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Work Plan
for
Risk Assessment
at
SWMUs 4, 5, 9, and 10

Naval Surface Warfare Center
Crane Division
Crane, Indiana

VOLUME I - TEXT

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
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QUALITY ASSURANCE PROJECT PLAN
FOR
RISK ASSESSMENT
AT
SWMUs 4, 5, 9, AND 10

NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

REVISION 1
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COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0010

Date 8/28/00
KAREN M. SMECKER
TASK ORDER MANAGER
TETRA TECH NUS, INC.

Date 8/28/00
DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

Date 8/28/00
PAUL V. FRANK
QUALITY ASSURANCE MANAGER
TETRA TECH NUS, INC.

Date 10-27-00
ALLEN DEBUS
QUALITY ASSURANCE COORDINATOR
U.S. EPA REGION 5

Date 10/31/00
PETER RAMANAUSKAS
PERMITTING PROJECT MANAGER
U.S.EPA REGION 5

Date 11/16/00
TOM BRENT
SITE MANAGER
NSWC CRANE

Date 12/4/00
KATHY KREPS
LABORATORY DIRECTOR
LAUCKS TESTING LABORATORIES, INC.

Date 11/27/00
~~BELEN RUEDA~~ Patty L. Ragsdale
LABORATORY MANAGER
TRIANGLE LABORATORIES, INC.

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Jim Hinsicker

SIGNATURE

Environmental Protection Department Manager

TITLE

DATE

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ACRONYMS

ALPEC	Ammunition Loading and Production Engineering Center
AMSL	above mean sea level
ASL	above screening level
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
B&R	Brown and Root
BAF	Bioaccumulation Factor
BG3	below ground surface
BOD	Biological Oxygen Demand
BSL	below screening level
BTAG	Biological Technical Assistance Team
CAAA	Crane Army Ammunition Activity
CASCO	Central Ammunition Supply Control Office
CCME	Canadian Council of Ministers of the Environment
CDDs	chlorinated dibenzo-p-dioxins
CDFs	chlorinated dibenzofurans
CDI	Chronic Daily Intake
CEC	Cation Exchange Capacity
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CMS	Corrective Measure Studies
COC	Chemical of Concern
COD	Chemical Oxygen Demand
COPC	Chemical of Potential Concern
CRAVE	Carcinogenic Risk Assessment Verification Endeavor
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
CTO	Contract Task Order
DOQ	Digital Ortho Quarter Quads
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
EDQL	Ecological Data Quality Levels

EGIS	Environmental Geographic Information System
EMR	Environmental Monitoring Reports
ER-L	Effects Range-Low
ER-M	Effects Range-Medium
FOL	Field Operations Leader
FSP	Field Sampling Plan
HASP	Health and Safety Plan
HI	Hazard Indices
HMTC	Hazardous Material Technical Center
HQ	Hazard Quotient
HSM	Health and Safety Manager
HSWA	Hazardous and Solid Waste Amendments
IA	Installation Agreement
IAS	Initial Assessment Study
ICR	Incremental Cancer Risk
IDEM	Indiana Department of Environmental Management
IEUBK	Integrated Exposure Uptake Biokenetic Model
ILCR	Incremental Lifetime Cancer Risk
MS	Information Management System
IRIS	Integrated Risk Information System
LAN	Local Area Network
LOAEL	Lowest Observed Adverse Effects Level
MCL	Maximum Contaminant Level
MHSPE	Netherlands Ministry of Housing, Spatial Planning, and Environment for Soil Protection
NACIP	Navy Assessment and Control of Installation Pollutants
NAD	Naval Ammunition Depot
NEESA	Naval Energy and Environmental Support Agency
NOAEL	No Observed Adverse Effects Level
NSWC	Naval Surface Warfare Center
NWSCC	Naval Weapons Support Center Crane
OMOE	Ontario Ministry of Environment and Energy
OPPTS	Office of Prevention, Pesticides, and Toxic Substances
ORNL	Oak Ridge National Laboratory
OSHA	Occupation Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAHs	Polyn uclear Aromatic Hydrocarbons

PCB	Polychlorinated Biphenyl
PM	Project Manager
PRGs	Preliminary Remediation Goals
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAGS	Risk Assessment Guide for Superfund
RCRA	Resource Conservation Recovery Act
RFI RCRA	Facility Investigation
RL	Reporting Limit
RME	Reasonable Maximum Exposure
RPM	Remedial Project Manager
RQAC	RCRA Quality Assurance Coordinator
SCS	Soil Conservation Service
SERA	Screening-level Ecological Risk Assessment
SL	screening level
SMC	Sample Management Coordinator
SOP	Standard Operating Procedure
SOUTH DIV	US Navy Southern Division Naval Facilities Engineering Command
SQB	Sediment Quality Benchmarks
SQC	Sediment Quality Criteria
SSL	Soil Screening Level
SSO	Site Safety Officer
SSSLs	Surface Soil Screening Levels
SVOC	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
SWSL	Surface Water Screening Levels
TEF	Toxicity Equivalence Factors
TIC	Tentatively Identified Compounds
TOC	Total organic Carbon
TOM	Task Order Manager
TPH	Total Petroleum Hydrocarbon
TRVs	Terrestrial Reference Values
TSD	Treatment, Storage and Disposal Facility
TSS	Total Suspended Solids

TSSDS	Tri-Service Spatial Data Standards
TtNUS	Tetra Tech NUS
UCL	Upper Confidence Limit
U.S. ACE	US Army Corps of Engineers
USDA	US Department of Agriculture
U.S. EPA	US Environmental Protection Agency
USGS	US Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
WES	Waterways Experiment Station
WQS	Water Quality Standards

1.0 INTRODUCTION

(Note: Brown & Root Environmental was purchased on January 1, 1998 and became Tetra Tech NUS, Inc. (TtNUS)). This Risk Assessment Work Plan has been prepared in support of the completion of Baseline Human Health Risk Assessments and Screening-Level Ecological Risk Assessments for four Solid Waste Management Units (SWMUs) at the Naval Surface Warfare Center (NSWC) Crane located in Crane, Indiana. The four SWMUs addressed in this Work Plan include SWMU 4 - McComish Gorge, SWMU 5 - Old Burn Pit, SWMU 9 - Pesticide Control Area/R-150 Tank Area, and SWMU 10 - Rockeye. This Work Plan was prepared by TtNUS on behalf of the U.S. Navy Southern Division Naval Facilities Engineering Command (SOUTHDIV) and NSWC Crane. The work was performed in response to Contract Task Order (CTO) Number 0010 under Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62467-94-D-0888.

In 1981 the Navy initiated the Navy Assessment and Control of Installation Pollutants (NACIP) Program. This initiation included an investigation for designated sites at the facility. These investigations were known as the Initial Assessment Study (IAS). The Naval Energy and Environmental Support Agency (NEESA) completed the IAS in 1983 with assistance from the Ordnance Environmental Support Agency and the U.S. Army Corps of Engineers (U.S. ACE) Waterways Experiment Station (WES). The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations. Based on the conclusions of the IAS, it was determined that SWMUs 4, 5, 9, and 10 did not represent an immediate human health and environmental threat. It was, however, recommended that further study be conducted at these four SWMUs to evaluate potential long-term impacts.

In 1989 NSWC Crane was given a final Resource Conservation and Recovery Act (RCRA) Part B Permit. The permit contained corrective action requirements to be performed at its SWMUs. In response to the IAS recommendations and the requirements of the permit, RCRA Facility Investigations (RFIs) were initiated for the four SWMUs.

Based on requirements of the RCRA Part B Permit, various phases of investigations have been conducted at SWMUs 4, 5, 9, and 10. The first investigation consisted of Phase II RFIs. The objective of the Phase II RFIs was to determine the presence or absence of contamination at the sites. These studies primarily addressed soil contamination. Nature and extent of contamination was characterized during the Phase III RFIs. Although Phase III Work Plans were prepared for most of the sites, Rockeye is the only site for which the entire Work Plan was implemented and a final report prepared and submitted to

USEPA. Due to funding constraints only a portion of the Work Plan was implemented for the other sites and no final reports were prepared. Ground water samples were mainly collected as part of the Phase III studies. Based on the results of these investigations, chemical releases to the environment from past operations conducted at the SWMUs have been identified, requiring the performance of a human health and ecological assessments.

1.1 OBJECTIVE

The objective of this Work Plan is to outline the activities necessary to conduct Baseline Human Health Risk Assessments and Screening-Level Ecological Risk Assessments for SWMUs 4, 5, 9, and 10. Conclusions from these risk assessments will be used by risk managers to determine whether further activities (such as remediation, long-term monitoring, etc.) are warranted at these sites. The risk assessments will be conducted in accordance with the RCRA Corrective Action requirements identified in NSWC Crane's RCRA Part B Permit (issued in 1989), U.S. Environmental Protection Agency's (U.S. EPA) Risk Assessment Guidance for Superfund (RAGS) (U.S. EPA, December 1989), Ecological Risk Assessment Guidance for Superfund (U.S. EPA, June 1997), and other available risk assessment guidance.

1.2 SCOPE OF WORK

The tasks identified as being necessary to complete the Baseline Human Health Risk Assessments and Preliminary Ecological Risk Assessments for the four SWMUs are as follows:

- Evaluation of Historical Data;
- Field Investigation;
- Laboratory Analysis;
- Data Management; and
- Risk Assessment.

A brief description of these tasks is provided below.

1.2.1 Evaluation of Historical Data

An evaluation of the historical data was conducted as part of the scoping effort for the proposed field investigation. These data were used to focus the proposed field investigation by assisting in the identification of chemicals of interest and spatial distribution of contamination. The historical data were

compared with applicable, current risk-based screening levels for the protection of human health and the environment. Any chemicals that were reported at concentrations exceeding the screening levels were identified as detected parameters of interest. The parameters of interest were used to assist in the selection of the analytical suites for the proposed field investigations for each SWMU.

Comparisons of historical site data to applicable, current risk-based screening criteria are presented in this Work Plan. Figures illustrating exceedances of the risk-based screening levels also are provided.

1.2.2 Field Investigation

Since the proposed field investigations are intended to collect data sufficient for the risk assessments, a conceptual site model was developed for each SWMU. The site-specific model defines the contaminant sources, release mechanisms, migration pathways, exposure, and potential human and ecological receptors based on current and future land use. For each SWMU, the model and information on the detected parameters of interest were then used to develop an appropriate sampling and analytical program (i.e., target analyte list, sample locations, type and depth of sampling, etc.).

The proposed field investigations for the SWMUs are detailed in this Work Plan. The field investigation activities include surface soil sampling, surface water and sediment sampling, borehole drilling (subsurface soil sampling) and well installation, and ground water sampling at or in the vicinity of the four SWMUs. In general, proposed sample locations were identified based on exceedances of the risk-based screening levels, perceived gaps in the historical data, and receptor contact points.

1.2.3 Laboratory Analysis

Upon collection of the environmental samples identified in this Work Plan, the samples will be analyzed at a fixed-base laboratory. A specific analytical program has been defined for each SWMU based on the detected parameters of interest. Specific laboratory Quality Assurance/Quality Control (QA/QC) requirements, as well as other project-specific QA/QC requirements, are provided in the associated Quality Assurance Project Plan (QAPP), which is contained in Appendix C.

1.2.4 Data Management

The data collected as part of the risk assessment field investigation will be subjected to a formal data validation process and compiled into an Environmental Geographic Information System (EGIS) for NSWC Crane. Although various QA/QC procedures will be performed through the implementation of the associated QAPP, the analytical data will be reviewed to ensure its validity. A discussion of the data

validation process and the specific procedures used to manage the data upon completion of data validation are outlined in this Work Plan.

1.2.5 Risk Assessment

Current U.S. EPA risk assessment guidance will be used to conduct the Baseline Human Health Risk Assessments and the Screening-Level Ecological Risk Assessments for SWMUs 4, 5, 9, and 10. Because of various uncertainties associated with data quality, the historical data for these SWMUs will not be used quantitatively in the risk assessments. However, the historical data will be used in a qualitative fashion to support conclusions of the risk assessments. As noted previously, the results of the risk assessments will be used for decision-making purposes by risk managers to determine whether further actions (such as remediation, long-term monitoring, etc.) are warranted at these four SWMUs or whether they can be closed out with no further action. A recommendation of whether further action is needed will be provided in the conclusions of the risk assessment.

The general procedures and methodologies to be used in performing the risk assessments are identified in this Work Plan. The Baseline Human Health Risk Assessment will consist of Data Evaluation, Exposure Assessment, Toxicity Assessment, Risk Characterization, and Uncertainty Analysis. The Screening-Level Ecological Risk Assessment will include a Problem Formulation, Analysis Phase, Risk Characterization, and Uncertainty Analysis.

