps 1 and 2 of the ERA process are discussed in the following section (Section 5.2.1.5).

Hazard Quotients (HQs) are calculated by dividing the maximum chemical concentration in the medium being evaluated by the corresponding medium-specific screening value or, in the case of upper trophic level receptors, by dividing the exposure dose by the corresponding ingestion-based screening value. Chemicals with HQs greater than or equal to 1.0 were considered to potentially require further evaluation in the Screening-Level ERA. The following conservative methodology was used to identify chemicals that exceeded the screening value for abiotic media:

- The maximum detected concentration in each ecologically relevant medium was used to calculate media-specific HQs. For a given medium, chemicals with HQs greater than or equal to 1.0, based on maximum detected concentrations were identified as potentially requiring further evaluation for that medium.
- For chemicals not detected in any samples of a particular medium, the maximum reporting limit was used to calculate media-specific HQs. For a given medium, non-detected chemicals with HQs greater than or equal to 1.0 based on maximum reporting limits were identified as potentially requiring further evaluation for that medium.

- Chemicals (detected and non-detected) without screening values for a given medium were identified as not requiring further evaluation for that medium. The lack of a screening value may indicate that the chemical is not considered toxic enough or prevalent enough in environmental media to develop a screening value. The lack of screening values for some chemicals is considered an uncertainty in the ecological screening-level evaluation.

To determine chemicals that exceeded a screening level by evaluating food web exposures, maximum chemical concentrations in ecologically relevant abiotic media were used to estimate dietary doses for each receptor. All chemicals identified as important bioaccumulative chemicals by the USEPA (2000a) were evaluated in the food web model. HQs were calculated with NOAELs, LOAELs, and Maximum Acceptable Toxicant Concentrations (MATCs) (the geometric mean of the NOAEL and LOAEL). NOAELs provide the most conservative risk estimate, while calculations with LOAELs provide the least conservative risk estimate. Calculations with MATCs provide realistic risk estimates since the MATC represents an estimation of the threshold concentration (i.e., the concentration above which a toxic effect on the test endpoint is produced). For the Screening-Level ERA, chemicals (detected and non-detected) with NOAEL-based HQs greater than or equal to 1.0 were identified as potentially requiring further evaluation. Identical to the media-specific screening, chemicals without ingestion-based screening values were identified as not requiring further evaluation for upper trophic level receptors. HQs exceeding 1.0 indicate the potential for risk since the chemical concentration or dose (exposure) exceeds the screening value (effect). However, screening values and exposure estimates are derived using intentionally conservative assumptions such that HQs greater than or equal to 1.0 do not necessarily indicate that risks are present or impacts are occurring. Rather, they identify chemical-pathway-receptor combinations requiring further evaluation. Following the same reasoning, HQs that are less than 1.0 indicate that risks are very unlikely, enabling a conclusion of no unacceptable risk to be reached with high confidence. Chemicals that exceeded the screening levels were further evaluated to determine frequency of detection, whether concentrations were above background levels and whether the chemical was associated with past DuPont/DoD use. If sufficient data has been collected, the physical distribution and frequency of detection of a chemical in a site medium or exposure area can be used to remove a chemical from consideration for further ecological evaluation. The premise behind this evaluation criterion is that a chemical with limited presence in a medium or exposure area is unlikely to be contacted frequently and, therefore, does not pose as great a potential ecological risk as do more frequently detected chemicals. This ecological screen is concerned with population effects and less with effects on individual receptors.

5.2.1.5 Uncertainties

The procedures used in this evaluation to assess risks to ecological receptors, as in all such assessments, are subject to uncertainties because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. The major uncertainties associated with the Screening-Level ERA and their effect on risk conclusions are presented and discussed below.

Available Data Set

- Sample locations for data collected for the Focused Site Inspection were selected to provide specific data in areas that were the most likely to have been contaminated by historical Site activities and that represented potential migration pathways at specific AOCs. A limited number of samples were collected at each AOC to provide this information. The sample design was intended to represent worst case contamination at the AOCs, and was

not intended to represent AOC-wide (i.e., realistic mean) concentrations of specific chemicals. As such, the Screening-Level ERAs for the AOCs are likely to be conservative and provide a protective estimate of potential ecological risk. However, because of the limited number of samples collected, it is possible that more highly contaminated areas at the AOCs are present and are not represented by the available data.

Identification of Chemicals Exceeding Screening Values

- Reporting limits for many chemicals exceeded soil, surface water, and/or sediment screening values, resulting in the identification of non-detected chemicals exceeding a screening value. In addition, chemicals without available screening values were identified as exceeding screening values even if they were not detected. This approach likely overstates the number of actual chemicals exceeding screening values and is overly conservative when compared to the approach outlined in the National Oil and Hazardous Substances Pollution Contingency Plan's (NCP) Hazard Ranking System (40 Code of Federal Regulations [CFR], Part 300, Appendix A). The Hazard Ranking System does not establish a release for measurements less than the contract required detection limit when a USEPA certified laboratory performs the analysis. All samples used in the exposure estimates were analyzed by a certified laboratory; however, only 10% of the data were validated by a third party. The next step in the ERA process (Step 3) would result in a refined list of chemicals potentially requiring further evaluation that would only include non-detected chemicals under special circumstances (e.g., if a non-detected chemical is a known Site contaminant and detections limits were elevated beyond both standard method detection limits and the ecological screening value). In addition, in Step 3, a literature search is typically conducted to locate available toxicological data that may be useful in evaluating potential risk from chemicals for which no ecological screening criteria have been established.
- A second source of uncertainty related to the identification of chemicals potentially requiring further evaluation applies to the use of NOAEL-based screening values in risk calculations for upper trophic level receptors. The use of NOAEL-based screening values is extremely conservative since NOAELs give no indication as to how much higher a concentration must be before adverse effects are observed.

Exposure Point Concentrations

- As is typical in a Screening-Level ERA, a finite number of samples of environmental media are used to develop the exposure estimates. The maximum measured concentration provides a conservative estimate for immobile biota or those with a limited home range. The most realistic exposure estimates for mobile species with relatively large home ranges and for species populations (even those that are immobile or have limited home ranges) are those based on the mean chemical concentrations in each medium to which these receptors are exposed. This is reflected in the wildlife dietary exposure models contained in the Wildlife Exposure Factors Handbook (USEPA, 1993), which specify the use of average media concentrations. Given the mobility of the upper trophic level receptor species used in the Screening-Level ERA, the use of maximum chemical concentrations (rather than mean concentrations) to estimate the exposure via food webs is very conservative. However, based on the limited spatial coverage of the samples available, a calculated mean may not provide a very accurate estimate of the true site mean, and thus may not provide a very accurate picture of potential risks at the Site.

Medium-Specific Screening Values

- The toxicological benchmarks used as screening values for sediment do not take into consideration site-specific factors (e.g., TOC or acid volatile sulfide/simultaneously extracted metals [AVS/SEM] that can influence the bioavailability of chemicals to ecological receptors. This tends to make the resulting screening values very conservative and likely overestimates potential risk.
- A second source of uncertainty related to medium-specific screening values applies to surface waters and sediments. Surface water and sediment screening values for many chemicals were derived from literature-based toxicological data for a limited number of species. Uncertainty is added to the risk assessment when using criteria not developed for a particular community of species. Though the measurement endpoints for fish and frogs include comparisons of chemical concentrations in both surface water and sediment with medium-specific screening values, not all benchmarks were developed based on fish and/or frog test species and are therefore not necessarily protective of those communities.

Ingestion-Based Screening Values

- Data on the toxicity of many chemicals to the receptor species were sparse or lacking, requiring the extrapolation of data from other wildlife species or from laboratory studies with non-wildlife species. This is a typical limitation for ecological risk assessments because so few wildlife species have been tested directly for most chemicals. The uncertainties associated with toxicity extrapolation were minimized through the selection of the most appropriate test species for which suitable toxicity data were available. The factors that were considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method, and similarity of diet.
- A second source of uncertainty related to the derivation of ingestion screening values applies to metals. Most of the toxicological studies on which the ingestion screening values for metals were based used forms of the metal (such as salts) that have high water solubility and high bioavailability to receptors. Since the analytical samples on which site-specific exposure estimates were based measured total metal concentrations, regardless of form, and these highly bioavailable forms are expected to compose only a fraction of the total metal concentration, this is likely to result in an overestimation of potential risks for these chemicals.
- A third source of uncertainty related to the derivation of ingestion screening values concerns the use of uncertainty factors. For example, in some cases NOAELs were extrapolated to LOAELs using an uncertainty factor of ten. This approach is likely to be conservative as use of an uncertainty factor of five instead of ten (as supported by a peer-reviewed assessment outlined in Dourson and Stara, 1983) would have resulted in a smaller “range of reasonable risk” considered for food web exposures. As such, the evaluation of the potential for risk from certain chemicals to aquatic populations and communities may be particularly conservative in nature. The use of an uncertainty factor of 10, although potentially conservative, also serves to counter some of the uncertainty associated with interspecies extrapolations, for which a specific uncertainty factor was not used.
- A fourth source of uncertainty related to the derivation of ingestion-based screening values applies to mercury and selenium. The ingestion-based screening values used for these two metals were based on organometallic (methylated) forms. For example, the NOAEL-based mercury screening value used for birds (0.0064 mg/kg-BW/day) is based on a laboratory

study that used methyl mercury dicyandiamide as the test material. Screening values for inorganic forms of mercury are substantially higher (0.45 mg/kg-BW/day for mercuric chloride). Given that inorganic forms likely contribute significantly to the total mercury and selenium, use of NOAEL-based screening values based on organometallic forms tends to make the screening values for these metals extremely conservative and likely overestimates potential risk.

Ecological Receptors

- Although exposure pathways to reptiles are likely to be complete, a specific reptilian species was not selected as a receptor species in the Screening-Level ERA because the life history and toxicological database concerning the effects of chemicals on reptiles is severely limited. It was assumed that any reptiles present at FGOW are not exposed to significantly higher concentrations of chemicals and are not more sensitive to chemicals than the other upper trophic level receptor species evaluated in the risk assessment. This is likely to be a reasonable assumption since the limited available data indicate that this group is not generally more sensitive than the other vertebrate groups addressed in the Screening-Level ERA. This assumption was, however, a source of uncertainty in the risk assessment. Furthermore, as a group, reptilian species may occupy many trophic levels (herbivores, omnivores, insectivores, and carnivores).

Exposure Routes

- Inhalation and/or dermal adsorption represent potential exposure routes for upper trophic level receptors. They were not evaluated in the Screening-Level ERA because they were considered insignificant relative to ingestion exposures. While this is a reasonable assumption based on the discussion presented in the section on Exposure Routes and Pathways, the exclusion of inhalation and dermal adsorption represents a source of uncertainty.

Food Web Exposure Modeling

- Chemical concentrations in terrestrial and aquatic food items (plants, earthworms, small mammalian omnivores, aquatic invertebrates, and fish) were modeled from measured media concentrations and were not directly measured. The use of generic, literature-derived exposure models and bioaccumulation factors introduces some uncertainty into the resulting estimates. The values selected and methodologies employed were intended to provide a reasonable estimate of potential food web exposure concentrations.
- A second source of uncertainty related to the food web models is the use of default assumptions for exposure parameters such as BCFs and BAFs. Although BCFs or BAFs for many bioaccumulative chemicals were readily available from the literature and were used in the Screening-Level ERA, the use of a default factor of 1.0 to estimate the concentration of some chemicals in receptor prey items is a source of uncertainty. However, for most chemicals, the assumption that the chemical body burden in the prey item is at the same concentration as in soil/sediment is conservative, particularly when many of the chemicals are known not to accumulate to any significant degree. It is possible that use of a default factor of 1.0 to estimate the concentration of some chemicals may result in an underestimation of potential risks for those chemicals that may tent to bioaccumulate and/or biomagnify.
- A third source of uncertainty related to the food web models is the use of unrealistically conservative exposure parameters. The use of maximum ingestion rates and minimum body weights result in a conservative estimate of exposure. In addition, AUFs were

assumed to equal one. This is a conservative assumption since a significant percentage of each upper trophic level receptor species time could be spent foraging off-site in areas not impacted by site-related chemicals or areas where chemical concentrations are expected to be significantly lower.

Chemical Mixtures

- Information on the ecotoxicological effects of chemical interactions is generally lacking, which required (as is standard for ecological risk assessments) that the chemicals be evaluated on a compound-by-compound basis during the comparison to screening value. This could result in an underestimation of risk (if there are additive or synergistic effects among chemicals) or an overestimation of risks (if there are antagonistic effects among chemicals). Though cumulative effects may be indirectly examined via detailed literature reviews and toxicity testing of site media, this level of investigation is reserved for that employed during a baseline ecological risk assessment, which has a goal of collecting and interpreting site-specific information. It is important to note that Norwood et al. (2003) performed a review of the impacts of mixtures of inorganic chemicals on aquatic biota and found that additive, synergistic, and antagonistic responses were found with equal frequency. This indicates that generalizations cannot be made in Step 2 and that these impacts need to be examined based on specific potential ecological risk drivers identified for a particular habitat and receptor population, which is an activity designed to be performed during a baseline ecological risk assessment.

5.2.1.6 Screening-Level ERA Decision Point

The results of the Screening-Level ERA were used to evaluate the status of each AOC, in terms of potential ecological risk. In addition, current and probable future use of the property are taken into consideration (See Figure 11). Possible decision points following completion of the Screening-Level ERA included the following:

- No further action is warranted: This decision is appropriate if the Screening-Level ERA indicates that sufficient data are available on which to base a conclusion of no unacceptable risk (HQ values for each media-pathway-receptor combination is less than one).
- Further evaluation is warranted: This decision is appropriate if the Screening-Level ERA indicates that there is the potential for unacceptable risk for one or more media-pathway-receptor combinations.
- Further data are required: This decision is appropriate if the Screening-Level ERA indicates that there is insufficient data on which to base a risk estimate.
- Take remedial action: This decision may be appropriate for sites in which the potential for unacceptable risks was identified following the Screening-Level ERA but these potential risks could be best addressed through remedial action (e.g., presumptive remedy, soil removal) rather than additional study.

In all cases, it should be noted that the Screening-Level ERA is a highly conservative evaluation. The next step in the ERA process (Step 3) includes a refinement of the list of chemicals under consideration for additional ecological evaluation based on more realistic exposure assumptions, site specific factors that may influence chemical bioavailability, and comparisons of site data to literature-based toxicity data in cases where ecological screening criteria are lacking. Step 3 results in the identification of potential ecological risk drivers at the site, or a conclusion that no additional action or evaluation is warranted.

Screening-Level ERAs for individual AOCs are presented in the following sections.

5.2.2 AOC1, Waste Disposal Ditch, Primary and Secondary Settling Ponds

The environmental setting and historical analytical data are described in Section 2.5.1. Analytical results from this Focused SI work are discussed in Section 4.3.1.

5.2.2.1 Conceptual Model

The waste disposal ditch, settling ponds and surrounding areas are now used for agricultural purposes with interspersed regions of mixed pine and hardwood forest and grassland. The ditch is vegetated and is dry with the exception of seasonal rain events during which it is a pathway for surface runoff (USACE, 2006a). There are no areas of stressed vegetation apparent. Surface water was only observed in AOC 1-Southern Section at the former dam/weir structure at the east boundary of AOC 1 - Southern Section. Portions of the AOC provide limited habitat in an area that is managed largely for agricultural purposes.

Potential sources of contamination at AOC 1 are the wastewater and the miscellaneous debris that was disposed of in the waste disposal ditch (former Coates Dump). Former DuPont/DoD activities may have contributed the following potential hazardous substances to the waste disposal ditch: nitrocellulose; DNT; DPA; industrial solvents and degreasers; POLs; mercury; PAHs; metals; oleum; sulfuric acid; and nitric acid (USACE, 2006a). Disposal activities in the Coates Dump occurred after FGOW operations, and include possible UMN and public disposal that may have contributed the following potential hazardous substances: VOCs, SVOCs, and metals. Surface soils may have been directly contaminated by historical Site activities. Subsurface soil and groundwater may have been contaminated via leaching, and surface water and sediment in the settling basins may have been contaminated via surface runoff. Shallow groundwater at the Site was observed at a depth of 40 feet. As this is well below the depth of the settling basins, groundwater is not likely to discharge to the surface, and this pathway is incomplete for ecological receptors. Terrestrial plants, invertebrates, and upper trophic level receptors may be exposed to contaminants in surface soils via direct contact and food chain transfer. Surface water present at the Site may be used as a drinking source by upper trophic level receptors.

The ecological receptors evaluated in the Screening-Level ERA include the following:

- Terrestrial plants and invertebrates
- Meadow vole
- Short-tailed shrew
- White-footed mouse
- Red hawk
- American robin
- Aquatic plants and invertebrates
- Raccoon

Based on the screening-level problem formulation, complete exposure pathways to terrestrial and aquatic receptors are present at AOC 1, and sufficient data are available to conduct the Screening-Level ERA.

5.2.2.2 Screening-Level Ecological Effects Evaluation

AOC 1-Northern Section - Surface Soil: Appendix 7, Table 12 presents the results of the screening-level risk calculation for AOC 1 Northern Section surface soil. Three samples were evaluated.

AOC 1 North, Explosives: The explosives 2,4-dinitrotoluene and 2,6-dinitrotoluene were detected in surface soils. Detected concentrations and detection limits of non-detects of 2,4-DNT were less than soil screening values. Conversely, both the sole detection of 2,6-DNT (0.12JJ mg/kg) and detection limits of the two non-detected samples (0.25 mg/kg) exceeded the soil screening value of 0.0328 mg/kg.

AOC 1 North, Metals: The metals arsenic, barium, cadmium, chromium, lead, and mercury were each detected in surface soils. Concentrations of lead and mercury in each of the three surface soil samples exceeded their respective soil screening values. The maximum HQ for mercury was 110 (location FGOW-AOC1N-SS-SS1), while the maximum HQ for lead was 7.09 (also at location FGOW-AOC1N-SS-SS1).

Mercury: The background level was exceeded in each sample. However, mercury was not detected in surface water in AOC 1 South and did not exceed sediment screening values in AOC 1 South, indicating a lack of impacts downstream from AOC 1 North.

Lead: The background level was exceeded in each sample.

Cadmium: Cadmium was detected in two of three surface soil samples at concentrations less than the soil screening value; however, the detection limit of the sample that was non-detect (0.67U mg/kg in FGOW-AOC1-SS-GP1) exceeded the soil screening value of 0.36 mg/kg (HQ calculated with detection limit = 1.86). Because detections of cadmium were less than the screening value, the HQ calculated with the detection limit of the non-detect was less than 10 (i.e. detection limit and screening value were within an order of magnitude), and because cadmium is not among the chemicals identified as used historically at the Site, cadmium is not recommended for further study.

Selenium: Selenium was not detected in the three surface soil samples; however, detection limits for each sample (range 2.1U mg/kg to 3.7 mg/kg) exceeded the soil screening value of 0.52 mg/kg. The detection limits were within an order of magnitude as the screening level, indicating that is unlikely that selenium is present at concentrations that would pose unacceptable risk to ecological receptors. Selenium is not recommended for further ecological evaluation at AOC 1 North..

AOC 1 Northern Section, SVOCs: Two SVOCs, bis(2-ethylhexyl)phthalate and di-n-butylphthalate, were detected in AOC 1 Northern Section surface soil. Bis(2-ethylhexyl)phthalate was detected in 1 of 3 samples at 94 J mg/kg, which is less than the soil screening value of 925 ug/kg; however, the detection limits in the two non-detected samples (460,000 ug/kg and 550,000 ug/kg) exceeded this screening value by three orders of magnitude. The sole detection of di-n-butylphthalate (460 ug/kg) exceeded the soil screening value of 150 µg/kg, and detection limits of the two non-detected samples (460,000 ug/kg and 550,000 ug/kg) also exceeded this screening value. It should be noted that detection limits for SVOCs in samples FGOW-AOC1N-SS-SS1 and FGOW-AOC1N-SS-SS2 were elevated above detection limits in sample FGOW-AOC1N-SS-GP1 by three orders of magnitude. The elevated

detection limits exceeded soil screening values of nearly all of the analyzed SVOCs, leading to the identification of 54 non-detected SVOCs that exceeded screening values. In addition, 7 non-detected SVOCs did not have soil screening criteria and are not recommended for further ecological evaluation.

AOC 1 Northern Section, VOCs: Nine VOCs were detected in surface soil collected from AOC 1 Northern Section. Of these, 1,2,3-trichlorobenzene and 1,2,4-trimethylbenzene did not have established soil screening values; the others did not exceed screening values. The minimum of all screening values listed for VOCs presented on Appendix 7, Table 2 is 35.2 ug/kg for 1,2-dibromo-3-chloropropane. The sole detection of 1,2,3-trichlorobenzene (3.2JQJ ug/kg), both detections of 1,2,4-trimethylbenzene (1,3J ug/kg and 1.1JQJ ug/kg), and detection limits of non-detected samples (ranging from 7.1 to 8.9 ug/kg) were less than this minimum screening value. Based on these available screening values, 1,2,3-trichlorobenzene and 1,2,4-trimethylbenzene are not likely to pose unacceptable ecological risk; although this cannot be stated with certainty due to the lack of specific screening values for these chemicals. Based on low detections and lack of screening values, 1,2,3-trichlorobenzene and 1,2,4-trimethylbenzene are not recommended for additional evaluation. In addition, sixteen non-detected VOCs do not have screening criteria and are not recommended for further evaluation.

AOC 1 Northern Section, Nitrocellulose: Nitrocellulose was detected in each of the three surface soil samples from AOC 1 Northern Section. Detected concentrations ranged from 2,500 mg/kg to 18,000 mg/kg. Nitrocellulose lacks a soil screening criterion, appears to be virtually non-toxic, and is not recommended for further evaluation.

AOC 1-Middle Section – Surface Soil: Appendix 7, Table 13 presents the results of the screening-level risk calculation for AOC 1-Middle Section surface soil. Six surface soil samples were evaluated.

AOC 1 Middle, Explosives: The explosive 2,4-DNT was detected in two of the six surface soils at concentrations less than the soil screening value; detection limits of non-detected samples were also less than the screening value. 2,6-DNT was not detected; however, detection limits exceeded the soil screening value of 0.0328 mg/kg. The screening criteria and detection limit for 2,6-DNT are within an order of magnitude. It is considered unlikely that 2,6-DNT is present at AOC 1 – Middle at concentrations that pose unacceptable ecological risk. 2,6-DNT is not recommended for additional ecological evaluation at AOC 1, Middle.

AOC 1 Middle, Metals: The metals arsenic, barium, cadmium, chromium, lead, and mercury were each detected in surface soils. Maximum concentrations of chromium, lead, and mercury exceeded their respective soil screening values. The maximum HQ for chromium was 1.12, the maximum HQ for lead was 3.55, and the maximum HQ for mercury was 49.00.

Chromium: Because the concentration of chromium only exceeded its screening value in one sample and that exceedance was marginal (29 mg/kg compared to a screening value of 26 mg/kg), chromium is not recommended for further evaluation.

Mercury: Mercury was not detected in surface water in AOC 1 South and did not exceed sediment screening values in AOC 1 South, indicating a lack of impacts downstream from AOC 1 Middle. Four of the 6 soil samples from AOC 1 Middle contained concentrations exceeding the screening value and 3 of 6 samples exceeded the background level.

Lead: Four of the six soil samples exceeded the screening value and 3 of 6 samples exceeded the background level.

Cadmium: Cadmium was detected in four of the six surface soil samples at concentrations less than the soil screening value; however, the detection limits of the samples that were non-detect (0.6 mg/kg and 0.62 mg/kg) exceeded the soil screening value of 0.36 mg/kg (maximum HQ calculated with detection limit = 1.72). Because detections of cadmium were less than the screening value, the HQs calculated with the detection limits of the non-detects were less than 10 (i.e. detection limit and screening value were within an order of magnitude), and because cadmium is not among the chemicals identified as used historically at the Site, cadmium is not recommended for further ecological evaluation.

Selenium: Selenium was not detected in the surface soil samples; however, detection limits for each sample (range 3.6 mg/kg to 4.3 mg/kg) exceeded the soil screening value of 0.52 mg/kg. The detection limits were within an order of magnitude of the screening level, indicating that it is unlikely that selenium is present at concentrations that would pose unacceptable risk to ecological receptors. Selenium is not recommended for further ecological evaluation at AOC 1 Middle.