1.3 ORGANIZATION OF WORK PLAN

The remainder of this section identifies the organization of this Work Plan. Section 1.0 provides this introduction. Section 2.0 describes the project organization and responsibilities. Section 3.0 consists of the Facility description, which includes the location and description of the Base, the history of NSWC Crane, and the physical setting for NSWC Crane. Section 4.0 summarizes the methodologies used to develop the proposed field investigations for the four SWMUs. Sections 5.0 through 8.0 contain the site-specific information for the SWMUs 4, 5, 9, and 10, respectively. The site-specific information included in these sections consists of a description of the background, physical setting, previous investigations, results of the historical data evaluation, and proposed field investigation for the site. Section 9.0 presents the system and format of the database to be compiled in support of risk assessment activities. This section also describes the overall approach for the data validation of investigation-derived data. Section 10.0 contains the general methodologies to be used to conduct the Baseline Human Health Risk Assessments. Section 11.0 provides a description of the general methodologies for the performance of the Screening-Level Ecological Risk Assessments.

Three key documents were prepared in conjunction with this Work Plan. A Field Sampling Plan (FSP) was prepared to describe the field activities that will be required for the field investigations. The relevant Standard Operating Procedures (SOPs) for the proposed field investigations are included in the FSP, which is presented in Appendix A. The site-specific Health and Safety Plan (HASP) outlines the health and safety procedures and guidelines to be used during the performance of the field operations and is provided in Appendix B. Attached to the HASP are the Occupational Safety and Health Administration (OSHA) Poster, Medical Data Sheet, and the Chemical Data Sheets/Hazard Lines. The QAPP, provided in Appendix C, describes the quality assurance and quality control procedures to be used to ensure that the data are usable for their intended purposes (for risk assessments).

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents the project management and organization for the risk assessment investigations to be conducted at SWMUs 4, 5, 9, and 10 at NSWC Crane. At the direction of the U.S. EPA Project Manager (PM), TtNUS, on behalf of the U.S. Navy and NSWC Crane, is responsible for the overall management, implementation of contract field activities, and preparation of the Risk Assessment Report. Personnel from the Navy and NSWC Crane will be actively involved and will coordinate with TtNUS personnel in a number of areas. The authorities and organizational relationship of key personnel are depicted in Figure 2-1. Corresponding addresses and telephone numbers of key personnel also are listed by organization in Table 2-1.

2.1 MANAGEMENT

Responsibilities for program management, quality assurance, field investigation, and subcontractors are discussed in the following sections. It is intended that the individuals named will perform the designated responsibilities to the extent that the specific person is available to perform the stated activities.

2.1.1 U.S. EPA Project Manager

The U.S. EPA PM will oversee the implementation of this risk assessment investigation at NSWC Crane. The U.S. EPA PM represents the Agency's interests and will provide input from this perspective as well as lend general historical and technical assistance to NSWC Crane field activities.

2.1.2 Indiana Department of Environmental Management

Although the U.S. EPA will oversee the project, the Indiana Department of Environmental Management (IDEM) PM also will have the opportunity to review and comment on the risk assessment investigation at NSWC Crane.

2.1.3 Navy Project Managers

The Navy Remedial Project Manager (RPM) acts as the focal representative for the U.S. Navy, providing management, technical direction, and oversight for all NSWC Crane project activities performed by contractors (i.e., TtNUS) and their subcontractors. In matters such as facilitation of access, oversight, etc., the Navy RPM is assisted by the NSWC Crane Site Manager. Additional responsibilities of the RPM include the following:

FIGURE 2-1

PROJECT ORGANIZATION CHART
NSWC CRANE, INDIANA

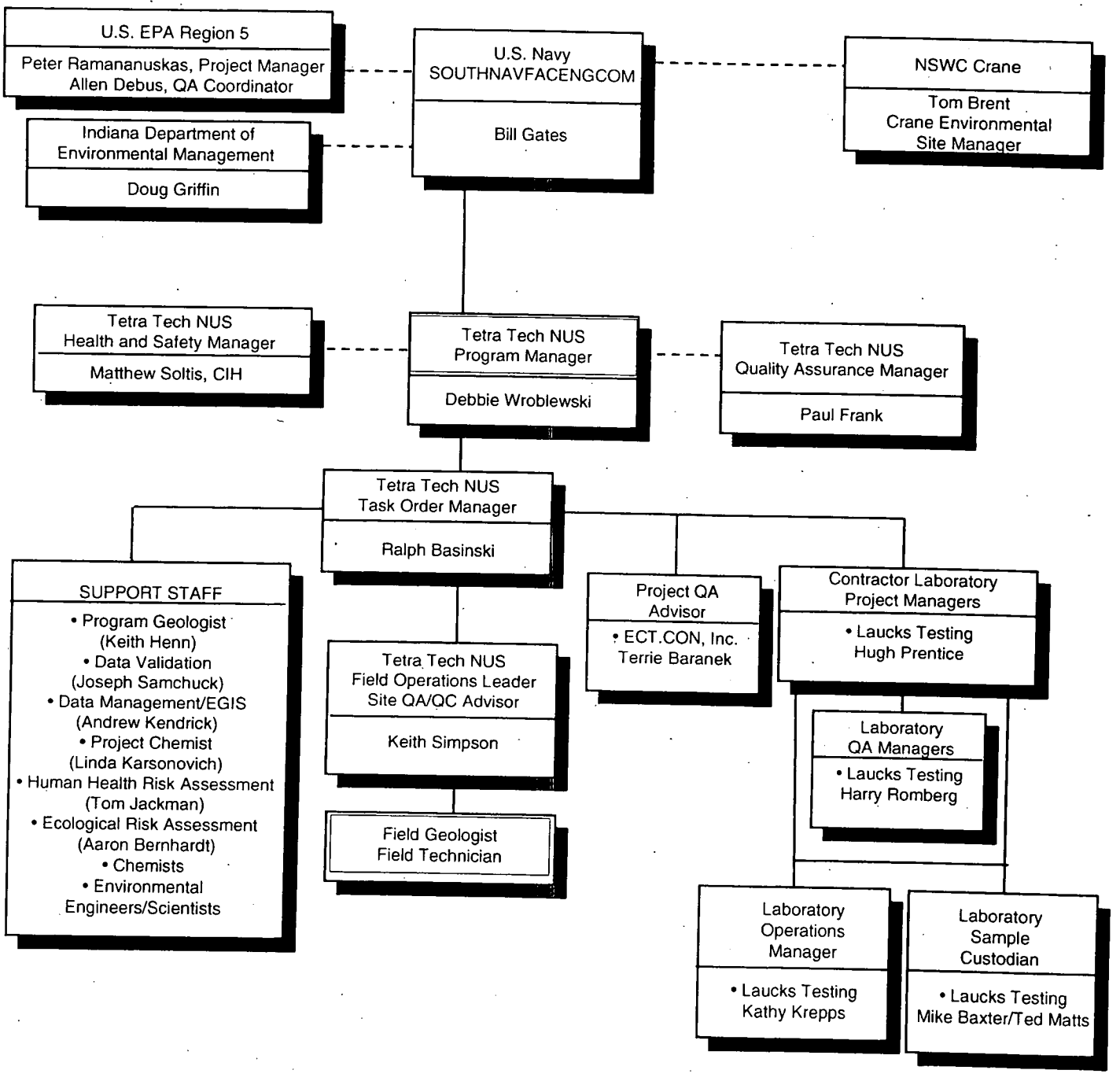

TABLE 2-1

CONTACT LIST
NSWC CRANE, INDIANA
PAGE 1 OF 2

PERSON/ TITLE/ ORGANIZATION	ADDRESS	TELEPHONE
Peter Ramanauskas Project Manager U.S. EPA Region 5	U.S. EPA Region 5 West Jackson Street Chicago, Il 60604	(312) 886-7890
Allen Debus QA Coordinator U.S. EPA Region 5	U.S. EPA Region 5 West Jackson Street Chicago, IL 60604	(312) 886-6186
Doug Griffin Corrective Action Section Office of Land Quality Hazardous Waste Permits Indiana Department of Environmental Management	IDEM Corrective Action Section Office of Land Quality Hazardous Waste Permits 100 N. Senate Avenue Indianapolis, IN 46206-6015	(317) 233-2710
Bill Gates Remedial Project Manager U.S. Navy SOUTHNAVFACENGCOM	Department of Navy SOUTHNAVFACENGCOM Code 1829 2155 Eagle Drive N. Charleston, SC 29406	(803) 820-7360 FAX: (803) 820-7465
Tom Brent Environmental Site Manager NSWC Crane	NSWC Crane Code 095 B-3260 300 Highway 361 Crane, IN 47522-5009	(812) 854-6160 FAX: (812) 854-4177
Debbie Wroblewski Program Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8968 FAX: (412) 921-4040
Paul Frank Quality Assurance Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8950 FAX: (412) 921-4040
Matt Soltis Health and Safety Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8912 FAX: (412) 921-4040
Ralph Basinski Task Order Manager Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8308 FAX: (412) 921-4040
Keith Simpson Field Operations Leader Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8131 FAX: (412) 921-4040
Keith Henn Program Geologist Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220-2745	(412) 921-8623 FAX: (412) 921-4040
Joseph Samchuck Data Validation Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8510 FAX: (412) 921-4040

TABLE 2-1

CONTACT LIST
NSWC CRANE, INDIANA
PAGE 2 OF 2

PERSON/ TITLE/ ORGANIZATION	ADDRESS	TELEPHONE
Andy Kendrick Data Management/EGIS Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8250 FAX: (412) 921-4040
Linda Karsonovich Project Chemist Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8729 FAX: (412) 921-4040
Tom Jackman Human Health Risk Assessment Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8724 FAX: (412) 921-4040
Aaron Bernhardt Ecological Risk Assessment Tetra Tech NUS	Tetra Tech NUS 661 Andersen Drive Pittsburgh, PA 15220	(412) 921-8433 FAX: (412) 921-4040
Terrie Baranek Project QA Advisor ECT.CON Inc.	ECT.CON Inc. 3531 Fox Chase Drive Imperial, PA 15126	(724) 695-8042 FAX: (724) 695-2698
Hugh Prentice Project Manager Laucks Testing	Laucks Testing 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5491
Harry Romberg Lab QA Manager Laucks Testing	Laucks Testing 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5491
Kathy Krepps Lab Operations Manager Laucks Testing	Laucks Testing 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5491
Mike Baxter/Ted Matts Lab Sample Custodian Laucks Testing	Laucks Testing 940 South Harney Street Seattle, WA 98053	(206) 767-5060 FAX: (206) 767-5491

- Define project objectives and develop a detailed work plan schedule;
- Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task;
- Acquire and apply technical resources (i.e., contractors) as needed to ensure performance within budget and schedule constraints;
- Review the work performed on each task to ensure its quality, responsiveness, and timeliness;
- Review and analyze overall task performance with respect to planned requirements and authorizations;
- Approve all reports (deliverables) before their submission to U.S. EPA Region 5;
- Ultimately be responsible for the preparation and quality of interim and final reports; and
- Represent the project team at meetings and public hearings.

2.1.4 Contractor Project Management

Program Manager

The TtNUS Navy Southern Division CLEAN Program Manager provides operations, technical, and administrative leadership and oversees and supports quality policies. The Program Manager assigns project Task Order Managers (TOMs) and oversees their performance. The Program Manager also ensures the availability of technical and support resources for program operations and maintains consistency in procedures and projects among CTO assignments. In these matters, the Program Manager is assisted by the TOM.

Task Order Manager

The TtNUS TOM has the overall responsibility for ensuring that the project meets U.S. EPA and IDEM objectives, as well as Navy and TtNUS quality standards. The TOM is responsible for the preparation and distribution of the planning documents, at the direction of the Navy RPM, to all parties connected with the

project, including any subcontractors. The TOM is also responsible for the implementation of field activities and the preparation of the risk assessments. The TOM will report to the Navy RPM and is responsible for technical quality control and project oversight. Additional responsibilities of the TOM are:

- Assembling and managing the TtNUS project team;
- Ensuring timely resolution of project-related technical, quality, safety, or waste management issues;
- Functioning as primary interface with the Navy RPM and NSWC Crane Site Manager, field personnel, and subcontractor points-of-contact;
- Monitoring and evaluating subcontractor performance;
- Coordinating and overseeing work performed by field and office technical staff (including data validation, statistical evaluations, and report preparation);
- Coordinating and overseeing maintenance of all project records;
- Coordinating and overseeing review of project deliverables; and
- Preparing and issuing final deliverables to the Navy.

Health and Safety Manager

The TtNUS Health and Safety Manager (HSM) is responsible for the following:

- Overseeing the development and review of the Site Security and HASP;
- Implementation of the Site Security and HASP;
- Assigning the Site Safety Officer and supervising his or her performance;
- Conducting Health and Safety audits; and
- Preparing Health and Safety reports for management.