AOC 1 Middle, SVOCs: Seven SVOCs, were detected in AOC 1-Middle Section surface soil. Di-n-butyl phthalate was detected in 4 of 6 samples and some of the detected concentrations exceeded the soil screening value. Benzoic acid was detected but does not have a soil screening value and is therefore not recommended for additional ecological evaluation. In addition, 25 non-detected SVOCs had detection limits that exceeded soil screening values, and 7 non-detected SVOCs did not have screening values. SVOCs without screening values are not recommended for further ecological evaluation. Of the 25 non-detected SVOCs with detection limits exceeding soil screening values, 16 had detection limits within an order of magnitude of the screening level, indicating that it is unlikely that these chemicals are present at concentrations that would pose unacceptable risk to ecological receptors. These 16 chemicals are: 1,4-Dichlorobenzene, 2,6-Dichlorophenol, 2-Chlorophenol, 2-Nitrophenol, 3-Nitroaniline, 4-Chloroaniline, 4-Nitrophenol, Benzo(a)pyrene, bis(2-Chloroethoxy)methane, Butyl benzyl phthalate, Hexachlorobenzene, Hexachloroethane, N-Nitrosodi-n-propylamine, N-Nitrosodiphenylamine, Nitrobenzene, and Pentachlorophenol, and they are not recommended for further ecological evaluation.

AOC 1 Middle, VOCs: Three VOCs were detected in surface soil collected from AOC 1-Middle Section. Of these, p-isopropyltoluene did not have a soil screening value; the others did not exceed screening values. In addition 18 non-detected VOCs did not have screening values. VOCs without screening values are not recommended for additional ecological evaluation.

AOC 1 Middle, Nitrocellulose: Nitrocellulose was detected in each of the five of the six surface soil samples from AOC 1-Middle Section. Detected concentrations ranged from 6.3 mg/kg to 11,000 mg/kg. Nitrocellulose does not have a soil screening criterion, appears to be virtually non-toxic, and is not recommended for further ecological evaluation..

AOC 1-Southern Section – Surface Soil: Appendix 7, Table 14 presents the results of the screening-level risk calculation for AOC 1-Southern Section surface soil. Five surface soil samples were evaluated.

AOC 1 Southern Section, Explosives: Neither of the two explosives analyzed in AOC 1-Southern Section surface soils was detected. The detection limit for 2,6-DNT exceeded the soil screening value. The screening criteria and detection limit for 2,6-DNT are within an order of magnitude. It is considered unlikely that 2,6-DNT is present at AOC 1 South at concentrations

that pose unacceptable ecological risk. 2,6-DNT is not recommended for additional ecological evaluation at AOC 1 Southern Section.

AOC 1 Southern Section, Metals: The metals arsenic, barium, cadmium, chromium, lead, and mercury were each detected in surface soils. Maximum concentrations of chromium, lead, and mercury exceeded their respective soil screening values. The maximum HQ for chromium was 1.04, the maximum HQ for mercury was 3.80, and the maximum HQ for lead was 29.09.

Chromium: Because the concentration of chromium only exceeded its screening value in one sample and that exceedance was marginal (27 mg/kg compared to a screening value of 26 mg/kg), chromium is not recommended for further ecological evaluation.

Lead: The screening level for lead is 11 mg/kg and the background level is 18 mg/kg. Four of 5 samples had concentrations between 14 and 24 mg/kg, which do not greatly exceed the screening level, and in 2 samples, do not exceed the background level. Only one sample had a larger concentration of 320 mg/kg.

Mercury: Mercury was not detected in surface water in AOC 1 South and did not exceed sediment screening values in AOC 1 South, indicating that impacts are limited to soil. Of the 5 samples, only 1 exceeded the screening value and none exceeded the background value. Based this low frequency of exceedances, further ecological evaluation of mercury at AOC 1 South is not recommended.

Cadmium: Cadmium was detected in two of the six surface soil samples at concentrations less than the soil screening value; however, the detection limits of the samples that were non-detect (0.63 mg/kg, 0.66 mg/kg, and 0.68 mg/kg) exceeded the soil screening value of 0.36 mg/kg (maximum HQ calculated with detection limit = 1.89). Because detections of cadmium were less than the screening value, the HQs calculated with the detection limits of the non-detects were less than 10 (i.e. detection limit and screening value were within an order of magnitude), and because cadmium is not among the chemicals identified as used historically at the Site, cadmium was not recommended for further ecological evaluation.

Selenium: Selenium was not detected in the surface soil samples; however, detection limits for each sample (range 3.8 mg/kg to 6 mg/kg) exceeded the soil screening value of 0.52 mg/kg. The detection limits were within an order of magnitude of the screening level, indicating that it is unlikely that selenium is present at concentrations that would pose unacceptable risk to ecological receptors. Selenium is not recommended for further ecological evaluation at AOC 1 South.

AOC 1 Southern Section, SVOCs: Seventeen SVOCs were detected in AOC 1-Southern Section surface soil. Of these, benzo(a)anthracene, benzo(a)pyrene, and chrysene had maximum detections that exceeded the soil screening value.

Benzo(a)anthracene, benzo(a)pyrene, and chrysene: The maximum HQ for benzo(a)anthracene was 2.69, for benzo(a)pyrene was 9.87, and for chrysene was 3.81. For each of these chemicals, the screening level was exceeded in only one sample. Further ecological evaluation of these 3 chemicals based on this low exceedance of screening levels is not recommended.

Benzoic acid and carbazole: Benzoic acid and carbazole were detected but do not have ecological screening values. No further ecological evaluation is recommended.

Bis(2-ethylhexyl)phthalate: Bis(2-ethylhexyl)phthalate was detected in two samples at concentrations less than the soil screening value; however, the detection limit of one of the non-detected samples exceeded the soil screening value of 925 µg/kg (location-specific HQ = 4.54). Because the detected concentrations and two of the three detection limits for non-detects were less than soil screening criteria, and the HQ calculated with the maximum detection limit was

less than 10 (i.e. detection limit and screening value were within an order of magnitude), bis(2-ethylhexyl)phthalate was not recommended for further ecological evaluation.

In addition, 27 non-detected SVOCs had detection limits that exceeded soil screening values, and 6 non-detected SVOCs did not have screening values. The 6 non-detected SVOCs without screening values are not recommended for additional ecological evaluation. Of the 27 non-detected SVOCs with detection limits exceeding soil screening values, 13 had detection limits that were within an order of magnitude of the screening levels, indicating that it is unlikely that these chemicals are present at concentrations that would pose unacceptable risk to ecological receptors. The 13 following chemicals are not recommended for further ecological evaluation at AOC 1 Southern Section: 1,2-Dichlorobenzene, 1,4-Dichlorobenzene, 2,6-Dichlorophenol, 2-Methylnaphthalene, 2-Nitrophenol, 3-Nitroaniline, 4-Chloroaniline, 4-Nitrophenol, Hexachloroethane, N-Nitrosodi-n-propylamine, N-Nitrosodiphenylamine, Nitrobenzene, and Pentachlorophenol.

AOC 1 Southern Section, VOCs: Five VOCs were detected in surface soil collected from AOC 1-Southern Section. Of these, 1,2,3-trimethylbenzene and p-isopropyltoluene did not have soil screening criteria and are not recommended for further ecological evaluation. The other detected VOCs did not exceed screening values. In addition 17 non-detected VOCs did not have screening values and are not recommended for additional ecological evaluation.

AOC 1 Southern Section, Nitrocellulose: Nitrocellulose was detected in three of the five surface soil samples from AOC 1-Southern Section. Detected concentrations ranged from 12 mg/kg to 74 mg/kg. Nitrocellulose does not have a soil screening criterion, appears to be virtually non-toxic, and is not recommended for further ecological evaluation.

AOC 1 Southern Section – Surface Water: Appendix 7, Table 15 presents the results of the screening-level risk calculation for AOC 1-Southern Section surface water. Two surface water samples were evaluated.

AOC 1 - Southern Section, Surface Water, Explosives: Neither of the two explosives analyzed in AOC 1-Southern Section surface water was detected. Detection limits were less than screening values, so neither explosive exceeded screening values.

AOC 1 - Southern Section, Surface Water, Metals: The metals arsenic, barium, chromium, lead, and selenium were each detected in surface water. The maximum detected concentration of arsenic exceeded its respective screening value in one sample. The maximum HQ for arsenic was 4.00. Two non-detected metals (mercury and silver) had detection limits that exceeded the surface water screening values.

AOC 1 - Southern Section, Surface Water, PAHs: Ten PAHs were detected in AOC 1-Southern Section surface water. Of these, anthracene and benzo(a)anthracene were detected at concentrations less than surface water screening values; however, detection limits of the non-detected sample exceeded surface water screening values. Because the detections of these chemicals were less than screening criteria, and the detection limits were within an order of magnitude of the screening criteria, anthracene and benzo(a)anthracene are not recommended for further ecological evaluation. Three non-detected PAHs did not have screening criteria and are not recommended for further ecological evaluation.

AOC 1 - Southern Section, Surface Water, VOCs: One VOC was detected in surface water at a concentration less than its screening criteria. Fifteen non-detected VOCs were identified that did not have screening criteria, and 7 had detection limits that exceeded screening values. The 15 non-detected VOCs without screening values are not recommended for additional ecological evaluation. For the non-detected VOCs with detection limits exceeding screening values, 3 had detection limits within an order of magnitude of the screening value. It is considered unlikely that these 3 chemicals (carbon disulfide, carbon tetrachloride, and vinyl chloride) are present at concentrations that would pose an unacceptable risk to ecological receptors and they are not recommended for further ecological evaluation. The remaining non-detected VOCs with detection limits exceeding screening values are: 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, cis-1,3-dichloropropene, and trans-1,3-dichloropropene.

AOC 1 - Southern Section, Surface Water, Nitrocellulose: Nitrocellulose was detected in both surface water samples from AOC 1 Southern Section. Detected concentrations ranged from 0.19B mg/L to 0.23 mg/L. Nitrocellulose does not have a screening criterion, appears to be virtually non-toxic, and is not recommended for further ecological evaluation..

AOC 1-Southern Section – Sediment: Appendix 7, Table 16 presents the results of the screening-level risk calculation for sediment. Two samples were evaluated.

AOC 1 - Southern Section, Sediment, Explosives: Neither of the two explosives analyzed in AOC 1- Southern Section sediment was detected. However, both 2,4-DNT and 2,6-DNT had detection limits that exceeded the sediment screening value. The detection limit for 2,6-DNT is within an order of magnitude of its screening value and it is considered unlikely that 2,6-DNT is present at concentrations that would pose an unacceptable risk to ecological receptors. 2,6-DNT is not recommended for further ecological evaluation in the sediment.

AOC 1 - Southern Section, Sediment, Metals: The metals arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver were each detected in sediment. Of these, barium and selenium did not have screening values and are not recommended for additional ecological evaluation. The remaining metals were detected at concentrations below screening levels.

AOC 1 - Southern Section, Sediment, PAHs: Sixteen PAHs were detected in AOC1 Southern Section sediments. Of these, acenaphthene (maximum HQ = 1.64), dibenz(a,h)anthracene (maximum HQ = 1.27), and indeno(1,2,3-cd)pyrene (maximum HQ = 2.06) were detected at concentrations in excess of sediment screening values. In each case, the screening criteria were exceeded in only one of the two samples.

AOC 1 - Southern Section, Sediment, VOCs: Six VOCs were detected in sediment. Of these, 2-butanone and acetone had maximum detections that exceeded sediment screening values. 2-butanone was detected in the blanks and acetone is a frequent laboratory artifact. Additional ecological evaluation of these 2 chemicals is not recommended. 1,3,5-Trimethylbenzene was detected, does not have a sediment screening value and is not recommended for additional ecological evaluation. In addition, 3 non-detected VOCs had detection limits that exceeded screening values, and 32 non-detected VOCs had no sediment screening values. The 32 non-detected VOCs without sediment screening values are not recommended for additional ecological evaluation. Of the 3 non-detected VOCs with detection limits exceeding screening values, the detection limits for 4-methyl-2-pentanone were within an order of magnitude of the screening value, and it is considered unlikely that this chemical is present at concentrations that

would pose an unacceptable risk to ecological receptors. The remaining detected VOCs are 1,1-dichloroethane and bromomethane.

AOC 1 - Southern Section, Sediment, Nitrocellulose: Nitrocellulose was detected in one of the two sediment samples at 12 mg/kg. Nitrocellulose does not have a screening criterion, appears to be virtually non-toxic, and is not recommended for further ecological evaluation.

AOC 1, Food Web Exposures
Results of the risk calculations for terrestrial and aquatic food web exposures are provided in Appendix 7, Table 17. For the terrestrial evaluation, soil data from the Northern, Middle, and Southern sections of AOC1 were combined and the maximum detection for each chemical from the combined data set was used as an estimate of soil concentrations.

AOC 1, Terrestrial Food Web Exposures: Based on the comparison of maximum surface soil and surface water exposure doses to NOAEL-based screening values, arsenic, chromium, lead, mercury, selenium, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, acenaphthylene, benzo(b)fluoranthene, chrysene, hexachlorobutadiene, hexachlorobenzene, hexachloroethane, and pentachlorophenol had HQs exceeding 1.0 for one or more terrestrial receptors. No NOAEL was available for avian species for 1,2,4-trichlorobenzene, and no NOAELs were available for avian or mammalian species for 4-bromophenyl-phenylether, 4-chlorophenyl-phenylether, or hexachloroethane. Of the chemicals exceeding screening criteria for terrestrial food web exposures, arsenic, chromium, lead, mercury, selenium 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, acenaphthylene, benzo(b)fluoranthene, and chrysene were detected in one or more surface soil or surface water samples at the Site.

AOC 1, Aquatic Food Web Exposures: Based on the comparison of maximum exposure doses to NOAEL-based screening values for the raccoon, no chemicals exceeded screening criteria for the aquatic food web at AOC 1.

5.2.2.3 Screening-Level ERA Decision Point

Chemicals identified as exceeding screening levels in surface soil, surface water, and sediment at AOC 1 are indicated on Appendix 7, Tables 12 through 16. Chemicals that were identified as exceeding ecological screening values based on food web exposures are identified on Appendix 7, Table 17.

AOC 1 Northern Section, Soil

Chemicals considered for potential further ecological evaluation after initial screening include 2,6-DNT (detected once), mercury, lead, bis(2-ethylhexyl)phthalate, di-n-butylphthalate and 54 non-detected SVOCs with detection limits exceeding screening values. Of these chemicals, bis(2-ethylhexyl)-phthalate and di-n-butylphthalate are not recommended for additional ecological evaluation for the following reasons: 1) the detected concentration of bis(2-ethylhexyl)phthalate did not exceed the screening value, 2) each chemical was only detected once, 3) these chemicals are not related to DuPont/DoD activities, and 3) both chemicals are frequent sampling and laboratory artifacts.

AOC 1 Middle Section, Soil

Chemicals considered for potential further ecological evaluation after initial screening include mercury, lead, di-n-butylphthalate, and 9 non-detected SVOCs (2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 3,3-dichlorobenzidine, 4,6-dinitro-2-methylphenol, hexachlorobutadiene, N-nitrosodimethylamine, N-nitrosoppyrrolidine, and naphthalene). Of these chemicals, d-n-butylphthalate is not recommended for additional ecological evaluation because it is not related to DuPont/DoD activities and it is a frequent sampling and laboratory artifact.

AOC 1 Southern Section, Soil

Chemicals considered for potential further ecological evaluation after initial screening include lead and 14 non-detected SVOCs (2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 2-chlorophenol, 3,3-dichlorobenzidine, 4,6-dinitro-2-methylphenol, bis(2-chloroethoxy)methane, butyl benzyl phthalate, di-n-butyl phthalate, hexachlorobenzene, hexachlorobutadiene, N-nitrosodimethylamine, N-nitrosopyrrolidine, and naphthalene).

AOC 1 Overall Soil – Discussion

Explosives - 2,6-DNT is recommended for additional ecological evaluation in AOC 1 North.

Mercury – Mercury was detected at levels exceeding screening criteria and background in AOC 1 North and Middle and was detected at levels that did not exceed background on AOC 1 South. Mercury was also detected in AOCs 4, 5, 6, 7A, 7B, 7C, and 7D and exceeded ecological screening criteria in AOCs 5, 6, 7A, and 7D. Background levels were exceeded on AOCs 5, 6, and 7D. There is no apparent cluster or grouping of mercury detections. Mercury was not detected in surface water at AOC 1 Southern Section and did not exceed screening criteria in the sediment. The source of mercury is unknown. Mercury was not used in the production processes at FGOW. Mercury may have been present as an impurity in coal burned at the steam plant at FGOW or may have resulted from trickling filter bearings if they leaked. There is no documentation of leaking trickling filter bearings. Mercury detections may also be a result of UMN's application of wastewater biosolids to a test area on Rosemount Research Center beginning in 1974 and subsequent plowing of the test area. The surrounding area and portions of the AOC are managed for agricultural purposes. Additional ecological evaluation of mercury in AOC 1 soil with respect to DoD/DuPont activities is not recommended.

Lead – Lead was detected at levels exceeding ecological screening criteria and background levels in all three sections of AOC 1. Potential sources of lead at FGOW included processes in the sandblasting shop or paint shop. Lead detections may also be a result of UMN's application of wastewater biosolids to a test area on Rosemount Research Center beginning in 1974 and subsequent plowing of the test area. The surrounding area and portions of the AOC are managed for agricultural purposes.

Non-detected SVOCs – There were 54 non-detected SVOCs with detection limits that exceeded ecological screening values in AOC 1 Northern Section. A large number of these exceedances appear to be due to elevated detection limits in two of the samples. If screening levels are compared to the detection limits in the sample that does not have elevated detection limits, the number of remaining SVOCs in AOC 1 Northern Section goes down to 14, with a list

of chemicals that is very similar to the remaining non-detected SVOCs in AOC 1 Middle and AOC 1 Southern Sections. The remaining chemicals in AOC 1 North are 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 2-chlorophenol, 3,3-dichlorobenzidine, 4,6-dinitro-2-methylphenol, bis(2-chloroethoxy)methane, butyl benzyl phthalate, hexachlorobenzene, hexachlorobutadiene, N-nitrosodimethylamine, N-nitrosopyrrolidine, naphthalene, and pentachlorophenol. There is no evidence that any of these SVOCs was related to activities on FGOW. None of these chemicals was actually detected. No further ecological evaluation of these non-detected SVOCs in the AOC 1 soil is recommended.

AOC 1 Southern Section, Surface Water

Chemicals considered for potential further ecological evaluation after initial screening include arsenic, mercury, silver, and 4 non-detected SVOCs. There is no evidence that arsenic, silver, and the non-detected SVOCs were related to activities on FGOW and therefore these chemicals are not recommended for additional ecological evaluation. Mercury was not actually detected in the surface water. The surrounding area and portions of the AOC are managed for agricultural purposes. The relatively small area of surface water at AOC 1 Southern Section has limited ecological value. Further ecological evaluation of mercury, a chemical that was not detected, is not recommended. No further ecological evaluation of surface water at AOC 1 is recommended.

AOC 1 Southern Section, Sediment

Chemicals considered for potential further ecological evaluation after initial screening include: 2,4-dinitrotoluene, acenaphthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, 1,1-dichloroethane and bromomethane. Acenaphthene, dibenz(a,h)(anthracene, and indeno(1,2,3-cd)pyrene are PAHs. PAHs are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances. PAHs are usually found as a mixture containing two or more of these compounds, such as soot. There is no evidence that the 2 VOCs – 1,1-dichloroethane and bromomethane – were used during FGOW activities and they are not recommended for additional ecological evaluation.

Food Web Exposures – Terrestrial:

- Detected with Maximum Dose > Screening Value: arsenic, chromium, lead, mercury, selenium, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, acenaphthylene, benzo(b)fluoranthene, chrysene

- Food Web Exposures – Aquatic:
  - (no chemicals exceeding screening values)

Based upon the Screening-Level ERA, there is the potential for unacceptable risk to ecological receptors at AOC 1, and further evaluation is warranted.

5.2.3 AOC 2 Shipping/Storage Buildings

The environmental setting and historical analytical data summaries are described in Section 2.5.2. Analytical results from this Focused SI work are discussed in Section 4.3.2.

5.2.3.1 Conceptual Model

Potential sources of contamination at AOC 2 were the materials stored in the former storage buildings. DuPont production operations at FGOW may have contributed the following potential hazardous substances at the Shipping and Storage Buildings: nitrocellulose, DNT, and DPA (USACE, 2006a). Surface soils may have been directly contaminated by historical Site activities. Subsurface soil and groundwater may have been contaminated via leaching. As no surface water features are present on or in the vicinity of AOC 2, there is no complete exposure pathway to aquatic receptors. Terrestrial plants, invertebrates, and upper trophic level receptors may be exposed to contaminants in surface soils via direct contact and food chain transfer. The property is currently tilled agricultural land and is not managed for ecological purposes.

The ecological endpoints evaluated in the Screening-Level ERA include terrestrial plants and invertebrates. Potential risks to upper trophic level terrestrial receptors were not evaluated because the chemicals analyzed in Site media (DNT, DPA, and nitrocellulose) are not considered important bioaccumulative chemicals (USEPA, 2000a).

Based on the screening-level problem formulation, complete exposure pathways to terrestrial receptors are present at AOC 2, and sufficient data are available to conduct the Screening-Level ERA for those chemicals selected for evaluation at the AOC.

5.2.3.2 Screening-Level Ecological Effects Evaluation

Appendix 7, Table 18 presents the results of the screening-level risk calculation for AOC 2 surface soil. Two samples were evaluated. None of the analyzed parameters (2,4-DNT, 2,6-DNT, DPA, and nitrocellulose) were detected in either of the two soil samples. The detection limit of 2,6-DNT (0.25 mg/kg) exceeded the soil screening value of 0.0328 (HQ = 7.62). The detection limit for 2,6-DNT is within an order of magnitude of its screening value and it is considered unlikely that 2,6-DNT is present at concentrations that would pose an unacceptable risk to ecological receptors. 2,6-DNT is not recommended for further ecological evaluation. Nitrocellulose does not have a soil screening value, appears to be virtually non-toxic, and is not recommended for further ecological evaluation.

5.2.3.3 Screening-Level ERA Decision Point

2,6-DNT was not detected, but the detection limit exceeds the ecological screening value. However, it should be noted that the screening criteria and detection limit are within an order of magnitude. Nitrocellulose was not indicated to be present at the Site and has no screening value. While uncertainties should be noted, it is considered unlikely that 2,6-DNT or nitrocellulose are present at AOC 2 at concentrations that pose unacceptable risk to ecological receptors. In addition, the site is tilled agricultural land. No additional ecological evaluation of this site is recommended.

5.2.4 AOC 3, Miscellaneous Drainage Areas

The environmental setting and historical analytical data are described in Section 2.5.3. Analytical results from this Focused SI work are discussed in Section 4.3.3.

5.2.4.1 Conceptual Model

The potential source of contamination at AOC 3 is drainage/runoff water from various storage and shipment buildings. Shipping cases may have been accidentally dropped either inside or outside the shipping/storage houses at other locations. Releases from shipping cases may have contributed the following potential hazardous substances at the Miscellaneous Drainage Areas: nitrocellulose, DNT and DPA (USACE, 2006a). Surface soils may have been directly contaminated by materials held within dropped cases, and contaminants may have migrated to the drainage areas with surface runoff. Subsurface soil and groundwater may have been contaminated via leaching. As no surface water features are present on or in the vicinity of AOC 3, there is no complete exposure pathway to aquatic receptors. Terrestrial plants, invertebrates, and upper trophic level receptors may be exposed to contaminants in surface soils via direct contact and food chain transfer. These drainage areas/depressions are now surrounded mainly by agricultural land belonging either to private owners or the Regents of the UMN. Vegetation observed during the PA Site reconnaissance was noted to be healthy in both areas with no signs of distress. Bay West did not observe surface water in either of the two drainage areas during the Site visits.

The ecological endpoints evaluated in the Screening-Level ERA include terrestrial plants and invertebrates. Potential risks to upper trophic level terrestrial receptors were not evaluated because the chemicals analyzed in Site media (DNT, DPA, and nitrocellulose) are not considered important bioaccumulative chemicals (USEPA, 2000).

Based on the screening-level problem formulation, complete exposure pathways to terrestrial receptors are present at AOC 3, and sufficient data are available to conduct the Screening-Level ERA for those chemicals selected for evaluation at the AOC.

5.2.4.2 Screening-Level Ecological Effects Evaluation

Appendix 7, Table 19 presents the results of the screening-level risk calculation for AOC 3 surface soil. Five samples were evaluated. 2,4-DNT, 2,6-DNT, and DPA were not detected in any of the surface soil samples. The detection limit of 2,6-DNT (0.25 mg/kg) exceeded the soil screening value of 0.0328 mg/kg. Nitrocellulose was detected in each of the five surface soil samples at concentrations ranging from 1B mg/kg to 8.2 mg/kg, but does not have a screening value.