Project Chemist

The TtNUS Project Chemist will serve as the focal point for the analytical requirements of the project and as a coordinator for sample collection, subsequent data analysis, and data reporting performed by the

subcontract laboratory. This person is responsible for resolving questions the laboratory may have regarding QAPP requirements and deliverables and coordination of sample data package deliverables received from the laboratory. The Project Chemist reports to the TOM or designee.

Sample Management Coordinator

The TtNUS Sample Management Coordinator will be responsible for generating sample pre-printed sample tags, tracking environmental samples as they are collected in the field, and for documenting receipt and confirmation of the samples by the analytical laboratory. The Sample Management Coordinator reports to the TOM or designee.

Data Validation Coordinator

The TtNUS Data Validation Coordinator will be responsible for scheduling completion of the reduction, validation, and documentation activities related to the sample data package deliverables received from the laboratory. This person is also responsible for reviewing the data validation memoranda and ensuring that the data validation qualifiers are transferred to the electronic database. The Data Validation Coordinator reports to the TOM or designee.

Data Management/EGIS Leads

The TtNUS Data Management and EGIS Leads will be responsible for managing the field and analytical data generated during the project. Their duties will include inputting and reviewing the transfer of field measurements from sample logsheets to the electronic database. They will be responsible for accumulation, control, and storage of the project data in accordance with the Data Management Section of this Work Plan (Section 9.0) and with the QAPP (Section 9.0). These persons will report to the TOM or designee.

Risk Assessment Leads

The TtNUS Human Health and Ecological Risk Assessment Leads will be responsible for the completion of the risk assessments. Their duties will include inputting and reviewing the transfer of field measurements from sample logsheets to the electronic database. They will be responsible for ensuring that the site-specific evaluations are conducted in accordance with the latest U.S. EPA risk assessment guidance. These persons will report to the TOM or designee.

2.2 QUALITY ASSURANCE

This section identifies the quality assurance responsibilities for the NSWC Crane Risk Assessment Investigation at SWMUs 4, 5, 9, and 10. Responsibilities of the U.S. EPA Region 5, TtNUS personnel, and the analytical laboratory are discussed.

2.2.1 U.S. EPA Region 5 Quality Assurance Coordinator

The U.S. EPA Region 5 RCRA Quality Assurance Coordinator (RQAC) has the responsibility to review and approve the QAPP and provide overall QA support and review. The IDEM has the responsibility to review and approve the QAPP and provide overall quality assurance. Additional U.S. EPA and IDEM responsibilities may include:

- Coordinating external performance and system audits of the contracted laboratory and
- Reviewing and evaluating analytical field and laboratory procedures.

2.2.2 TtNUS Quality Assurance Manager

The TtNUS Quality Assurance Manager (QAM) is responsible for overall quality assurance for the project and reports directly to the TtNUS Program Manager. The QAM has the responsibility for the following specific activities:

- Developing, maintaining, and monitoring quality assurance policies and procedures;
- Providing training to TtNUS staff in QA/QC policies and procedures;
- Conducting systems and performance audits to monitor compliance with environmental regulations, contractual requirements, QAPP and Work Plan requirements, and corporate policies and procedures;
- Auditing project records;
- Monitoring subcontractor quality controls and records;
- Assisting in the development of corrective action plans; ensuring correction of nonconformances reported in internal or external audits;

- Overseeing the implementation of the QAPP;
- Overseeing and reviewing the development and revision of the QAPP;
- Overseeing the responsibilities of the TtNUS Site QA/QC Advisor; and
- Preparing QA reports for management.

2.2.3 Project QA Advisor

The Project QA Advisor provides support to the TOM in preparation and review of the QAPP. The QA Project Advisor communicates directly with the TOM on QA/QC matters.

2.2.4 Laboratory Responsibilities

As discussed in Section 7.0 of the attendant QAPP, Laucks Testing Laboratories, Inc., of Seattle, Washington, will perform all sample analyses for this field activity.

The subcontracted laboratory is responsible for analyzing all samples in accordance with the analytical methods and additional requirements specified in the attendant QAPP. It also will be the analytical laboratory's responsibility to properly dispose of unused sample aliquots. Responsibilities of key laboratory personnel are outlined in the following paragraphs.

Laboratory Project Manager

The Laboratory Project Manager will interface directly to the TtNUS TOM and QA Advisor and will perform the following:

- Ensure that method and project-specific requirements are properly communicated and understood by laboratory personnel;
- Ensure that all laboratory resources are available on an as required basis;
- Monitor analytical and project QA requirements;
- Review data packages for completeness, clarity, and compliance with project requirements; and
- Inform the TtNUS TOM of project status and any sample receipt or analytical problems.

Laboratory Operations Manager

Responsibilities of the Laboratory Operations Manager include the following:

- Support the QA program within the laboratory;
- Provide management overview of both production and quality-related laboratory activities;
- Maintain adequate staffing to meet project analytical and quality objectives;
- Approve all laboratory SOPs and QA documents;
- Supervise in-house chain-of-custody documentation; and
- Oversee the preparation of, and approving, final analytical reports before submittal to TtNUS.

Laboratory Quality Assurance Officer (QAO)

The Laboratory QAO will report directly to the Laboratory Operations Manager. The Laboratory QAO will be independent of laboratory production management to ensure that laboratory quality performance is assessed without schedule and cost considerations. Responsibilities of the Laboratory QAO include the following:

- Define appropriate laboratory QA procedures and monitor overall laboratory QA;
- Stop work if a condition adverse to the quality of work is encountered, if QA or quality control (QC) procedures are not followed, or if analytical out-of-control events are encountered that have not been corrected;
- Approve and maintain document control of all QA documents and SOPs;
- Perform and/or implement internal system and performance audits and verify completion of corrective actions cited in audits; and
- Direct laboratory participation in laboratory accreditation and certification programs.

Laboratory Sample Custodian

The Laboratory Sample Custodian will report to the Laboratory Operations Manager. Responsibilities of the laboratory Sample Custodian include the following:

- Receive and inspect the incoming sample containers;
- Record the condition of the incoming sample containers;
- Sign appropriate documents;
- Verify chain-of-custody;
- Notify laboratory project manager of sample receipt and inspection;
- Assign a unique identification number and customer number, and enter each into the sample receiving log;
- With the help of the laboratory project manager, initiate transfer of the samples to appropriate lab sections; and
- Control and monitor access/storage of samples and extracts.

Laboratory Technical Staff

The laboratory technical staff will be responsible for sample analysis based on the analytical methods and requirements specified in the attendant QAPP.

2.3 FIELD INVESTIGATION

TtNUS will be responsible for all field activities related to this risk assessment investigation. The TtNUS field team will be organized according to the activities planned. Field team members will be selected based on the type and extent of effort required. All team members will be appropriately skilled and trained for the tasks they are assigned to perform. The team will consist of a combination of the following personnel:

- Field Operations Leader (FOL);
- Site QA/QC Advisor;
- Site Safety Officer; and
- Field Technical Staff.

2.3.1 Field Operations Leader

The FOL is responsible for coordinating all onsite personnel and for providing technical assistance, when required. The FOL, or designee, will coordinate and lead all sampling activities and will ensure the availability and maintenance of all sampling materials/equipment. The FOL is responsible for the completion of all sampling, field and chain-of-custody documentation; will assume custody of all samples; and will ensure the proper handling and shipping of samples. The FOL is a highly experienced

environmental professional who will report directly to the TtNUS TOM. Specific FOL responsibilities include the following:

- Function as a communications link between field staff members, the Site QA/QC Advisor, Site Safety Officer, the Site Manager, and the TOM;
- Oversee the mobilization and demobilization of all field equipment and subcontractors;
- Coordinate and manage the Field Technical Staff;
- Adhere to the work schedules provided by the TOM;
- Bear responsibility for maintenance of the site logbook, and field recordkeeping;
- Initiate field task modification requests, when necessary; and
- Identify and resolve problems in the field; resolve difficulties in consultation with the NSWC Crane Site Manager; implement and document corrective action procedures and provide communication between the field team and upper management.

2.3.2 Site QA/QC Advisor

The FOL (or assistant) will act as the Site QA/QC Advisor, who is responsible for ensuring adherence to all QA/QC guidelines as defined in the FSP and QAPP. Strict adherence to these procedures is critical to the collection of acceptable and representative data. The following is a summary of the Site QA/QC Advisor's responsibilities:

- Ensure that field duplicates and field quality control blanks are collected with the proper frequency;
- Ensure that additional volumes of sample are supplied to the analytical laboratory with the proper frequency to accommodate laboratory QA/QC analyses;
- Ensure that measurement and test equipment are calibrated, used, and maintained in accordance with applicable procedures;
- Act as liaison between site personnel, laboratory personnel, and the QAM; and

- Manage bottleware shipments and oversees sample preservation.

2.3.3 Site Safety Officer

The FOL (or designee) will also serve as the Site Safety Officer (SSO). The duties of the SSO are detailed in the HASP. The SSO has stop-work authority, which can be executed upon the determination of an imminent safety hazard.

2.3.4 Field Technical Staff

The Field Technical Staff for this project will be drawn from TtNUS's pool of qualified personnel. All designated field team members will be experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work. Field Technical Staff are responsible for complying with field-related requirements as presented in the QAPP, as well as the requirements in this Work Plan.

3.0 FACILITY DESCRIPTION

3.1 FACILITY LOCATION AND DESCRIPTION

NSWC Crane is located in the southern portion of Indiana, immediately east of Crane Village and Burns City. The Facility is approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky (Figure 3-1). NSWC Crane encompasses 62,463 acres (approximately 98 square miles), with the majority of the Facility located in the northern portion of Martin County. Smaller portions of the Facility are located in Greene, Davies, and Lawrence Counties. NSWC Crane is located in a rural, sparsely populated area. Most of the Facility is forested, and the surrounding area is wooded or farmed land. NSWC Crane provides naval support for equipment, shipboard weapons systems, and ordnance. In addition, NSWC Crane supports the Crane Army Ammunition Activity (CAAA) with production and renovation of conventional ammunition and storage, shipment, demilitarization, and disposal of conventional ammunition (Murphy, 1992b). Descriptions of SWMUs 4, 5, 9, and 10 are provided in Sections 5.0 through 8.0, respectively. The locations of the SWMUs are shown on Figure 3-1.

3.2 FACILITY HISTORY AND ACTIVITIES

This section provides general information on the history of NSWC Crane and its activities.

3.2.1 History of Ownership and Operation

In 1940 Congress authorized construction of a Naval Ammunition Depot (NAD) in southern Indiana, and in late 1941 the Naval Ammunition Depot Burns City was commissioned. In 1943 NAD Burns City was renamed NAD Crane, and the Town of Crane was built to house the rapidly growing number of civil service employees. NAD Crane's overall mission was to load, prepare, renovate, receive, store, and issue ammunition to the fleet.

During World War II, NAD Crane's mission expanded to include pyrotechnics production, mine filling, rocket assembly, field storage, torpedo storage, and ordnance spare parts and mobile equipment storage. During the 1950s, several new departments were created, the Ammunition Loading and Production Engineering Center (ALPEC) was transferred to Crane, and the Central Ammunition Supply Control Office (CASCO) was established. NAD Crane supplied ammunition to the fleet during the Korean and Vietnam Conflicts. During the Southeast Asia crisis, the number of full-time employees at NAD Crane grew to 6,800.