5.2.4.3 Screening-Level ERA Decision Point

2,6-DNT was not detected, but the detection limit exceeds the ecological screening value. However, it should be noted that the screening criteria and detection limit are within an order of magnitude. It is considered unlikely that 2,6-DNT is present at AOC 3 at concentrations that pose unacceptable ecological risk. Nitrocellulose was detected in each of the five surface soil samples analyzed; however, a lack of screening criterion for this chemical prohibits an evaluation of the potential risk from this chemical. It should be noted that a search of the scientific literature was conducted, and no information regarding the potential ecotoxicity of nitrocellulose was located. Additional ecological evaluation of this AOC is not recommended.

5.2.5 AOC 4, Sanitary Buildings

The environmental setting and historical analytical data are described in Section 2.5.4. Analytical results from this Focused SI work are discussed in Section 4.3.4.

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5.2.5.1 Conceptual Model

The potential source of FGOW contamination at AOC 4 is the former boiler house which may have contributed metals, PAHs and POLs from the storage or use of fuel (coal or heating oil) and boiler maintenance activities. Surface soils may have been directly contaminated by these contaminants, while subsurface soil and groundwater may have been contaminated via leaching. As no surface water features are present on or in the vicinity of AOC 4, there is no complete exposure pathway to aquatic receptors. Terrestrial plants, invertebrates, and upper trophic level receptors may be exposed to contaminants in surface soils via direct contact and food chain transfer. However, at least half of the site is being managed for agricultural purposes and is planted with crops.

The ecological endpoints evaluated in the Screening-Level ERA include the following:

- Terrestrial plants and invertebrates
- Meadow vole
- Short-tailed shrew
- White-footed mouse
- Red hawk
- American robin
- Aquatic plants and invertebrates

Based on the screening-level problem formulation, complete exposure pathways to terrestrial receptors are present at AOC 4, and sufficient data are available to conduct the Screening-Level ERA for those chemicals selected for evaluation at the AOC.

5.2.5.2 Screening-Level Ecological Effects Evaluation

Surface Soil: Appendix 7, Table 20 presents the results of the screening-level risk calculation for AOC 4 surface soil. Four samples were evaluated.

AOC 4, Metals: The metals arsenic, barium, cadmium, chromium, lead, mercury, and selenium were detected in surface soil. Of these, lead and selenium had maximum detected concentrations that exceeded soil screening values. The maximum HQ for lead was 1.36 and the maximum HQ for selenium was 7.12.

Lead: Two of the four detections of lead exceeded the screening criteria but both exceedances of the screening criteria were marginal (13 and 15 mg/kg vs. screening criteria of 11 mg/kg). Detections of lead did not exceed the background level of 18. Lead is not recommended for further ecological evaluation.

Selenium: The maximum HQ of 7.12 was based on a non-detected sample with a detection limit that exceeded the screening value. Both the detected values and the detection limits for non-detected samples are within an order of magnitude of the screening value.

Cadmium: All detections of cadmium were less than the soil screening value; however, the detection limit for one non-detected sample (0.62 mg/kg) exceeded the screening value of 0.36 mg/kg (HQ calculated with detection limit = 1.72. Because all detected concentrations were less than the screening value, and the detection limit was within an order of magnitude of the screening value, cadmium is not recommended for further ecological evaluation.

AOC 4, PAHs: Four PAHs were detected in surface soils. All detections of these chemicals were less than soil screening values. Indeno(1,2,3-cd)pyrene was not detected, but detection limits (340 mg/kg to 440 mg/kg) exceeded the screening value of 99.4 mg/kg. Because the detection limits and screening value are within an order of magnitude, it is considered unlikely that indeno(1,2,3-cd)pyrene is present at levels of ecological concern. No PAHs are recommended for further ecological evaluation.

Terrestrial Food Web Exposures: Based on the comparison of maximum surface soil exposure doses to NOAEL-based screening values, arsenic, chromium, lead, mercury, and selenium had HQs exceeding 1.0 for one or more terrestrial receptors. Each of these metals was detected in surface soil at the AOC. All of the detections of arsenic, chromium, lead and mercury were less than the respective background levels and these chemicals are not recommended for additional ecological evaluation.

5.2.5.3 Screening-Level ERA Decision Point

The only chemical considered for potential further ecological evaluation after initial screening is selenium, with detected values and detection limits for non-detected samples that are within an order of magnitude of the ecological screening value. Selenium is not known to be associated with FGOW processes and at least half of the site is being managed for agricultural purposes, making the site of limited ecological value. Selenium is not recommended for additional ecological evaluation.

Based upon the Screening-Level ERA, it is unlikely that there is unacceptable risk to ecological receptors at AOC 4, and no further ecological evaluation is recommended.

5.2.6 AOC 5, Dinitrotoluene Storage Bunkers

The environmental setting and historical analytical data are described in Section 2.5.5. Analytical results from this Focused SI work are discussed in Section 4.3.5.

5.2.6.1 Conceptual Model

The potential source of contamination at AOC 5 is DNT, DPA, explosives, and other chemicals (fertilizers, paints, and petroleum products) that may have been stored in the storage bunkers. Past DuPont/DoD operations may have contributed the following potential hazardous substances at the DNT Storage Bunkers: nitrocellulose, DNT, and DPA (USACE, 2006a). Storage of other chemicals (including fertilizers, paints, and petroleum products) may have occurred after the property was transferred to UMN. This area appears to be fairly heavily used by UMN to support farming operations. There are several buildings present and there are actively used roads within the site. The site appears to present minimal value for ecological habitat. Surface soils may have been contaminated by spills of stored materials. Subsurface soil and groundwater may have been contaminated via leaching. As no surface water features are present on or in the vicinity of AOC 5, there is no complete exposure pathway to aquatic receptors. Terrestrial plants, invertebrates, and upper trophic level receptors may be exposed to contaminants in surface soils via direct contact and food chain transfer.

The ecological endpoints evaluated in the Screening-Level ERA include the following:

- Terrestrial plants and invertebrates
- Meadow vole

- Short-tailed shrew
- White-footed mouse
- Red hawk
- American robin

Based on the screening-level problem formulation, complete exposure pathways to terrestrial receptors are present at AOC 5, and sufficient data are available to conduct the Screening-Level ERA for those chemicals selected for evaluation at the AOC.

5.2.6.2 Screening-Level Ecological Effects Evaluation

Surface Soil: Appendix 7, Table 22 presents the results of the screening-level risk calculation for AOC 5 surface soil. Twelve samples were evaluated.

AOC 5, Pesticides: Eleven pesticides were detected in surface soil. Of these, 4,4'-DDE, 4,4'-DDT, aldrin, dieldrin, endrin, and gamma-chlordane were detected at concentrations in excess of soil screening values. Maximum HQs ranged from 1.05 (4,4'-DDE) to 3,469 (dieldrin). For 4,4'-DDE, only one detection exceeded the screening value, and the exceedance was marginal (22 µg/kg vs. 21 µg/kg). Endrin was only detected once out of 12 samples. For gamma-chlordane, only one detection exceeded the screening value. Based on low frequency of exceedance and low frequency of detection, these 3 pesticides are not recommended for additional ecological evaluation. Eight non-detected pesticides had detection limits that exceeded screening values, and one non-detected pesticide did not have a screening value. The non-detected pesticide without an ecological screening value (endrin ketone) is not recommended for additional ecological evaluation. Of the non-detected pesticides with detection limits exceeding screening values, Endosulfan I and alpha-BHC had detection limits within an order of magnitude of the screening value, making it unlikely that these chemicals are present at concentrations that pose unacceptable risk. These 2 pesticides are not recommended for additional ecological evaluation.

AOC 5, Explosives: The explosive 2,4-DNT was detected once at an estimated concentration in surface soil but the detected concentration was less than the soil screening value. 2,6-DNT was not detected, but the detection limit was greater than the soil screening value. It should be noted that the screening criteria and detection limit are within an order of magnitude. It is considered unlikely that 2,6-DNT is present at AOC 5 at concentrations that pose unacceptable ecological risk.

AOC 5, Metals: Six metals were detected in surface soils. Of these, cadmium (maximum HQ = 7.22), chromium (maximum HQ = 1.08), lead (maximum HQ = 30), and mercury (maximum HQ = 6.7) had maximum concentrations that exceeded screening values.

Cadmium: The screening value was exceeded in 5 out of 12 samples. Detections of cadmium exceeded the background level in one sample and equaled the background level in one sample.

Chromium: The maximum detection of chromium is only marginally over the screening level (28 mg/kg vs. a screening level of 26 mg/kg) and the maximum chromium detection is at the upper limit of background. Further ecological study of chromium at this site is not recommended.

Lead: Lead exceeded screening and background levels in more than half of the samples.

Mercury: The screening level was exceeded in 4 of 12 samples and the background level was exceeded in only 2 of 12 samples.

Selenium: Selenium was not detected but the detection limits exceeded the screening value. The detection limits are within an order of magnitude of the screening value, making it unlikely that selenium is present at concentrations that pose unacceptable ecological risk. Further ecological evaluation of selenium at this site is not recommended.

AOC 5, PAHs: Fifteen PAHs were detected in surface soils. Of these, benzo(a)anthracene, benzo(a)pyrene, chrysene, and naphthalene had maximum detected concentrations that exceeded soil screening values. Maximum HQs ranged from 1.54 (benzo(a)anthracene) to 4.47 (benzo(a)pyrene). The screening level for benzo(a)anthracene was exceeded in one out of 12 samples.

AOC 5, Nitrocellulose: Nitrocellulose was detected in surface soils and does not have a screening value. Nitrocellulose appears to be virtually non-toxic and is not recommended for further ecological evaluation.

Terrestrial Food Web Exposures: Based on the comparison of maximum surface soil exposure doses to NOAEL-based screening values, arsenic, cadmium, chromium, lead, mercury, and selenium had HQs exceeding 1.0 for one or more terrestrial receptors. With the exception of selenium, each of these metals was detected in surface soil at the AOC. Arsenic detections did not exceed background levels and arsenic is not recommended for additional ecological evaluation. The detection limits for selenium are within an order of magnitude of the screening values, making it unlikely that selenium is present at concentrations that pose unacceptable ecological risk. Further ecological evaluation of selenium at this site is not recommended.

5.2.6.3 Screening-Level ERA Decision Point

Chemicals considered for potential further ecological evaluation after initial screening include: the pesticides 4,4'-DDT, aldrin and dieldrin; metals cadmium, lead and mercury; and PAHs benzo(a)anthracene, benzo(a)pyrene, chrysene and naphthalene. Screening information for surface soil at AOC 5 are indicated on Appendix 7, Table 22. Many non-detected chemicals lacked screening criteria or had detection limits in excess of screening values. Chemicals that had HQs exceeding 1 based on food web exposures are identified by shaded cells on Appendix 7, Table 23.

The pesticides are not considered to be likely DuPont/DoD-related chemicals. Aldrin was first produced in 1948 (post-DuPont/DoD use of the property) and dieldrin was produced from aldrin. It is unlikely that the pesticides are present due to DuPont/DoD activities and likely that they are related to the decades of UMN agricultural use of the area. In addition, the site is of marginal ecological value due to structures and active human use of the area. Further ecological evaluation of pesticides at the site is not recommended.

There is no evidence to suggest that cadmium or lead are related to DuPont/DoD use of AOC 5. There do not appear to be widespread levels of mercury that exceed screening or background levels and the site is of marginal ecological value due to structures and active human use of the area. Further ecological evaluation of metals at this site is not recommended.

As part of FGOW, this site was intended to store DNT. There is no evidence to linking the presence of PAHs at the site to the short period of DuPont/DoD activities. Buildings at the site

were turned over to UMN intact. Further ecological evaluation of the site is not recommended due to chemicals that are not related to DuPont/DoD activities and marginal ecological value of the site itself.

5.2.7 AOC 6, 154th Street Disturbed Area

The environmental setting and historical analytical data are described in Section 2.5.6. Analytical results from this Focused SI work are discussed in Section 4.3.6.

5.2.7.1 Conceptual Model

The potential source of contamination at AOC 6 are PAHs and metals that may have been disposed at the AOC in association with DuPont operations at FGOW (USACE, 2006a). Surface soils may have been directly contaminated by these chemicals, while subsurface soil and groundwater may have been contaminated via leaching. As no surface water features are present on or in the vicinity of AOC 6, there is no complete exposure pathway to aquatic receptors. The area is an approximately football-field-size depression containing large amounts of surface and buried construction debris. Debris including rebar, concrete, and asphalt is visible on the ground surface. It is not known when the debris was placed at the site. The 154th Street Disturbed Area is now overgrown with weeds, brush, and trees, and is surrounded by agriculture fields. There are no sign of stressed vegetation at the site. Terrestrial plants, invertebrates, and upper trophic level receptors may be exposed to contaminants in surface soils via direct contact and food chain transfer.