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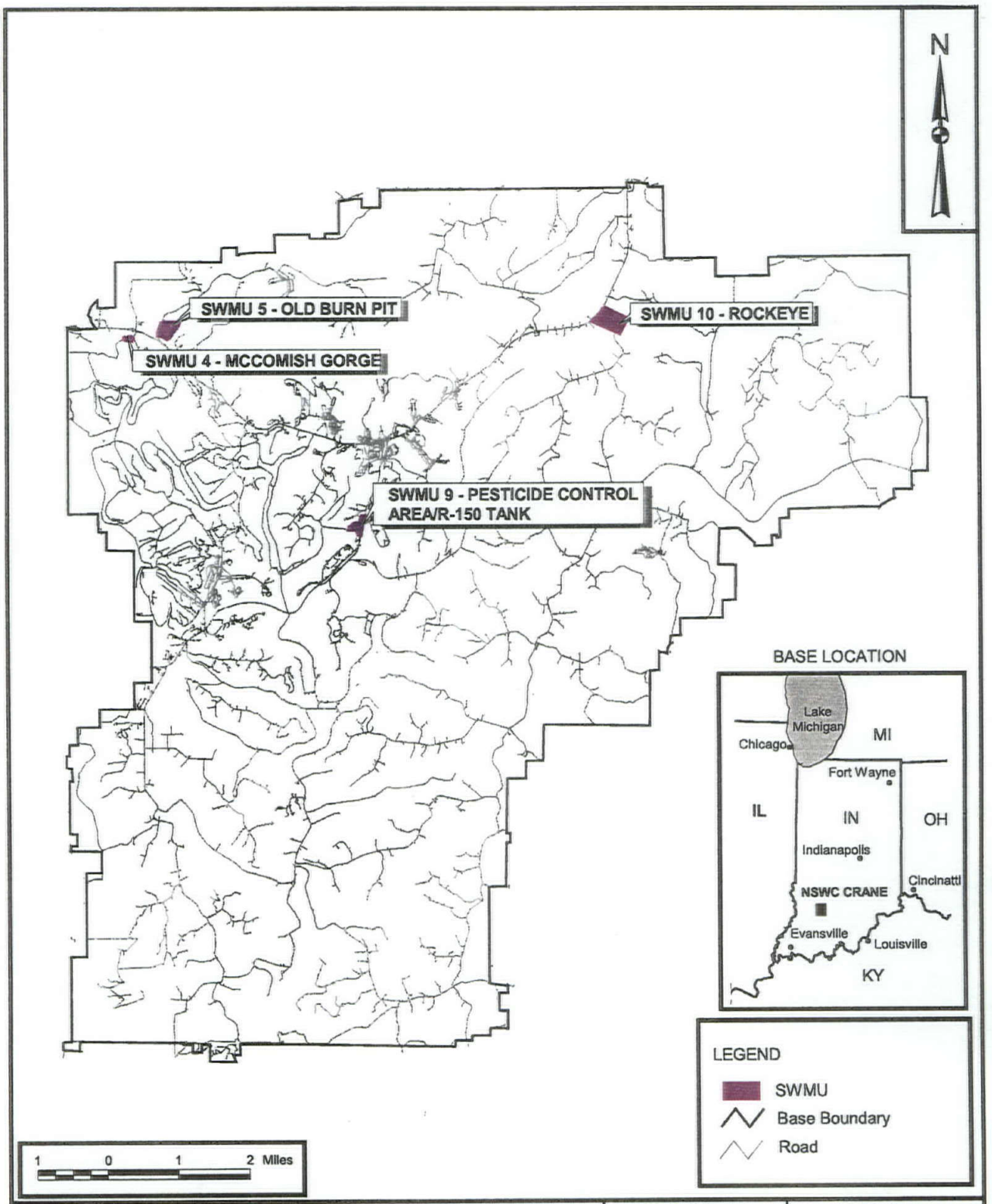

DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NO.
J. LAMEY	3/3/99		7141	0010
CHECKED BY	DATE	SITE LOCATION MAP SWMUs 4, 5, 9, AND 10 NSWC CRANE, INDIANA	APPROVED BY	DATE 10/18/99
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-1	REV

P:\GIS\NSWC_CRANE\CTO-10_SWMU04.APR 10/18/99 JAL SITE LOCATION LAYOUT

In 1975 NAD Crane was designated Naval Weapons Support Center Crane (NWSCC). Its new mission was to provide support for ships, aircraft, equipment, shipboard weapons systems and assigned ordnance items, and to perform additional functions as directed.

In 1977 the Single Manager Concept was implemented. The CAAA was created, and the Army assumed ordnance production, storage, and related responsibilities as a tenant organization. Other functions remained Navy, and currently the Navy retains ownership of all real estate and facilities at NSWC Crane. Responsibility for overall station safety, security, and environmental protection remains with the Commanding Officer, NSWC Crane. In 1992 the Facility was designated as Naval Surface Warfare Center Crane (NSWC Crane). Presently, approximately 4,000 people are employed at NSWC Crane.

Operations specific to SWMUs 4, 5, 9, and 10 are detailed within Sections 5.1 (SWMU 4), 6.1 (SWMU 5), 7.1 (SWMU 9), and 8.1 (SWMU 10) of this Work Plan.

3.2.2 History of Regulatory Actions

Following promulgation of the U.S. EPA RCRA hazardous waste regulatory program, NSWC Crane filed notification and application to operate as a RCRA hazardous waste treatment, storage, or disposal (TSD) facility in October 1980. Interim status was granted subject to operating requirements and applicable technical standards found in Title 40 Code of Federal Regulations, Part 265 (40 CFR Part 265).

Corrective Action programs established as part of the 1984 RCRA Hazardous and Solid Waste Amendments (HSWA) required NSWC Crane to address past releases of hazardous waste or hazardous constituents at SWMUs. Accordingly, NSWC Crane submitted a Hazardous Waste Management Report to the U.S. EPA in January 1985. Following the Hazardous Waste Management Report, a RCRA Facility Assessment (A.T. Kearney, Inc., 1987) was conducted to characterize the potential for releases of hazardous waste or constituents from 100 SWMUs identified during the assessment.

On December 23, 1989, the U.S. EPA issued the Federal portion of the Final RCRA Part B permit for NSWC Crane to the U.S. Navy. This permit established the Corrective Action requirements and compliance schedules obligating the U.S. Navy to perform RFIs at 33 SWMUs, to conduct Corrective Measure Studies (CMSs), and to implement Corrective Measures if needed. The Corrective Action requirements identified in the RCRA Part B permit are directed primarily at addressing the human health and ecological impacts of past waste management operations at NSWC Crane.

3.3 PHYSICAL SETTING

This section briefly describes the climate, physiography and topography, hydrology, geology and stratigraphy, hydrogeology, and ecology of NSWC Crane. More detailed descriptions for each SWMU are included in Sections 5.2 (SWMU 4), 6.2 (SWMU 5), 7.2 (SWMU 9), and 8.2 (SWMU 10) of this Work Plan.

3.3.1 Climate

NSWC Crane is located in a temperate climatic zone displaying a wide temperature range among seasons. In general, the winters are generally mild with short periods of very cold weather, and the summers are warm and humid. The temperature ranges from an average minimum January temperature of 26°F to an average maximum July temperature of 89°F. Precipitation is fairly evenly distributed throughout the year, with the maximum precipitation occurring during the spring and early summer. The area receives an average of 44 inches of precipitation annually, with 42 inches of rainfall and 15 inches of snowfall (NEESA, 1983). The average humidity ranges from 40 to 90 percent in summer and 60 to 90 percent in winter. The prevailing wind is from the south-southwest (McElrath, 1988). Additional information on climatic conditions at NSWC Crane can be found in the RCRA Air Quality Assessment (B&R Environmental, 1997).

3.3.2 Physiography and Topography

NSWC Crane is located in the unglaciated area of the Crawford Uplands Physiographic Province. This region is described as a rugged, highly vegetated, dissected plateau that is bounded by the Mitchell Plain Physiographic Province to the east and the Wabash Lowland Physiographic Province to the west (U.S. ACE WES 1995). The Mitchell Plain is described as a low dissected limestone plateau characterized by sinkholes and karst topographic features. The boundary between the Crawford Upland and the Mitchell Plain is marked by the highly irregular, eastern facing Chester Escarpment. Springs, caverns, caves, and other solution weathering features can be found along this escarpment and on the eastern edge of the Facility. The boundary between the Crawford Upland and the Mitchell Plain near the western boundary of NSWC Crane is gradual (U.S. ACE WES, 1995).

The terrain is predominantly rolling with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions of NSWC Crane. Deciduous trees and shrubs cover most of the region. The elevations across the Facility range from about 500 feet above mean sea level (AMSL) to about 850 feet AMSL. Lake Greenwood extends west to east across the northern part of the Facility. Topographic relief in the Crawford Upland ranges from 100 to 350 feet. Greater relief exists in the eastern part of NSWC Crane near the Chester Escarpment (U.S. ACE WES, 1995). A topographic and

surficial geologic map of the entire facility has been compiled by Kvale (1992) and Blunck (1995) after U.S. Geological Survey 7.5 minute quadrangle maps (Indian Springs, Scotland, Koleen, Owensburg, Odon, Williams, Loogootee, and Shoals).

3.3.3 Hydrology

The surface drainage at NSWC Crane has formed a dense, dendritic pattern throughout the installation that flows generally to the south and southwest. Seven primary creeks in five drainage basins carry surface water off the installation, where it eventually drains into the East Fork of the White River and then to the Wabash River to the southwest. The seven creeks that drain NSWC Crane include Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, Indiana Creek, and Seed Tick Creek. Figure 3-2 shows the surface drainage features and the individual drainage basins at NSWC Crane.

Drainage Basin IV consists of Boggs and Turkey Creeks, which are the primary drainageways for the installation and drain the majority of the area. The northern and northwestern sections (Basin I) are drained by Furst Creek, the eastern portion (Basin III) is drained by the Sulphur Creek complex, the extreme eastern portion (Basin II) is drained by Indiana Creek (not shown on Figure 3-2), and the southwestern section (Basin V) is drained by Seed Tick Creek.

Also located within the installation are several small ponds and Lake Greenwood, an 800-acre man-made, spring-fed lake in the northwestern portion of the installation. Lake Greenwood is the main source of water at NSWC Crane and is also used for recreation (NEESA, 1983). None of the surface water from the four SWMUs drains into Greenwood Lake. SWMU 4 and 5 drain into Furst Creek; SWMU 9 drains into Boggs Creek; and SWMU 10 drains primarily into Sulphur Creek and Turkey Creek.

3.3.4 Geology and Stratigraphy

3.3.4.1 General Geology and Stratigraphy

The geology at NSWC Crane is generally characterized by thin overburden deposits overlying bedrock. The overburden deposits generally range in depth from the surface down to 0 to 65 feet (U.S. ACE WES, 1998a) below ground surface (bgs). These deposits generally consist of two types: Quaternary-age unconsolidated deposits and unconsolidated residual soil derived from the underlying bedrock. Bedrock underlying the Facility consists of sedimentary rock from the Lower Pennsylvanian-age Raccoon Creek Group and the Upper

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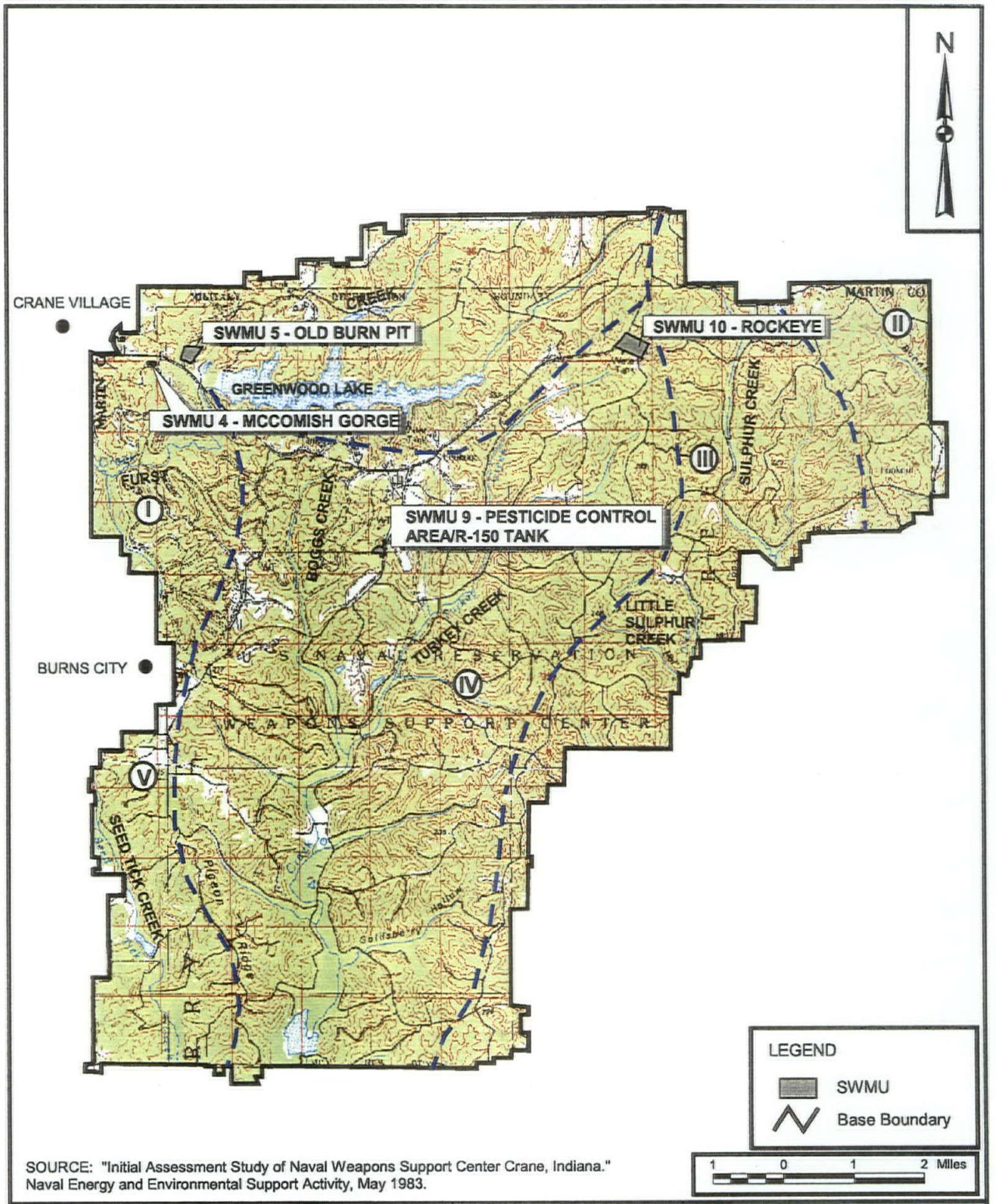

SOURCE: "Initial Assessment Study of Naval Weapons Support Center Crane, Indiana." Naval Energy and Environmental Support Activity, May 1983.