The ecological receptors evaluated in the Screening-Level ERA include the following:

- Terrestrial plants and invertebrates
- Meadow vole
- Short-tailed shrew
- White-footed mouse
- Red hawk
- American robin

Based on the screening-level problem formulation, complete exposure pathways to terrestrial receptors are present at AOC 6, and sufficient data are available to conduct the Screening-Level ERA for those chemicals selected for evaluation at the AOC.

5.2.7.2 Screening-Level Ecological Effects Evaluation

Surface Soil. Appendix 7, Table 24 presents the results of the screening-level risk calculation for AOC 6 surface soil. Six samples were evaluated.

AOC 6, Metals: The metals arsenic, barium, cadmium, chromium, lead, mercury, and silver were detected in surface soil. Of these, cadmium, chromium, lead and mercury had maximum detected concentrations that exceeded soil screening values. Maximum HQs ranged from 1.65 (chromium) to 15.45 (lead).

Cadmium: The maximum cadmium detection does not exceed the background value. Further ecological evaluation of cadmium is not recommended.

Chromium: Chromium exceeds the screening value and the background value in only one of 6 samples and the maximum detection is within an order of magnitude of the screening level. Further ecological evaluation of chromium is not recommended.

Lead: The screening level is exceeded in all 6 samples and the background level is exceeded in 4 of 6 samples.

Mercury: The screening level is exceeded in 4 of 6 samples and the background level is exceeded in 2 of 6 samples. The maximum detection is within an order of magnitude of the screening level.

Selenium: Selenium was not detected but has a detection limit that exceeded the soil screening value. The screening criteria and detection limit are within an order of magnitude. It is considered unlikely that selenium is present at AOC 6 at concentrations that pose unacceptable ecological risk. Further ecological evaluation of selenium is not recommended.

AOC6, PAHs: Fourteen PAHs were detected in surface soils. Of these, benzo(a)anthracene, benzo(a)pyrene, chrysene, and naphthalene had maximum detected concentrations that exceeded soil screening values. Maximum HQs for PAHs ranged from 1.75 (benzo(a)anthracene) to 4.80 (benzo(a)pyrene). One non-detected PAH (2-methylnaphthalene) had detection limits that exceeded the soil screening value. The screening criteria for 2-methylnaphthalene and its detection limit are within an order of magnitude. It is considered unlikely that 2-methylnaphthalene is present at AOC 6 at concentrations that pose unacceptable ecological risk. Further ecological evaluation of 2-methylnaphthalene is not recommended.

Terrestrial Food Web Exposures: Based on the comparison of maximum surface soil exposure doses to NOAEL-based screening values, arsenic, cadmium, chromium, lead, mercury, and selenium had HQs exceeding 1.0 for one or more terrestrial receptors (Appendix 7, Table 25) and exceeded screening criteria. None of the detections of arsenic exceeded the background level, therefore arsenic is not recommended for additional ecological evaluation. With the exception of selenium each of these metals was detected in surface soil at the AOC.

Screening-Level ERA Decision Point:

Chemicals considered for potential further ecological evaluation after initial screening include: lead, mercury, benzo(a)anthracene, benzo(a)pyrene, chrysene, and naphthalene. Cadmium, chromium, and selenium are also considered based on terrestrial food web exposures.

There was no known use of cadmium, chromium, or selenium at FGOW and these chemicals are not recommended for additional ecological evaluation.

Based upon the Screening-Level ERA, there is the potential for unacceptable risk to ecological receptors at AOC 6, and further evaluation is warranted.

5.2.8 AOC 7, Steam Plant and Associated 26.7 Acres

The environmental setting and historical analytical data are described in Section 2.5.7. Analytical results from this Focused SI work are discussed in Section 4.3.7.

5.2.8.1 Conceptual Model

The potential source of contamination at AOC 7 is the steam plant and structures contained on the associated 26.7 acres. Former operations at these structures may have resulted in surface

soil contamination from spills or leaks. Subsurface soil and groundwater may have been contaminated via leaching. As no surface water features are present on or in the vicinity of AOC 7, there is no complete exposure pathway to aquatic receptors. Terrestrial plants, invertebrates, and upper trophic level receptors may be exposed to contaminants in surface soils via direct contact and food chain transfer. Operations at FGOW may have contributed the following potential hazardous substances at this AOC:

- AOC 7A: PCBs, industrial solvents and degreasers, POLs, and heavy metals
- AOC 7B: industrial solvents and degreasers, POLs, and heavy metals
- AOC 7C: nitrocellulose, DNT, DPA, industrial solvents and degreasers, POLs, mercury, heavy metals, oleum, nitric and sulfuric acids, and SVOCs
- AOC 7D: nitrocellulose, DNT, DPA, industrial solvents and degreasers, POLs, mercury, SVOCs, heavy metals, oleum, sulfuric and nitric acids, and PCBs

Current uses of AOC 7 are as follows:

AOC 7A: The north quarter of AOC 7A is currently farmland and the remainder is currently not used and contains the remnants of a number of collapsed buildings.

AOC 7B: No historical features are currently visible in this area and AOC 7B is well graded. Currently, this area is not used. According to discussions with UMN representatives during the February 21, 2007 Site visit, the 49th International Union of Operating Engineers (IUOE) extensively reworked subsurface soils in AOC 7B as part of their training. The topsoil was removed and stockpiled on the south side of AOC 7C and AOC 7D. Excavations may have extended down as far as 30 ft bgs. All of the underground utilities, including culverts used to transport wastewater, were reportedly removed. The culverts are currently being stored in AOC 7D, south of Building 401-A.

AOC 7C: This area is currently not used. The only historical features currently remaining in this area are remnants of the coal conveyor towers and field office. According to discussions with UMN representatives during the February 21, 2007 Site visit, the 49th IUOE may have extensively reworked the subsurface soils in this area. A culvert is located in the northeast corner of AOC 7C. Water collected in this area during a rain event. Otherwise surface water was not observed in the ditches and culverts.

AOC 7D: Stockpiled topsoil reportedly removed from AOC 7B is located in the southwest corner of AOC 7C and the south side of AOC 7D. The placement of this soil occurred after DuPont/DoD operations. The area is currently not used. Features currently remaining in this area include the ditches and towers, and remnants of building or structure foundations. The secondary containment reservoir and water tower are not present.

The ecological endpoints evaluated in the Screening-Level ERA include the following:

- Terrestrial plants and invertebrates
- Meadow vole
- Short-tailed shrew
- White-footed mouse
- Red hawk

- American robin

Based on the screening-level problem formulation, complete exposure pathways to terrestrial receptors are present at AOC 7, and sufficient data are available to conduct the Screening-Level ERA for those chemicals selected for evaluation at the AOC.

5.2.8.2 Screening-Level Ecological Effects Evaluation

AOC 7A – Northwest Quadrant Surface Soil. Appendix 7, Table 26 presents the results of the risk screening AOC 7A Northwest Quadrant surface soil. Eleven samples were evaluated.

AOC 7A, PCBs: The PCBs Aroclor-1254 and Aroclor-1260 were detected in surface soils in AOC 7A and do not have screening values. Further ecological evaluation of chemicals without screening values is not recommended.

AOC 7A, Metals: Seven metals were detected in surface soils. Of these, cadmium (maximum HQ=4.17), chromium (maximum HQ=1.54), lead (maximum HQ = 47.27), and mercury (maximum HQ = 1.9) had maximum detections that exceeded soil screening values. For cadmium, only 2 detections exceeded the background level and these were minimal exceedances (both detections were 1.5 mg/kg vs. a background level of 1.4 mg/kg). Additional ecological evaluation of cadmium is not recommended. For chromium, only one out of 11 samples exceeded the screening criteria and background level; therefore further ecological evaluation of chromium is not recommended. Eight of 11 samples exceeded the lead screening criteria. Two of 11 samples exceeded the mercury screening criteria, however, neither of these detections exceeded the background level for mercury. Further ecological evaluation of mercury is not recommended. Selenium was not detected but its detection limits exceeded the soil screening value. The screening criteria and detection limit for selenium are within an order of magnitude. It is considered unlikely that selenium is present at AOC 7A at concentrations that pose unacceptable ecological risk. Further ecological evaluation of selenium is not recommended.

AOC 7A, SVOCs: Seventeen SVOCs were detected in surface soils. Of these, 2-methylnaphthalene (maximum HQ = 1.17), benzo(a)anthracene (maximum HQ=21.11), benzo(a)pyrene (maximum HQ=55.92), benzo(b)fluoranthene (maximum HQ=2.68), chrysene (maximum HQ=23.26), fluoranthene (maximum HQ=2.46), indeno(1,2,3-cd)pyrene (maximum HQ=3.33), naphthalene (maximum HQ=83.50), phenanthrene (maximum HQ=5.25), and pyrene (maximum HQ=2.93) had maximum detections that exceeded screening values. Carbazole was detected, but due to a lack of soil screening value, is not recommended for further ecological evaluation. In addition, 32 non-detected SVOCs had detection limits that exceeded screening values, and 6 non-detected SVOCs did not have screening values. The non-detected SVOCs are not recommended for additional ecological evaluation. Of the 32 non-detected SVOCs with detection limits exceeding screening values, the following had screening criteria and detection limits that are within an order of magnitude: 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, 2-nitroaniline, 4-chloro-3-methylphenol, 4-nitroaniline, and diethyl phthalate It is considered unlikely that these 8 non-detected SVOCs are present at AOC 7A at concentrations that pose unacceptable ecological risk. The following 24 non-detected SVOCs had detection limits that exceeded the screening criteria by greater than an order of magnitude: 1,4-dichlorobenzene, 2,4-dimethylphenol, 2,4-dinitrophenol, 2,6-dichlorophenol, 2-chloronaphthalene, 2-chlorophenol, 2-nitrophenol, 3,3-dichlorobenzidine, 3-nitroaniline, 4,6-dinitro-2-methylphenol, 4-chloroaniline, 4-nitrophenol, bis(2-chloroethoxy)methane, butyl benzyl phthalate, di-n-butyl phthalate, hexachlorobenzene,

hexachlorobutadiene, hexachloroethane, N-nitrosodi-n-propylamine, N-nitrosodimethylamine, N-nitrosodiphenylamine, N-nitrosopyrrolidine, nitrobenzene, and pentachlorophenol.

AOC 7A, VOCs: Ten VOCs were detected in surface soil. Of these, 1,2,3-trimethylbenzene and p-isopropyltoluene did not have screening values and are not recommended for additional ecological evaluation. The remaining detected VOCs did not exceed screening values. In addition, 17 non-detected VOCs lacked screening values and are not recommended for further ecological evaluation.

AOC 7B – Northeast Quadrant Surface Soil: Appendix 7, Table 27 presents the results of the screening-level risk calculation for AOC 7 Northeast Quadrant surface soil. Three surface soil samples were evaluated.

AOC 7B, Explosives: The explosive 2,6-DNT was detected in surface soils and the detection limit exceeded the soil screening value of 0.033 mg/kg. However, the detection limit and the screening value are within an order of magnitude, making it unlikely that 2,6-DNT is actually present at AOC 7B at concentrations that pose unacceptable ecological risk. This chemical is not recommended for additional ecological evaluation.

AOC 7B, Metals: Six metals were detected in surface soils, but all detections were less than soil screening values. Selenium was not detected, but detection limits exceeded the soil screening value. However, the detection limits and screening value are within an order of magnitude, making it unlikely that selenium is actually present at AOC 7B at concentrations that pose unacceptable ecological risk. Selenium is not recommended for further ecological evaluation.

AOC 7B, SVOCs: No SVOCs were detected in surface soils. Fourteen non-detected SVOCs were identified had detection limits that exceeded screening values, and eight non-detected SVOCs had no screening values. The non-detected SVOCs without screening values are not recommended for further ecological evaluation. The following chemicals had detection limits and screening values within an order of magnitude, making it unlikely that these chemicals are actually present at AOC 7B at concentrations that pose unacceptable ecological risk: 2-chlorophenol, 3,3-dichlorobenzidine, bis(2-chloroethoxy)methane, butyl benzyl phthalate, di-n-butyl phthalate, hexachlorobenzene, hexachlorobutadiene, and naphthalene. The preceding SVOCs are not recommended for additional ecological evaluation. SVOCs with detection limits that exceed screening values by greater than an order of magnitude include: 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 4,6-dinitro-2-methylphenol, N-nitrosodimethylamine, and N-nitrosopyrrolidine.

AOC 7B, VOCs: Five VOCs were detected in surface soils. Of these, 1,2,4-trimethylbenzene does not have a screening value and is not recommended for further ecological evaluation. The remaining detected VOCs did not exceed screening values. In addition, 18 non-detected VOCs do not have screening values and are not recommended for additional ecological evaluation.

AOC 7C – Southeast Quadrant Surface Soil: Appendix 7, Table 28 presents the results of the screening-level risk calculation for AOC 7C Southeast Quadrant surface soil. Twelve surface soil samples were evaluated.

AOC 7C, Explosives: 2,4-DNT and 2,6-DNT were not detected in surface soil. Of these, 2,6-DNT had a detection limit that exceeded the soil screening value. However, the detection limits

and screening value are within an order of magnitude, making it unlikely that 2,6-DNT is actually present at AOC 7C at concentrations that pose unacceptable ecological risk. 2,6-DNT is not recommended for further ecological evaluation.

AOC 7C, Metals: Six metals were detected in surface soils. All were detected at concentrations below their soil screening values. Selenium was not detected but the detection limit exceeded the screening value. The detection limit was within an order of magnitude of the screening value, making it unlikely that selenium is present at concentrations that would present an unacceptable ecological risk. Selenium is not recommended for additional ecological evaluation.

AOC 7C, SVOCs: Seven SVOCs were detected in surface soils. Of these, dibenzofuran did not have a screening value and is not recommended for additional ecological evaluation. The remaining detected SVOCs were below screening levels. In addition, 14 non-detected SVOCs had detection limits that exceeded screening values, and 7 non-detected SVOCs did not have screening values. The non-detected SVOCs without screening values are not recommended for additional ecological evaluation. Of the 14 non-detected SVOCs with detection limits exceeding screening values, 2-chlorophenol, 3,3-dichlorobenzidine, bis(2-chloroethoxy)methane, butyl benzyl phthalate, di-n-butyl phthalate, hexachlorobenzene, hexachlorobutadiene, and naphthalene had detection limits within an order of magnitude of the screening limit, indicating it is unlikely that these chemicals are present at AOC 7C in concentrations that would present an unacceptable ecological risk. The 8 preceding SVOCs are not recommended for additional ecological evaluation. The following SVOCs had detection limits that exceeded screening values by greater than an order of magnitude: 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 4,6-dinitro-2-methylphenol, N-nitrosodimethylamine, and N-nitrosopyrrolidine.

AOC 7C, VOCs: Three VOCs were detected in surface soils, of these, p-isopropyltoluene did not have a screening value and is not recommended for further ecological evaluation. The remaining detected VOCs did not exceed screening values. In addition, 17 non-detected VOCs did not have screening values and are not recommended for additional ecological evaluation.

AOC 7C, Nitrocellulose: Nitrocellulose was detected in surface soil and does not have a screening value. Nitrocellulose appears to be virtually non-toxic and is not recommended for further ecological evaluation.

AOC 7D – Southwest Quadrant Surface Soil: Appendix 7, Table 29 presents the results of the screening-level risk calculation for AOC 7D Southwest Quadrant surface soil. Nine samples were evaluated.

AOC 7D, PCBs: The PCBs Aroclor-1254 and Aroclor-1260 were detected in surface soils and do not have screening values. Five non-detected PCBs do not have screening values. Chemicals with no ecological screening values are not recommended for further ecological evaluation.

AOC 7D, Explosives: Neither of the two explosives were detected in surface soils; however, 2,6-DNT had a maximum detection limit that exceeded the soil screening value. Because the detection limit and the soil screening value are within an order of magnitude of each other, it is unlikely that 2,6-DNT is present at AOC 7D at concentrations that would present an

unacceptable ecological risk. No further ecological evaluation of 2,6-DNT at AOC 7D is recommended.

AOC 7D: Metals: Seven metals were detected in surface soils. Of these, barium (maximum HQ=1.03), cadmium (maximum HQ=5.56), chromium (maximum HQ=1.08), lead (maximum HQ=66.36), mercury (maximum HQ=11), and selenium (maximum HQ=11.00) had maximum detections that exceeded soil screening values. The maximum barium detection was only marginally over the soil screening level (340 mg/kg vs. 330 mg/kg). All other detections of barium were less than the screening level. Additional ecological evaluation of barium is not recommended. Only one detection of cadmium actually exceeded the soil screening value. There were non-detected samples where the detection limit exceeded the soil screening value, but the detection limits of these samples were within an order of magnitude of the soil screening value, making it unlikely that cadmium is present at these locations at concentrations that would present an unacceptable ecological risk. No additional ecological evaluation of cadmium is recommended. Only one detection of chromium exceeded the soil screening level and that exceedance was marginal (28 mg/kg vs. 26 mg/kg). Further ecological evaluation of chromium at AOC 7D is not recommended. Six out of nine samples had lead detections that equaled or exceeded the soil screening value and 4 of these also exceeded the background level. Two out of nine samples exceeded soil screening levels for mercury; only one sample exceeded background levels. Based on low frequency of exceedance of the soil screening level and the background level, further ecological evaluation of mercury is not recommended. Selenium was only detected once at AOC 7D. The detection limits for the non-detected samples exceeded the soil screening value but were within an order of magnitude of the screening value. Based on low frequency of detection and the likelihood that selenium is not present in concentrations that would present an unacceptable ecological risk at locations where it was not detected, additional ecological evaluation of selenium is not recommended.

AOC 7D, SVOCs: Twenty-one SVOCs were detected in surface soils. Of these, benzo(a)anthracene (maximum HQ=1.29), benzo(a)pyrene (maximum HQ=3.62), bis(2-ethylhexyl)phthalate (maximum HQ=10.81), chrysene (maximum HQ=1.31), and naphthalene (maximum HQ=2.72) had maximum detections that exceeded screening values. Only one detection each of benzo(a)anthracene, bis(2-ethylhexyl) phthalate and chrysene actually exceeded the screening values. All non-detected samples of benzo(a)anthracene, bis(2-ethylhexyl) phthalate and chrysene had detection limits below screening criteria. Only one detection of benzo(a)pyrene exceeded the soil screening level. Naphthalene was detected twice and both detections exceeded the screening criteria. All detection limits for naphthalene exceeded the screening criteria but were within an order of magnitude of the screening criteria. Carbazole and dibenzofuran were detected and did not have screening values; they are not recommended for additional ecological evaluation. In addition, 18 non-detected SVOCs had detection limits that exceeded screening values, and 6 non-detected SVOCs did not have screening values. The non-detected SVOCs without screening values are not recommended for additional ecological evaluation. Of the 18 non-detected SVOCs with detection limits exceeding screening values, the following 11 had detection limits within an order of magnitude of the screening level: 1,4-dichlorobenzene, 2-chlorophenol, 3,3-dichlorobenzidine, 3-nitroaniline, bis(2-chloroethoxy)methane, butyl benzyl phthalate, di-n–butyl phthalate, hexachlorobenzene, hexachloroethane, N-nitrosodi-n-propylamine, and N-nitrosodiphenylamine. The preceding SVOCs are unlikely to be present at AOC 7D in concentrations that would present an unacceptable ecological risk and they are not recommended for further ecological evaluation. The remaining 7 non-detected SVOCs had detection limits greater than an order of magnitude over the screening level (2-chloronaphthalene, 2,4-dimethylphenol, 2,4-dinitrophenol, 4,6-

dinitro-2-methylphenol, hexachlorobutadiene, N-nitrosodimethylamine, and N-nitrosopyrrolidine).

AOC 7D, VOCs: Seven VOCs were detected in surface soils. Of these, 1,2,4-trimethylbenzene and m-xylene/p-xylene did not have screening values and are not recommended for further ecological evaluation. The remaining detected VOCs did not exceed screening values. In addition, 17 non-detected VOCs did not have soil screening values and are not recommended for additional ecological evaluation.

AOC 7D, Nitrocellulose: Nitrocellulose was detected in surface soil and does not have a screening values. Nitrocellulose appears to be virtually non-toxic and is not recommended for further ecological evaluation.

AOC 7 – Terrestrial Food Web Exposures: Results of the risk calculations for terrestrial food web exposures are provided in Appendix 7, Table 30. For the terrestrial evaluation, soil data from each of the four quadrants of the AOC were combined and the maximum detection for each chemical from the combined data set was used as an estimate of soil concentrations.

Based on the comparison of maximum surface soil exposure doses to NOAEL-based screening values, the following had HQs exceeding 1.0 for one or more terrestrial receptors : arsenic, cadmium, chromium, lead, mercury, selenium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, hexachlorobutadiene, hexachlorobenzene, and indeno(1,2,3-cd)pyrene. In addition, no NOAEL was available for avian species for 1,2,4-trichlorobenzene, and no NOAELs were available for avian or mammalian species for 4-bromophenyl-phenylether, 4-chlorophenyl-phenylether, or hexachloroethane. These chemicals lacking NOAELs are not recommended for additional ecological evaluation. Of the chemicals that exceeded ecological screening values for terrestrial food web exposures, the following were detected in one or more surface soil samples at the AOC: arsenic, cadmium, chromium, lead, mercury, selenium, benzo(a)anthracene, benzo(a)pyrene, benzo(b) fluoranthene, chrysene, dibenz(a,h)anthracene, hexachlorobutadiene, and indeno(1,2,3-cd)pyrene.

5.2.8.3 Screening-Level ERA Decision Point

AOC 7A

Chemicals considered for further ecological evaluation after initial screening include:

Metals: Lead

Detected SVOCs: 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene.

Non-detected SVOCs: 1,4-dichlorobenzene, 2,4-dimethylphenol, 2,4-dinitrophenol, 2,6-dichlorophenol, 2-chloronaphthalene, 2-chlorophenol, 2-nitrophenol, 3,3-dichlorobenzidine, 3-nitroaniline, 4,6-dinitro-2-methylphenol, 4-chloroaniline, 4-nitrophenol, bis(2-chloroethoxy)methane, butyl benzyl phthalate, di-n-butyl phthalate, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, N-nitrosodi-n-propylamine, N-nitrosodimethylamine, N-nitrosodiphenylamine, N-nitrosopyrrolidine, nitrobenzene, and pentachlorophenol.

AOC 7B

Chemicals considered for further ecological evaluation after initial screening include:

Non-detected SVOCs: 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 4,6-dinitro-2-methylphenol, N-nitrosodimethylamine, and N-nitrosopyrrolidine

Because none of the preliminary chemicals recommended for additional ecological evaluation were actually detected, no further ecological evaluation of AOC 7B is recommended.

AOC 7C

Chemicals considered for further ecological evaluation after initial screening include:

Non-detected SVOCs: 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 4,6-dinitro-2-methylphenol, N-nitrosodimethylamine, and N-nitrosopyrrolidine.

Because none of the preliminary chemicals recommended for additional ecological evaluation were actually detected, no further ecological evaluation of AOC 7C is recommended.

AOC 7D

Chemicals considered for further ecological evaluation after initial screening include:

Metals: Lead

Detected SVOCs: benzo(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chrysene, and naphthalene

Non-detected SVOCs: 2-chloronaphthalene, 2,4-dimethylphenol, 2,4-dinitrophenol, 4,6-dinitro-2-methylphenol, hexachlorobutadiene, N-nitrosodimethylamine, and N-nitrosopyrrolidine

AOC 7, Terrestrial Food Web Exposures

Metals: arsenic, cadmium, chromium, lead, mercury, and selenium

SVOCs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, hexachlorobutadiene, and indeno(1,2,3-cd)pyrene

Based upon the Screening-Level ERA, there is the potential for unacceptable risk to ecological receptors at AOCs 7A and 7D due to metals and SVOCs, and further evaluation is warranted.

6.0 SUMMARY AND CONCLUSIONS

The Focused SI sample locations were selected to determine if a release and migration of potential hazardous substances to the groundwater, surface water, soil and/or sediment occurred as a result of activities performed in the seven AOCs, and if a release has occurred, whether or not it poses a potential risk to human health and the environment. Based on the results of the field work and the screening-level Risk Assessments, hazardous substances have been released impacting the groundwater, surface water, soil, and sediment. These releases occurred as a result of activities performed in the AOCs by either DoD/DuPont activities or subsequent land owners/tenants and there exist potential risks to human health and/or the environment.