DRAWN BY J. LAMEY — DATE 4/19/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER —	OWNER NO. —
CHECKED BY — — DATE	SURFACE DRAINAGE AT THE NAVAL SURFACE WARFARE CENTER CRANE ,INDIANA	APPROVED BY — DATE 10/18/99	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 3-2	REV 0

P:\GIS\NSWC_CRANE\0087.APR JAL 9/1/99 SURFACE DRAINAGE LAYOUT

Mississippian-age Stephensport and West Baden Groups. The following subsections describe the unconsolidated deposits and bedrock at NSWC Crane in greater detail.

3.3.4.2 Unconsolidated Deposits

The Quaternary-age deposits consist of alluvial, colluvial, and glacial outwash deposits consisting of silt, sand, and gravel; lacustrine deposits consisting of clay, silt, and sand; and loess deposits consisting of clay and silt.

Residual soils at NSWC Crane were derived from the underlying sedimentary rocks of the lower Pennsylvanian Raccoon Creek Group and the upper Mississippian Stephensport and West Baden Groups. These soils consist of clay, silt, sand; and fragmented and/or partially weathered bedrock.

Using the U.S. Department of Agriculture (USDA)/Soil Conservation Service (SCS) soil classification system (McElrath, 1988), the soil at NSWC Crane has been classified under 23 soil series. More specifically, the soil at the SWMUs present at the Facility has been classified under 15 soil series. Each of these soil series are defined by various soil characteristics (e.g., grain size, erosion, slope, drainage, parent material, or depositional source, etc.) specific to each series. Within these soil series various sub-classes or soil map units have been defined. Table 3-1 shows the soil series and map units present throughout the Facility and indicates which soil series are present at each SWMU.

3.3.4.3 Bedrock

Bedrock underlying the NSWC Crane consists of sedimentary rock from the Lower Pennsylvanian-age and the Upper Mississippian-age bedrock. The Lower Pennsylvanian bedrock (Raccoon Creek Group) at the site primarily consists of interbedded sandstone, siltstone, shale, coal with a total thickness varying from 0 to more than 300 feet (Fisher, 1996). The underlying Missisippian-age bedrock consists of limestone, shale, and sandstone (U.S. ACE WES, 1995; and Palmer, 1969). The relief of the unconformity between the Pennsylvanian and Mississippian bedrock has been measured to be as much as 100 feet (Kvale, 1992).

Pennsylvanian bedrock is absent in the deepest, present day drainage channels (e.g., Sulphur Creek, Turkey Creek) primarily due to erosion. In these locations, the Mississippian-age bedrock is exposed. A large number of SWMUs are located on ridges or other topographically high areas, primarily on top of Pennsylvanian bedrock. The surficial geology illustrating the mappable geologic units at NSWC Crane is provided as Figure 3-3. An outline of each SWMU is included in the figure as an illustration of the type of bedrock material underlying each SWMU.

TABLE 3-1

USDA/SCS SOIL CLASSIFICATIONS[1]
NSWC CRANE, INDIANA
PAGE 1 OF 2

Soil Series	Soil Type	Present at # of SWMUs	Soil Classification[2]		Soil Classification[3]		Description	Location	Depositional Environment
			Surface Soil[4]	Subsurface Soil[5]	Surface Soil[4]	Subsurface Soil[5]			
Alluvium									
Bartle	Ba	NP	silt loam	silt loam to silty clay loam	CL, CL- ML	CL, CL- ML	0 to 2 percent slopes, gently sloping, deep, poorly drained	lowlands	Lake plains & stream terraces
Birds	Bk	2	silt loam	silt loam	CL	CL	frequently flooded, nearly level, deep, poorly drained; on broad bottom land.	lowlands	Alluvium derived from loess uplands
Bonnie	Bo	NP	silt loam	silt loam	CL	CL	0 to 2 percent slopes, gently sloping, deep, poorly drained	lowlands	Alluvium derived from loess uplands
Burnside	Bu	4	loam	loam to channery loam	ML, CL, ML-CL	ML-CL, SC, GC, SM, GM	occassionally flooded, nearly level, deep, well drained; on flood plains	flood plains	Alluvium derived from sandstone, siltstone, and shale
Haymond	Hd	3	silt loam	silt loam	ML	ML, SM	frequently flooded, nearly level, deep, well drained; on bottom land	lowlands	Silty alluvium
Pekin	PeB	NP	silt loam	silt loam to silty clay loam	CL-ML	CL-ML	2 to 6 percent slopes, deep, well drained	outwash terraces	Loess and underlying alluvium
Wakeland	Wa	4	silt loam	silt loam	ML	ML	frequently flooded, nearly level, deep, somewhat poorly drained	flood plains	Silty alluvium derived from loess uplands
Wilbur	Wr	NP	silt loam	silt loam	ML, CL-ML	ML, CL-ML	0 to 2 percent slopes, deep, poorly drained	lowlands	Alluvium derived from loess uplands
Loess/Glacial Outwash									
Hosmer	HoB	2	silt loam	silt loam to silty clay loam	ML, ML-CL, CL	ML, ML-CL, CL	2 to 6 degree slopes, gently sloping, deep, well drained	uplands and ridgetops and on loess-capped lake plains.	Loess
Camden	CaB	NP	silt loam	silt loam,clay loam, sandy loam	CL, ML-CL	ML, CL, SM, SC	1 to 5 percent slopes, deep, well drained	stream terraces	Loess and underlying outwash material
Negley	NeE	2	silt loam to loam	loam, clay loam, gravely loam	ML, ML-CL, CL	SM, ML	8 to 35 percent slopes, moderately steep to steep, deep, well drained	loess and outwash	Loess capped and underlying outwash material
Parke	PaC2	1	silt loam	silty clay loam to sandy clay loam	CL-ML	SC, CL	6 to 18 percent slopes	uplands & sideslopes	Loess capped and underlying outwash material
Pike	Pk	NP	silt loam	silt loam to silty clay loam	CL	CL, SC	2 to 6 percent slopes, deep, well drained	outwash terraces	Loess capped and underlying outwash material
Residual Soils from Bedrock (both Pennsylvanian & Mississippian)/Colluvium									
Johnsburg	Jo	NP	silt loam	silty clay loam, silt loam, to sandy loam	CL, ML-CL	ML, CL, SM, SC	0 to 2 percent slopes, deep, poorly drained	uplands	Loess and material weathered from ss, siltstone, shale.
Udorthents	UhD	1	shaly silty clay loam	shaly silty clay loam	CL-ML, CL, ML	CL-ML, CL, ML	6 to 14 percent slopes, moderately steep to steep, moderately deep to deep, well drained	uplands	Excavated areas formerly used as landfills
Udorthents-Pits complex	Up	1	gravelly sand	gravel	GM	GM	NA	uplands	Material left from sandstone quarries and sand pits
Wellston	WeB	1	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC	2 to 6 percent slopes, gently sloping, deep, well drained	ridgetops	Loess and material weathered from ss, siltstone, shale.
	WeC2	5	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC	6 to 12 percent slopes, eroded, moderately sloping, deep, well drained	ridgetops and sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
	WeD2	8	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC	12 to 18 percent slopes, eroded, steeply sloping, deep, well drained	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.

TABLE 3-1

USDA/SCS SOIL CLASSIFICATIONS[1]
NSWC CRANE, INDIANA
PAGE 2 OF 2

Soil Series	Soil Type	Present at # of SWMUs	Soil Classification[2]		Soil Classification[3]		Description	Location	Depositional Environment
			Surface Soil[4]	Subsurface Soil[5]	Surface Soil[4]	Subsurface Soil[5]			
	WeD3	3	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC	12 to 18 percent slopes, severely eroded, steeply sloping, deep, well drained	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Wellston-Ebal	WID	NP	silt loam	silt loam, silty clay loam, to channery loam	ML	CL-ML, CL, SC, SM-SC, CH, GC	10 to 18 percent slopes, deep, well drained	sideslopes in uplands	Loess, colluvium, and material weathered from ss, siltstone, shale.
Wellston-Berks-Gilpin complex	WgG	5	silt loam to channery silt loam	silt loam, silty clay loam, to channery loam	ML, CL, CL-ML, SC, GM, GC	CL-ML, CL, SC, SM-SC	18 to 70 percent slopes, moderately to very steep, deep, well drained	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Wellston-Gilpin complex	WnE	16	silt loam to channery silt loam	silt loam, silty clay loam, to channery loam	ML, CL, CL-ML, SC, GM, GC	CL-ML, CL, SC, SM-SC	12 to 30 percent slopes, strongly sloping to steep, moderately deep	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Wellston-Udorthents complex	WpD[6]	8	silt loam to silty clay loam	silt clay loam to channery loam	ML, CL, CL-ML	CL-ML, CL, SC, SM-SC	12 to 18 percent slopes, strongly sloping, very shallow to deep	sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Zanesville	ZaB	6	silt loam to silty clay loam	silty loam, to sandy clay loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	2 to 6 percent slopes, gently sloping, deep, moderately to well drained	ridgetops in uplands	Loess and material weathered from ss, siltstone, shale.
	ZaC2	7	silt loam to silty clay loam	silty loam, to sandy clay loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	6 to 12 percent slopes, eroded, moderately sloping, deep, moderately to well drained	ridgetops and sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
	ZaC3	2	silt loam to silty clay loam	silty loam, to sandy clay loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	6 to 12 percent slopes, severally eroded, moderately sloping, deep, moderately to well drained	ridgetops and sideslopes in uplands	Loess and material weathered from ss, siltstone, shale.
Zanesville-Udorthents complex	ZnB[6]	13	silt loam to silty clay loam	silt loam, silty clay loam to loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	2 to 6 percent slopes, gently sloping, moderately to well drained	ridgetops in uplands	Loess and material weathered from ss, siltstone, shale.
	ZnC[6]	17	silt loam to silty clay loam	silt loam, silty clay loam to loam	CL-ML, CL, ML	CL-ML, CL, ML, SC, SM, GM	6 to 12 percent slopes, gently sloping, moderately to well drained	ridgetops in uplands	Loess and material weathered from ss, siltstone, shale.

Notes:

USDA United States Department of Agriculture
SCS Soil Conservation Service
NP - Not present at any SWMUs
SWMU - solid waste management units
SS - Sandstone
NA - Not available
1 Information taken from McElrath, G., Jr., 1998, Soil Survey of Martin County, Indiana, Soil Conservation Service, United States Department of Agriculture.
2 United States Department of Agriculture (USDA) classification system
3 Unified Soil Classification System (USCS), abbreviations are as follows
CL - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
ML - Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
SC - Clayey sands, poorly graded sand-clay mixtures
SM - Silty sands, poorly graded sand-silt mixtures
GM - Silty gravels , poorly graded gravel-sand-silt mixtures
GC - Clayey gravels, poorly graded gravel-sand-clay mixtures.
4 Surface soil is from 0 to 12 inches below ground surface (bgs).
5 Subsurface soil is between 12 and 70 inches bgs or to the top of bedrock.
6 Soil at areas at the NSWC where a significant amount of construction and earth moving has removed most of the original soil, which has been deposited as fill on building sites.

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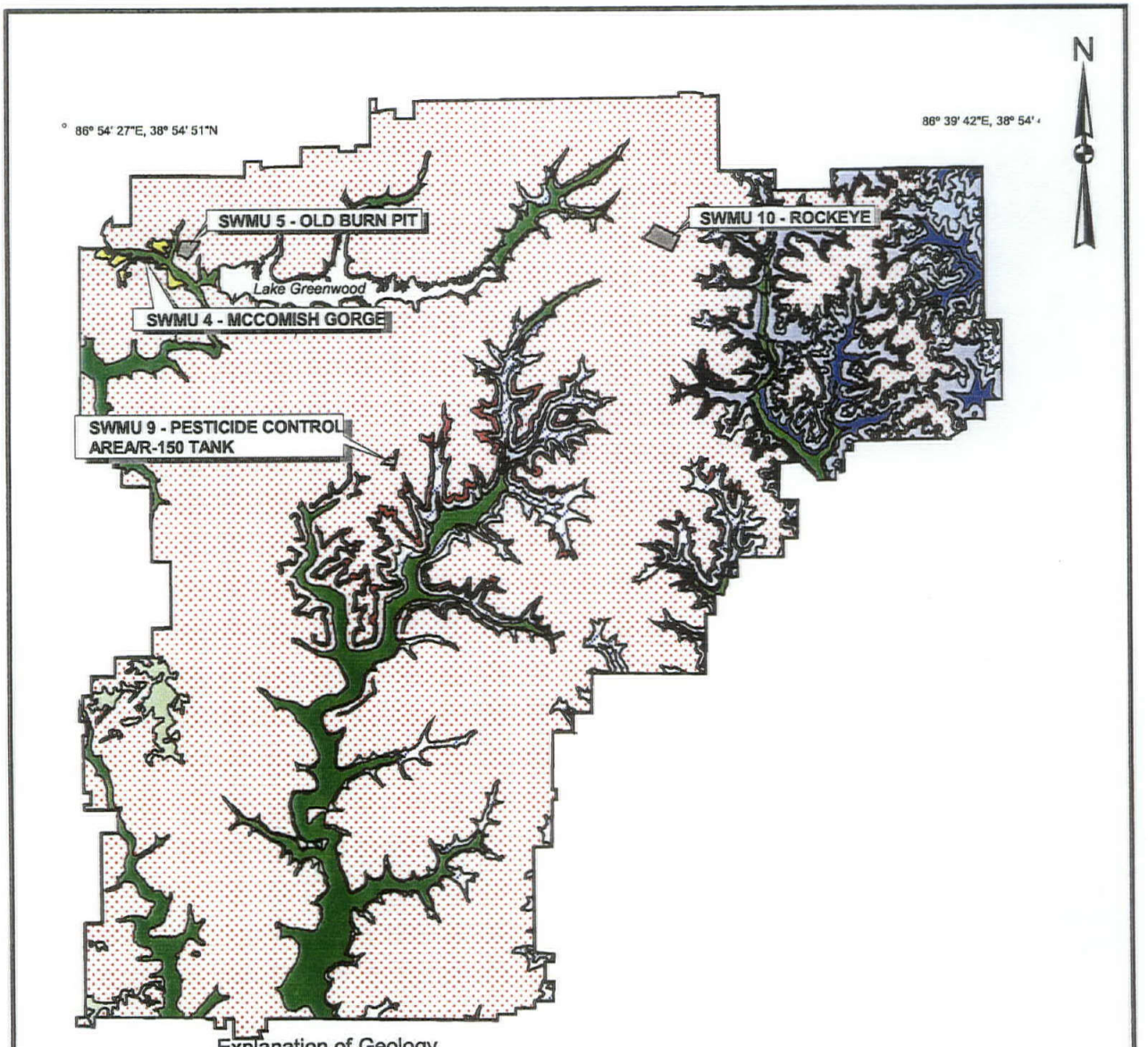


Explanation of Geology

Qal	*Alluvium*
Ql	*Loess*
Qo	*Glacial Outwash*
P	*Raccoon Creek Group and undifferentiated*
Ps	*Sandstone-dominated horizon of Lower Pennsylvanian*
M6	*Glenn Dean Ls, Hardinsburg Fm, Haney Ls, Indian Springs Shale Mbr, and undifferentiated*
M5	*Sandstone member of the Big Clifty Fm*
M4	*Beech Creek Ls*
M3	*Elwren Fm, Reelsville Ls, upper Sample Fm, and undifferentiated*
M2	*Lower part of Sample Fm, Beaver Bend Ls, Bethel Fm, and undifferentiated*
M1	*Paoli Ls, Ste Genevieve Ls, and undifferentiated*
	Select Solid Waste Management Units (SWMUs)

(Modified from Blunck, 1995)

DRAWN BY D. PERRY	DATE 15-MAR-99	Tetra Tech NUS, Inc.	CONTRACT NUMBER — / OWNER NO. —
CHECKED BY —	DATE —	SURFICIAL GEOLOGY MAP NAVAL SURFACE WARFARE CENTER CRANE, INDIANA	APPROVED BY K.M. Stoecher / DATE 10/18/99
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-3 / REV 0

P:\GIS\NSWC_CRANE\0087.APR 8/11/99 JAL SURFICIAL GEOLOGY MAP LAYOUT

The following paragraphs provide a brief description of the geologic formations as described by Palmer (1969), U.S. ACE WES (1995) and Kvale (1992). They are presented from youngest (first) to the oldest units. These geologic units are also illustrated on the stratigraphic column illustrated on Figure 3-4.

a. Mansfield Formation and Undifferentiated Lower Pennsylvanian, undifferentiated (Pennsylvanian Raccoon Creek Group). This unit consists of alternating beds of dark shale, sandstone, mudstone, siltstone, and discontinuous coal units.

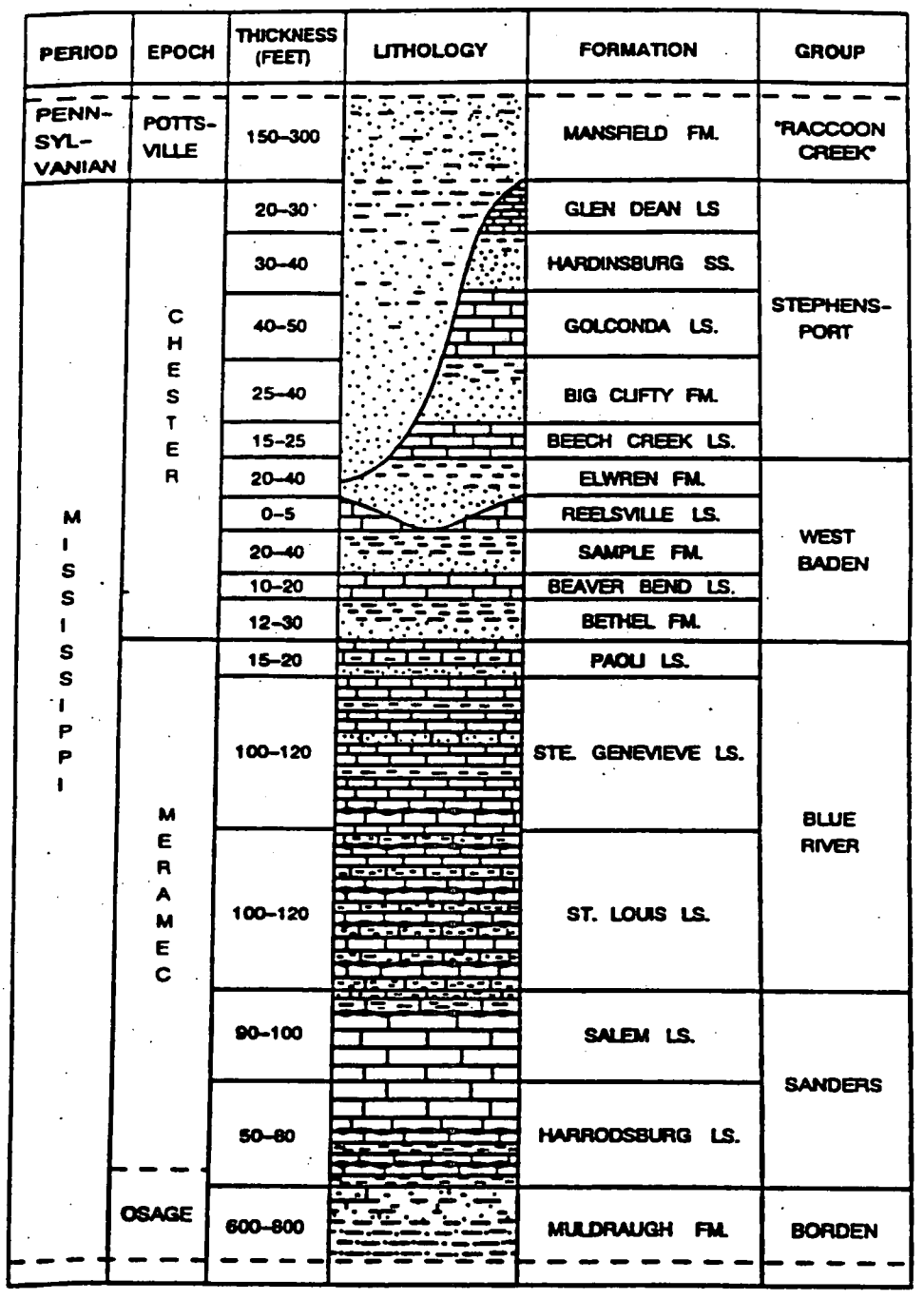
b. Glen Dean Limestone, Hardinsburg Formation, Golconda/Haney Limestone, Indian Springs Member, undifferentiated (Mississippian Stephensport Group). This unit consists of limestone (Glen Dean Formation), soft shale and cross-bedded sandstone (Hardinsburg Formation), shaley limestone and limey shales (Golconda/Haney Formation), and dark gray shale (Indian Springs Formation). Thickness of the unit ranges from 60 to 70 feet.

c. Big Clifty Sandstone member, Big Clifty Formation (Stephensport Group). The Big Clifty Sandstone is a tan to green-gray, massive to thick-bedded, rippled, fine- to very fine-grained, well sorted, rounded, friable sandstone with occasional shaly partings. Thickness of this unit ranges from 30 to 40 feet.

d. Beech Creek Limestone Formation (Stephensport Group). The Beech Creek Limestone consisted of fossiliferous, hard, and dense limestone. Joints in the limestone were sparse to numerous in core recovered from the 18 well borings which penetrated the unit. The Beech Creek Limestone displayed moderate to extensive solution-enlarged jointing at another site within NSWC Crane (U.S. ACE WES, 1988). Thickness of this unit ranges from 20 to 25 feet.

e. Elwren Formation, Reelsville Limestone, Upper Sample Formation, undifferentiated (West Baden Group). This unit consists of fine-grained interbedded sandstone and mudstone (Elwren Formation), a thin discontinuous limestone (Reelsville Limestone), and fine-grained sandstone (Upper Sample Formation). Thickness of this unit ranges from 65 to 75 feet.

f. Lower Sample Formation, Beaver Bend Limestone, Bethel Formation, undifferentiated (West Baden Group). This unit consists of dark greenish gray shale (Lower Sample), fossiliferous limestone (Beaver Bend Limestone), and a calcareous sandstone and shale (Bethel Formation). Thickness of this unit ranges from 50 to 60 feet.



SOURCE: Internal Draft, RCRA Facility Investigation Phase III Groundwater Release Characterization Report, SWMU 10/15 Rockeye, U.S. Army Corps of Engineers, December 1993

DRAWN BY J. LAMEY — DATE 4/19/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NO. CTO 0083
CHECKED BY — DATE —	STRATIGRAPHIC COLUMN FOR ROCK UNITS ENCOUNTERED AT THE NAVAL SURFACE WARFARE CENTER NSWC CRANE, INDIANA	APPROVED BY [signature] DATE 10/18/99	
COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE 3-4	REV 0

P:\GIS\NSWC_CRANE\0067.APR 4/19/99 JAL STRATIGRAPHIC COLUMN LAYOUT

g. Paoli Limestone, Ste. Genevieve, undifferentiated (Blue River). This unit consists of oolitic limestone and limestone (undifferentiated). Thickness of this unit is at least 35 feet (based on exposure in Boone Hollow at the northeastern corner of the Facility).

Structurally, NSWC Crane is located on the eastern edge of the Illinois Structural Basin, where the Pennsylvanian- and Mississippian-age bedrock dips to the west-southwest and southwest at approximately 30 to 35 feet per mile (U.S. ACE WES 1982, p. 10; Kvale, 1992). Locally, however, the dip of the Mississippian bedrock can range from 0 to 15 feet/mile to as much as 100 feet/mile (Sulphur Creek; Kvale, 1992).

3.3.5 Hydrogeology

U.S. ACE WES (1988) discussed regional ground water trends pertaining to the unglaciated southwest portion of Indiana. In general, ground water is contained in joint openings of limestone and sandstone aquifers. Although unit thicknesses may vary, the distribution of bedrock units at NSWC Crane (Figure 3 4) suggests similar aquifer characteristics throughout the facility. Surficial unconsolidated aquifers are thin and have limited potential as water supplies.

Aquifers beneath NSWC Crane are considered to be vertically isolated from each other by interlayered shale beds, which act as aquitards. Ground water recharge in the unconsolidated surficial aquifers occurs from infiltration from the ground surface. Ground water recharge in the underlying bedrock units occurs where aquifer units outcrop. After entering an aquifer outcrop, ground water flows by gravity down the dip of the aquifer unit. Given that the regional dip of rock units is to the southwest, regional ground water flow in all aquifers is directed toward the southwest. Local ground water flow at each of the four SWMUs is consistent with the regional flow direction. The locations of each of the four SWMUs relative to Lake Greenwood coupled with local and regional ground water flow directions indicate that ground water from the SWMUs does not discharge to Lake Greenwood.