Because there are other PRPs, in accordance with USACE ER 200-3-1, FUDS Program Policy, once a release has been confirmed the next step is to transfer the project to the PRP District where they will identify all viable PRPs, determine allocation of responsibilities, and determine the lead regulatory agency before proceeding to the RI phase.

The screening-level HHRA qualitatively evaluated the potential risk to human receptors based on exposure to chemicals detected at the seven AOCs. The screening-level ERA evaluated the potential risk to ecological receptors based on exposure to chemicals detected at the seven AOCs.

Additional detail on how each AOC passed or failed the screening-level HHRA or ERA is summarized below.

Screening-Level HHRA. The screening-level HHRA qualitatively evaluated the potential risk to human receptors based on exposure to chemicals detected at the seven AOCs. The strengths and weaknesses of the screening-level HHRA are discussed in Section 5.1 and the conservative measures incorporated into the Screening-Level HHRA are included in Section 5.1.4.5. The results are summarized as follows

- AOC 1-Northern Section: Based on the analytical results, AOC 1-Northern Section does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic and mercury in total soil. The maximum arsenic concentration was less than the maximum background arsenic concentration and the maximum mercury concentration exceeded the adjusted PRG but not the actual Region 9 PRG.

- AOC 1-Middle Section: Based on the analytical results, AOC 1-Middle Section does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic and mercury in total soil; and bis[2-ethylhexyl]phthalate in groundwater. The maximum arsenic concentration was less than the maximum background arsenic concentration and the maximum mercury concentration exceeded the adjusted PRG but not the actual Region 9 PRG. Regarding groundwater chemicals, bis(2-ethylhexyl)phthalate is frequently identified as a sampling or laboratory contaminant.

- AOC 1-Southern Section: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 1-Southern Section. The screening-level HHRA criteria that

were exceeded are as follows: the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene, along with arsenic in total soil; arsenic in sediment; and arsenic in surface water. Additional Site evaluation is recommended.

- AOC 2: Based on the analytical results, AOC 2 passed the screening comparison because no chemicals exceeded screening values. There were no positive detections in the soil or groundwater analytical results in this AOC.

- AOC 3: Based on the analytical results, AOC 3 passed the screening comparison because no chemicals exceeded screening values. There were no positive detections in the soil or groundwater analytical results in this AOC.

- AOC 4: Based on the analytical results, AOC 4 does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic in total soil. The maximum concentration of arsenic was less than the maximum background concentration of arsenic.

- AOC 5: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 5. The screening-level HHRA criteria that were exceeded are as follows: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, (all of the preceding chemicals are PAHs); dieldrin, and arsenic in total soil; no exceedances in groundwater. PAHs are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances. PAHs are usually found as a mixture containing two or more of these compounds, such as soot. As part of FGOW, this site was intended to store DNT. There is no evidence linking the presence of PAHs at the site to the short period of DuPont/DoD activities. Buildings at the site were turned over to UMN intact. It should be noted that the maximum arsenic concentration was less than the maximum background arsenic concentration. According to available information, there is no historical mention of FGOW use of dieldrin at AOC 5 and it was historically not available at the time of FGOW activities. Therefore, Dieldrin is likely a result of activities that occurred after FGOW operations. The bunkers are currently being used by the UMN for storage of a variety of materials including chemicals (such as fertilizers, paints, and petroleum products), machinery, scrap wood, and metal. No additional human health evaluation of AOC 5 with respect to DuPont/DoD activities is recommended.

- AOC 6: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 6. The screening-level HHRA criteria that were exceeded are as follows: PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene; and arsenic in total soil. No records were found to indicate the date the debris was deposited, but the Site may have been in use during demolition and dismantlement activities during and immediately following the operation of FGOW. It is also possible that some debris may have been placed at the Site more recently. Additional Site evaluation is recommended.

- AOC 7A: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 7A. The screening-level HHRA criteria that were exceeded are as follows: PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene,

dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, fluoranthene, naphthalene, and phenanthrene; carbazole, Aroclor-1254, Aroclor-1260, arsenic, and lead in total soil. Additional Site evaluation is recommended.

- AOC 7B: Based on the analytical results, AOC 7B does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: arsenic in total soil; chloroform, benzo(k)fluoranthene, and bis(2-chloroisopropyl)ether in groundwater. The maximum arsenic concentration in soil did not exceed the maximum background concentration of arsenic. Chloroform did not exceed its MCL. Benzo(k)fluoranthene and bis(2-chloroisopropyl)ether were each detected once in groundwater and were not detected in the soil at AOC 7B.

- AOC 7C: Based on the analytical results, AOC 7C does not appear to pose an unacceptable risk to human receptors. One or more chemical exposure concentrations marginally exceed screening criteria in this AOC as follows: benzo(a)pyrene and arsenic in total soil; and chloroform, benzo(a)anthracene, bis(2-ethylhexyl)phthalate, and chromium in groundwater. Benzo(a)pyrene was only detected once in soil, and that detection only marginally exceeded the screening level (65 µg/kg vs. 62 µg/kg). The maximum detection of arsenic in soil was less than the maximum background concentration. Chloroform and chromium do not exceed their respective MCLs. Bis(2-ethylhexyl)phthalate only marginally exceeds its MCL (6.6 µg/L vs. 6.0 µg/L). Benzo(a)anthracene was only detected once in groundwater.

- AOC 7D: Based on the analytical results, the screening-level HHRA criteria were exceeded in AOC 7D. The screening-level HHRA criteria that were exceeded are as follows: PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene; pentachlorophenol, PCBs, arsenic, barium, and lead in total soil; chloroform, 2,4,6-trichlorophenol, and 2-methylnaphthalene in groundwater. The detections of chloroform do not exceed the MCL. Additional Site evaluation is recommended.

Screening-Level ERA. The screening-level ERA evaluated the potential risk to ecological receptors based on exposure to chemicals detected at the seven AOCs. The screening-level ERA concluded the following:

- AOC 1-Northern Section: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 1-Middle Section: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 1-Southern Section: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 2: The potential for ecological risk at AOC 2 cannot be ruled out completely due to uncertainties in the evaluation. 2,6-DNT was not detected, but the detection limit exceeds the ecological screening value. However, it should be noted that the screening criteria and detection limit are within an order of magnitude. Nitrocellulose was not detected above the MDLs, but the lack of screening criteria for this chemical means that the potential risk from nitrocellulose, if it is present below the detection limit, cannot be evaluated. While there is no established screening value for nitrocellulose, available data on human health effects and mammalian toxicity suggest that this chemical is virtually nontoxic (Ryon, 1986). While these uncertainties should be noted, it is unlikely that 2,6-DNT or nitrocellulose are present at AOC 2 at concentrations that pose unacceptable risk to ecological receptors. In addition, the site is tilled agricultural land. No additional ecological evaluation of this site is recommended.

- AOC 3: The potential for ecological risk at AOC 3 cannot be ruled out completely due to uncertainties in the evaluation. 2,6-DNT was not detected, but the detection limit exceeds the ecological screening value. However, it should be noted that the screening criteria and detection limit are within an order of magnitude. It is considered unlikely that 2,6-DNT is present at AOC 3 at concentrations that pose unacceptable ecological risk. Nitrocellulose was detected in each of the five surface soil samples analyzed; however, a lack of screening criterion for this chemical prohibits an evaluation of the potential risk from this chemical. However, as stated above, while there is no established screening value for nitrocellulose, available data on human health effects and mammalian toxicity suggest that this chemical is virtually nontoxic (Ryon, 1986). Additional ecological evaluation of this AOC is not recommended.

- AOC 4: The only chemical considered for potential further ecological evaluation after initial screening is selenium, with detected values and detection limits for non-detected samples that are within an order of magnitude of the ecological screening value. Selenium is not known to be associated with FGOW processes and at least half of the site is being managed for agricultural purposes, making the site of limited ecological value. Selenium is not recommended for additional ecological evaluation. Based upon the Screening-Level ERA, it is unlikely that there is unacceptable risk to ecological receptors at AOC 4, and no further ecological evaluation is recommended.

- AOC 5: Chemicals considered for potential further ecological evaluation after initial screening include: the pesticides 4,4'-DDT, aldrin and dieldrin; metals cadmium, lead and mercury; and PAHs benzo(a)anthracene, benzo(a)pyrene, chrysene and naphthalene. The pesticides are not considered to be likely DuPont/DoD-related chemicals, due to non-availability prior to 1948 and the likelihood that these chemicals are related to the decades of UMN agricultural use of the area. There is no evidence to suggest that cadmium or lead are related to DuPont/DoD use of AOC 5. There do not appear to be widespread levels of mercury that exceed screening or background levels. As part of FGOW, this site was intended to store DNT. There is no evidence to linking the presence of PAHs at the site to the short period of DuPont/DoD activities. Buildings at the site were turned over to UMN intact. Further ecological evaluation of the site is not recommended based on chemicals that are not related to DuPont/DoD activities and the marginal ecological value of the site itself due to structures and active human use of the area.

- AOC 6: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 7A-Northwest Quadrant: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

- AOC 7B-Northeast Quadrant: Chemicals considered for further ecological evaluation after initial screening include the non-detected SVOCs: 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 4,6-dinitro-2-methylphenol, N-nitrosodimethylamine, and N-nitrosopyrrolidine. Because none of the preliminary chemicals recommended for additional ecological evaluation were actually detected, no further ecological evaluation of AOC 7B is recommended.

- AOC 7C-Southeast Quadrant: Chemicals considered for further ecological evaluation after initial screening include the non-detected SVOCs: 2,4-dimethylphenol, 2,4-dinitrophenol, 2-chloronaphthalene, 4,6-dinitro-2-methylphenol, N-nitrosodimethylamine, and N-nitrosopyrrolidine. Because none of the preliminary chemicals recommended for additional ecological evaluation were actually detected, no further ecological evaluation of AOC 7C is recommended.

- AOC 7D-Southwest Quadrant: There is the potential for unacceptable risk to ecological receptors at this AOC. This means one or more of the chemical exposure concentrations exceeded ecological screening values. Therefore, additional Site investigation is recommended.

Screening-level risk assessments are highly conservative evaluations. The next step in the risk assessment process would include the collection of additional Site specific data, a refinement of the list of chemicals under consideration for ecological evaluation based on more realistic exposure assumptions, considerations of background data, Site-specific factors that may influence chemical bioavailability, and comparisons of Site data to literature-based toxicity data in cases where screening criteria are lacking. This step would result in the identification of potential risk drivers at the Site, or a conclusion that no additional action or evaluation is warranted.

Migration of Chemicals. The soil borings generally encountered up to 16 ft of silts, sands and some clay underlain by poorly-graded sand. Chemicals are more likely to bind to silts and clays than to sandy soils. Therefore, chemicals detected in the silty surface soil samples are less likely to migrate into the underlying soils. This conclusion is supported by the fact that chemicals, if detected, were generally detected at higher concentrations in the surface soil samples than they were at depth. This indicates that the chemicals do not appear to be significantly migrating from their source areas.

The maximum depth that groundwater was encountered in each of the AOCs is summarized in the following table.

Area of Concern	Approximate Maximum Depth of Groundwater if encountered (ft bgs)
AOC 1-Northern Section	50
AOC 1-Middle Section	36
AOC 1-Southern Section	10
AOC 2	55
AOC 3	50
AOC 4	Not encountered to refusal 53 ft bgs
AOC 5	41
AOC 6	Not Applicable
AOC 7A-Northwest Quadrant	Not encountered to refusal 60 ft bgs
AOC 7B-Northeast Quadrant	68
AOC 7C-Southeast Quadrant	66
AOC 7D-Southwest Quadrant	64

In most cases, chemicals detected in the soils were not detected above MDLs and/or screening criteria in the groundwater. Therefore, it appears that significant migration of the chemicals from the surface soils to the underlying groundwater has not occurred. However, additional groundwater sampling is recommended to confirm the presence or absence of chemicals in areas where soil contamination is confirmed. Especially in those areas were the groundwater is shallow or if the chemicals detected are considered more mobile in the environment.

Analytical results indicate that chemicals were deposited along the AOC 1 waste disposal ditch, settling basins and outfall area (AOC 1-Southern Section). Surface water was only present in AOC 1-Southern Section. Therefore, surface water and sediment samples were only obtained in this location. Chemicals were detected in the surface water and sediments. The surface water below the dam/weir is the head of a stream that ultimately discharges into the Vermillion River. It is unknown if this stream is intermittent. If the sediments are disturbed there is a small potential that they could release the chemicals into the surface water and ultimately the Vermillion River.

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