Local variations in bedding, dip, aquifer and aquitard, thickness, the presence or absence of fractures, incision by surface drainage, and karstic conditions cause local ground water movement at NSWC Crane to differ from regional trends. Where erosion resulting from surface drainage has cut through aquifer units, springs and seeps are produced that locally complicate ground water flow. Springs and seeps are prevalent at contacts between aquitards and overlying aquifers. Ground water flowing from springs and seeps into surface water can potentially re-enter the ground water system as recharge to a lower aquifer outcroping downstream.

In the eastern portion of NSWC Crane, U.S. ACE WES (1988) hypothesized that karstic conditions are present primarily in major drainage valleys where erosion has cut into permeable sandstones overlying easily dissolved limestone units. Rapid infiltration in the Big Clifty Sandstone units has caused dissolution and weathering of the underlying Beech Creek Limestone. The result of this occurrence has been the creation of karst and collapse conditions along major drainageways within the eastern part of NSWC Crane.

3.3.6 Ecology

A biological characterization of NSWC Crane, including a listing of plants and animals found at the Facility, is presented in the Installation Assessment (IA; U.S. Army, 1978) and the IAS; (NEESA, 1983), and is summarized in Environmental Monitoring Reports (EMR; Halliburton NUS August and November, 1992). A list of the species that may inhabit NSWC Crane and are protected under the U.S. Endangered Species Act, Indiana Department of Natural Resources Heritage Data Center, or the U.S. Fish and Wildlife Service is summarized in the RCRA Facility Permit (U.S. EPA, July 1995).

4.0 DEVELOPMENT OF PROPOSED INVESTIGATIONS

This section of the Work Plan presents the methodologies used to develop the proposed field investigations for SWMUs 4, 5, 9, and 10. Information generic to all four SWMUs is presented in this section.

Because the primary objective of data collection activities for this CTO is the completion of human health and ecological risk assessments for each SWMU, the development of a conceptual site model (CSM) is essential for planning purposes. Section 4.1 provides general information on the preparation of site-specific CSMs. A description of the Data Quality Objectives (DQOs) developed as part of the planning process is presented in Section 4.2. The DQOs for the project were developed using U.S. EPA guidance (U.S. EPA, September 1994).

The site-specific proposed investigations for the four SWMUs are provided in Sections 5.0 through 8.0.

4.1 GENERAL CONCEPTUAL SITE MODEL

A site-specific CSM was used as a basis for the development of the proposed investigations for SWMUs 4, 5, 9, and 10. The CSM, which essentially defines the nature of the environmental problem at the site, depicts the relationship among the following elements:

- Site sources of contamination;
- Contaminant release mechanisms;
- Transport/migration pathways;
- Exposure routes; and
- Potential receptors.

Physical site characteristics, results of previous site investigations, hazard identification (detected chemicals of interest based on the previous investigations), and current and future land scenarios also were considered during the development of the site-specific CSMs. The site-specific CSMs for each SWMU, as well as details on the site background, physical setting, previous investigations, and hazard identification are presented in Sections 5.0 through 8.0. Figures illustrating the CSM for each SWMU are provided in the aforementioned sections. These figures also identify the potential exposure pathways, which will be quantitatively evaluated in the human health and ecological risk assessments.

The elements of the CSM (contaminant source, release mechanisms, transport/migration pathways, exposure routes, and potential receptors) establish the manner and degree to which a potential receptor may be exposed to chemicals present at each site. The degree of risk incurred by a potential receptor varies according to the means of exposure, the duration of exposure, and the specific chemical to which the receptor is exposed. An exposure, however long in duration, does not necessarily result in an "unacceptable" health or environmental risk, although risks generally increase with increased frequency and/or duration of exposure.

The elements of the CSM, including how they pertain to all four SWMUs, are presented in Sections 4.1.1 through 4.1.4.

4.1.1 Site Sources of Contamination

Each SWMU has its own distinct source of contamination. The following sources of contamination were identified for SWMUs 4, 5, 9, and 10:

- SWMU 4, McComish Gorge: The disposal of garbage, trash, and debris (primarily general refuse and possibly small arms munitions) at the site.

- SWMU 5, Old Burn Pit: Burning activities conducted in the burn pit area of the site, and the disposal of ash and metal debris in the gully north of the burn pit.

- SWMU 9, Pesticide Control/R-150 Tank Area: Pesticide storage and management practices at the former location of Buildings 55 and 2189, and the underground storage of solvents at the tank area.

- SWMU 10, Rockeye: Munitions loading operations, including sumps containing bomblet production wastewater and exhaust vents for the production facility.

These sources of contamination were identified based on a review of the previous RFI reports prepared for the sites.

4.1.2 Contaminant Release Mechanisms and Transport Pathways

4.1.2.1 Contaminant Release Mechanisms

Past activities at each SWMU may have resulted in contaminant releases to the surrounding environment. The following provides a summary of the contaminant release mechanisms that may have occurred at each SWMU:

- Direct disposal – At SWMUs 4 and 5, garbage, debris, trash, and ash were placed directly on the soil or were buried at the sites. Consequently, contaminants could have been released to the surrounding soil.

- Operational activities – At SWMU 9, operational activities may have resulted in contaminants being washed out of pesticide application containers to the surrounding soil. In addition, the handling of pesticides may have resulted in releases to the environment. At SWMU 10, wastewater from the bomblet production facilities was discharged to several surface water drainageways. Partially treated wastewater may have released contaminants to the sediment in these drainageways. In addition, exhaust vents from the production facilities may have deposited contaminants onto the soil near the vents.

4.1.2.2 Transport Pathways

Previous investigations for the four SWMUs have documented that a release of hazardous constituents from past operational activities has occurred. Historical data have shown a connection between surface soil and subsurface soil constituents and between subsurface soil and ground water constituents. The migration and percolation (leaching) of constituents from surface soil to subsurface soil to ground water is evident based on a review of the historical data.

In general, hazardous constituents may be transported from the SWMUs by a variety of mechanisms. These mechanisms include surface (stormwater) runoff and subsequent erosion of surface soil, infiltration of soluble chemicals and subsequent migration through the subsurface soil to the water table where they may migrate to downgradient locations, and wind erosion of surface soil.

Storms generate surface runoff, which is directed toward drainage ways present at the sites. Initially, this water may move across the site as sheet flow, which can entrain loose soil material. This soil is moved from the site as a sediment and will be deposited where the flow velocity diminishes below that needed to carry a particular grain size. Typically, at sites in undeveloped areas, this soil/sediment is deposited in

small drainage ways and migrates further downstream with each new storm, which also adds new material.

Soluble chemicals released to the ground surface may also migrate downward through the soil column with infiltrating precipitation. The migration of these chemicals may be somewhat impeded by the chemical's tendency to bind to soil organic material. Eventually, these soluble chemicals may reach the water table. Once in the ground water, they continue their migration via dispersion and advection in the downgradient direction. Eventually, these chemicals may discharge with the ground water to surface water bodies (creeks, streams, tributaries, or marsh/wet areas) near the site.

Surface runoff (i.e., movement of constituents in surface soil to surface water and sediment) is expected to be the primary transport pathway for the offsite migration of constituents detected in site media. The hilly terrain present at SWMUs 4, 5, 9, and 10 promotes this transport mechanism. The natural features of the SWMUs, such as erosional gullies and drainage ways, are indicators of surface runoff. Hydrogeologic data for the SWMUs, collected during previous site investigations, suggest that a connection (i.e., discharge) exists between the ground water and surface water bodies present near the sites. However, little to no surface water and sediment samples have been collected at the SWMUs to characterize this transport pathway.

Chemicals adsorbed to surface soil may also be released from a site via wind erosion of loose soil material. These particulates are carried downwind and potentially offsite if the grain size is small enough and the wind velocity is great enough. Additionally, chemicals also may be released from soil via volatilization. Volatile organic compounds (VOCs) were not typically identified as detected chemicals of interest for the soil at the SWMUs. In addition, most of the SWMUs are inactive and have been revegetated, which decreases the extent of particulate generation. Consequently, particulate generation and volatile emissions is not expected to be a primary transport pathway for SWMUs 4, 5, 9, and 10.

4.1.3 Exposure Routes

The manner in which a receptor comes into contact with contaminants is generally the result of interactions between a receptor's behavior or lifestyle and an exposure medium. Potential receptors could come into contact with potentially contaminated soil (surface and subsurface), ground water, surface water, sediment, and air.

Brief explanations of the potential routes of exposure per media are provided in this section. Details regarding how the exposure pathways will be evaluated in the risk assessments is provided in the risk assessment methodology sections of this Work Plan, Sections 10.0 (human health) and 11.0 (ecological).

4.1.3.1 Soil

Receptors may come into direct contact with soil affected by the release of chemicals from the source areas. During the receptor's period of contact, the individual may be exposed via inadvertent ingestion of a small amount of soil or via dermal absorption of certain contaminants from the soil. For human and ecological receptors, exposure to surface soil at the SWMUs is likely under current and future land use. However, human exposure to subsurface soil would only occur if ground-intrusive activities (i.e., excavations) were to occur at the SWMUs under a future land use scenario. Ecological receptors are not generally exposed to subsurface soil.

4.1.3.2 Ground Water

Direct exposure to ground water at the SWMUs does not occur under current land use. Future receptors may come in direct contact with ground water if ground water were used as a potable water supply or if shallow ground water was encountered during excavations (for construction, utility maintenance, etc.). Exposure routes for ground water include ingestion, direct contact, and inhalation of volatiles.

4.1.3.3 Surface Water and Sediment

Receptors also may come into direct contact with surface water and sediment in the various creeks, streams, tributaries, and marsh/wet areas present at the SWMUs. In most cases, because of the intermittent nature of a majority of the surface water bodies present near the SWMUs, exposure to surface water and sediment is expected to be of a short duration. Individuals may be exposed primarily via dermal contact and incidental ingestion. Exposure via inhalation of volatile emissions is expected to be relatively insignificant compared to exposure via dermal contact and incidental ingestion.

4.1.3.4 Air

This exposure pathway is based on the scenario that a receptor is immersed in air that contains suspended particulates and volatile organic vapors originating from the source areas. Subsequent exposure of the receptor occurs upon inhalation (and partial subsequent ingestion) of ambient air. As noted previously, this pathway is not expected to be significant for SWMUs 4, 5, 9, and 10. VOCs were typically not identified as detected parameters of interest in the surface (and subsurface) soil.

Additionally, most of the SWMUs are inactive and have been revegetated, which decreases the extent of particulate generation.

4.1.4 Potential Receptors

A variety of potential receptors could be exposed to site media under current and future land use conditions. Seven general classes of receptor groups have been identified for evaluation at SWMUs 4, 5, 9, and 10 to focus the risk assessment on potentially meaningful exposures, and, in general, to streamline the risk assessment process. These general receptors were identified by analyzing the interaction of current land use practices, potential future land use, and the identified sources of contamination. Instead of evaluating adults and adolescents for every possible exposure scenario under current and/or future land use, the potential receptors selected for evaluation were chosen to bracket the risks for a site. The selection of these general receptors was not meant to imply that other receptors were not applicable for a site. For example, for the current/future trespassing scenario, an adolescent was selected for evaluation based on the assumption that adolescents would most likely trespass onto sites more frequently than adults. The risks for an adult trespasser can be inferred based on the results of the evaluation for an adolescent trespasser. The general receptor classes include:

- Adolescent Trespassers (Ages 6 to 17) – Potential receptor under current and future land use. Older children and teenagers (civilians or family of military personnel living outside the SWMU boundaries) trespassing on or near a site while exploring, playing, etc. are evaluated. This receptor could potentially be exposed to surface soil (0 to 2 feet bgs), surface water, sediment, and air. Direct exposure to ground water is not anticipated for this receptor.

- Maintenance Workers – Likely receptor under current and future land use for SWMUs 9 and 10; potential receptor under future land use for SWMUs 4 and 5, which are not currently maintained. Includes adult military or civilian personnel assigned to groundskeeping activities at a SWMU. This receptor could potentially be exposed to surface soil and air. Maintenance workers are not assumed to be exposed to surface water, sediment, and ground water.

- Construction Workers - Potential receptor under current and future land use for SWMU 10; potential receptor under future land use for SWMUs 4, 5, and 9. Includes adult civilian personnel who may be involved in a short-term, one-time construction project at a site. This receptor would potentially be exposed to surface and subsurface soil to an estimated maximum depth of 10 feet bgs, ground water (primarily via dermal contact), and air. Exposure to surface water and sediment is not expected to occur for the construction worker. SWMUs 4 and 5 are not likely to be developed because of the

nature of the site (i.e., limitations associated with historical waste disposal practices and site physical setting); however, construction workers are evaluated at these SWMUs for exposure during short-term utility installations.

- Occupational Workers – Potential receptor under current and/or future land use for SWMU 10 only. Includes adult military or civilian personnel assigned to work at a SWMU. This receptor could potentially be exposed to surface soil and air. Occupational workers are not assumed to be exposed to surface water and sediment. As previously mentioned, SWMUs 4 and 5 are not likely to be developed for occupational use because of the nature of the site; therefore, occupational workers are not evaluated for these SWMUs. SWMU 9 is an inactive site, and therefore, there are no current receptors. Buildings are still present at the site and occupational receptors in the future scenario are possible.

- Recreational Users (Adults) – Potential receptor under future land use, assuming that the Facility was to close and would be turned into a state park. Includes civilians involved in recreational activities (hiking, biking, hunting, etc.). This receptor could potentially be exposed to surface soil, surface water, sediment, and air. Direct exposure to ground water is not anticipated for this receptor. Fishing is not considered to be applicable for the recreational user because the intermittent creeks, stream, and tributaries located near the SWMUs do not support substantial fish populations.

- Residents (Adults/Children) – Potential receptor under future land use, assuming that the Facility was to close and the site was developed for residential purposes. This receptor is assumed to reside within the SWMU boundaries and would potentially be exposed to surface soil, ground water, surface water, sediment, and air. Although enlisted and officer personnel reside at the Facility under current conditions, the residential scenario is not applicable for these receptors because they do not and would not be expected to reside within the boundaries of the SWMUs. A future residential scenario is considered unlikely given the critical nature of the Facility with respect to support of the U.S. Navy. This exposure scenario is included primarily for decision-making purposes (i.e., to identify whether institutional controls or remediation is needed before site closure).

- Ecological Receptors (Terrestrial and Aquatic) – Because the Facility is primarily a forested area, NSWC Crane supports a variety of ecological habitats. Terrestrial receptors, which may reside at the SWMU or come in contact with site media while trespassing on the site, could contact surface soil, surface water, and sediment. Aquatic receptors present in the creeks, streams, tributaries, and marsh/wet areas at the SWMUs may come in contact with contaminants in the surface water and sediment. Ecological receptors are not assumed to have direct contact with ground water.

One or more of these receptor groups are applicable for each SWMU and will be evaluated in the risk assessments. Table 4-1 contains a matrix summary of the particular combinations of receptor groups to be evaluated at each SWMU.

4.2 DATA QUALITY OBJECTIVES

The U.S. EPA has developed the DQO Process (U.S. EPA, September 1994), a systematic, strategic planning tool based on a scientific method, to assist in establishing criteria for data quality and in developing sampling and analysis designs. The following seven steps comprise the DQO Process:

- Definition of the environmental concern or problem to be studied at a site;
- Identification of the decision statements on which the problem solution is based;
- Identification of inputs required to make decisions about the sites;
- Definition of temporal and spatial boundaries of the problem to be solved;
- Development of a decision rule, indicating data use for solving the problem;
- Specification of potential errors associated with data use in context of the decision rule; and
- Development of an appropriate sampling and analysis plan.

The remainder of this section presents a summary of the DQO Process, as it pertains to the development of data collections activities for SWMUs 4, 5, 9, and 10.

4.2.1 Problem Definition

From 1981 to 1983, an IAS was conducted for several sites (including SWMUs 4, 5, 9, and 10) at NSWC Crane. The intent of the study was to identify sites posing a potential threat to human health and the environment from past hazardous materials operations. Although none of the sites were determined to represent immediate human health and environmental threats, 14 of the sites were recommended for further study to evaluate potential long-term impacts. SWMUs 4, 5, 9, and 10 were among these 14 sites. Subsequent to this initial study, phased RFIs were conducted at the four SWMUs to characterize and delineate the nature and extent of contamination in soil and ground water. Details regarding previous site-specific investigations are presented in Sections 5.3 (SWMU 4), 6.3 (SWMU 5), 7.3 (SWMU 9), and 8.3 (SWMU 10).

TABLE 4-1

SUMMARY OF POTENTIAL RECEPTORS BY SITE
SWMUs 4, 5, 9, AND 10
NSWC CRANE, INDIANA

Site	Adolescent Trespasser	Maintenance Worker	Construction Worker	Occupational Worker	Resident (Adult/Child)	Recreational User (Adult)	Ecological Receptors[3]
Current Scenario							
SWMU 4 - McComish Gorge	X[1]	--	--	--[2]	--	--	X
SWMU 5 - Old Burn Pit	X	--	--	--	--	--	X
SWMU 9 - Pesticide Control/ R-150 Tank Area	X	X	--	--	--	--	X
SWMU 10 - Rockeye	X	X	X	X	--	--	X
Future Scenario							
SWMU 4 - McComish Gorge	X	X	X	--	X	X	X
SWMU 5 - Old Burn Pit	X	X	X	--	X	X	X
SWMU 9 - Pesticide Control/ R-150 Tank Area	X	X	X	X	X	X	X
SWMU 10 - Rockeye	X	X	X	X	X	X	X

1 "X" indicates that the receptor will be evaluated in the human health or ecological risk assessments.
2 "--" indicates that the receptor is not a likely potential receptor and will not be evaluated in the human health risk assessment.
3 Includes terrestrial and aquatic receptors.

Based on the results of these previous investigations, chemical releases to the environment from past operations conducted at the SWMUs have been identified. As indicated by the historical data, the releases have occurred within the boundary of NSWC Crane.

The CSM described in Section 4.1 depicts the connections among constituent releases to the various site media, the migration of constituents to other media, and the potential exposures routes that could bring a receptor into contact with contaminated media.

A comparison of the historical data with current human health and ecological risk-based screening levels (i.e., hazard identification) suggests that the magnitude and persistence of these releases may pose an increased risk to current and future potential receptors. For SWMUs 4, 5, 9, and 10, historical data are available for soil and ground water matrices. The following screening criteria were used in the hazard identification for ground water:

- Federal Maximum Contaminant Levels (MCLs);
- U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water;
- Federal Ambient Water Quality Criteria (AWQC) for Freshwater (chronic values);
- Indiana Department of Environmental Management (IDEM) Tier I Default Cleanup Levels; and
- U.S. EPA Region 5 Ecological Data Quality Levels (EDQLs) for Surface Water.

Because ground water at the four SWMUs discharges to nearby surface water bodies (intermittent creeks, streams, etc.), comparisons of historical ground water data to surface water criteria were performed to identify a conservative list of detected chemicals of interest for the site.

The following screening criteria were used in the hazard identification for surface and subsurface soil:

- U.S. EPA Soil Screening Level (SSL) for Ingestion of Soil;
- U.S. EPA SSL for Inhalation (transfers from soil to air);
- U.S. EPA SSL for Migration to Ground Water (leaching);
- U.S. EPA Region 9 Preliminary PRGs for Residential Land Use;
- IDEM Tier I Surface Soil Default Cleanup Level for Residential Land Use;
- IDEM Tier I Subsurface Soil Default Cleanup Levels for Residential Land Use; and
- U.S. EPA Region 5 EDQLs for Soil.

A description of these criteria is presented in the risk assessment methodology sections of this Work Plan, Sections 10.0 (human health) and 11.0 (ecological). The numerical chemical-specific risk-based criteria values are presented in Appendix D. The comparison of historical data to the human health and ecological risk-based screening levels and the identification of detected parameters of interest for each SWMU are presented in Sections 5.0 through 8.0.

4.2.2 Decision Statement

The ultimate objective of this investigation is to determine whether hazardous constituents released into the environment by past SWMU operations pose an "unacceptable" or "acceptable" risk to potential human and/or ecological receptors. If "unacceptable" human health or ecological risks are identified for exposure to site media, a declaration of "unacceptable" risk will be issued and a recommendation for further action will be made. If "acceptable" risks are identified, no further action will be recommended for the SWMU.

4.2.3 Inputs Required for Decision Making

To achieve the objective stated in the previous section, a variety of inputs are required. The remainder of this Work Plan, as well as the FSP, HASP, and QAPP, provide details on the collection and interpretation of these inputs.

The primary inputs for the project are, as follows:

- Constituent data that will be used to develop representative exposure point concentrations for the defined human and ecological receptors;
- Risk-based screening levels used to determine detected parameters of interest in the planning stages and chemicals of potential concern (COPCs) during the risk assessments;
- Estimated Hazard Indices (HIs), representative of noncarcinogenic impacts (as defined in Sections 10.0 and 11.0 of this Work Plan) and derived from constituent concentration data;
- Estimated Incremental Lifetime Cancer Risks (ILCRs), representative of carcinogenic impacts (as defined in Section 10.0 of this Work Plan) and also derived from concentration data; and
- Target criteria used to identify "unacceptable" risks.

These inputs directly support the project objective of evaluating risks to potential receptors.

Exposure point concentrations will be generated for the constituents identified as being present in the environmental media as a result of a release from a past operational activity. To provide the necessary data, samples of the environmental media of interest will be collected from each SWMU and analyzed for various chemical parameters. A summary of the proposed field investigation (including objectives) for each SWMU is presented in Tables 5-5 (SWMU 4), 6-5 (SWMU 5), 7-5 (SWMU 9), and 8-9 (SWMU 10).

To address secondary issues of fate and transport of constituents (and ultimately the potential for risks outside of SWMU boundaries), additional data will be collected for soil and ground water samples. In addition to chemical parameters, soil samples will be analyzed for cation exchange capacity (CEC), pH, and total organic carbon (TOC). Surface water samples will be analyzed for total suspended solids (TSS) and hardness. Dissolved Oxygen, pH, and specific conductance are examples of ground water parameters to be measured.

The type, quality, and quantity of data must be sufficient to support the project objectives. Further details on the quality assurance of the analytical program are provided in the QAPP, located in Appendix C. The risk-based screening criteria identified in Section 4.2.1 will be used in the QAPP to evaluate the analytical methods for the proposed investigation.

4.2.4 Boundaries

To ensure that sufficient and representative data are available to quantify risks for the seven general classes of potential receptors, boundaries were set for the sampling program. General spatial boundaries for the proposed investigations are briefly defined in this section. SWMU-specific boundaries are provided in Sections 5.0 through 8.0.

Temporal boundaries are not considered for this investigation. The objective of this CTO is to evaluate potential risks to human and ecological receptors under current and future land use. This will be accomplished by evaluating the risks associated with site media under current conditions (i.e., current chemical concentrations).

4.2.4.1 Soil Sampling

For each SWMU, the proposed investigation for soil will be limited to locations within the SWMU boundaries to a maximum depth of 10 feet bgs or to bedrock, whichever is shallower. Data will be collected to assess the risks associated with residual soil contamination. The estimated maximum depth of a construction project (i.e., building foundation) is 10 feet bgs; therefore, potential human receptors are not expected to be exposed to subsurface soil at depths greater than 10 feet bgs. It is assumed that the majority of ecological receptors are not exposed to subsurface soil.

To address both the human and ecological receptors, soil sampling will be conducted in discrete intervals. Surface soil samples will be collected from 0 to 2 feet bgs intervals. Subsurface soil samples will be collected from a discrete depth between 2 to 10 feet bgs. Surface soil data will be used to assess risks for human and terrestrial ecological receptors. Subsurface soil data will be used to assess risks for human receptors only.

Background soil samples from locations not affected by site activities will not be collected during the proposed investigation. A separate Basewide background investigation for soils (surface and subsurface soil) is planned for NSWC Crane. The results of the soils background investigation will be used in the risk assessments for SWMUs 4, 5, 9, and 10, as identified in Sections 10.0 (human health) and 11.0 (ecological). The background data will be used to identify those detected soil constituents related to historical site activities compared to those constituents attributable to natural soil conditions. Only those chemicals identified as site-related constituents will be evaluated in the risk assessments.

4.2.4.2 Ground Water Sampling

Ground water at each SWMU will be investigated. Data will be collected from monitoring wells located within the SWMU boundaries, as well as locations upgradient and downgradient of the SWMU. Data from upgradient wells will be compared to data for downgradient and SWMU wells to (1) establish ground water conditions before entering the SWMU (not affected by site activities), (2) to identify whether detected constituents are present as a result of historical site activities, and (3) to evaluate the potential for risks outside of the SWMU boundaries.

4.2.4.3 Surface Water and Sediment Sampling

Surface water and sediment sampling will be conducted. Data will be collected from locations affected by site activities and from upstream and downstream locations. Data from upstream locations will be compared to data for downstream and SWMU-affected locations to (1) establish surface water and

sediment conditions not affected by site activities, (2) to identify whether detected constituents are present as a result of historical site activities, and (3) to evaluate the potential for risks outside of the SWMU boundaries.

4.2.5 Decision Rules

The decision rule is the culmination of the first four planning steps of the DQO Process. It identifies the constituents being monitored or evaluated, the constituent-related parameters to be measured, the criterion used to determine whether an environmental problem (i.e., risk) exists, and the actions taken if a problem does or does not exist. The decision rule identifies how the data will be used when making decisions regarding the estimated risks for exposure to site media.

For this investigation, three sequential decision rules have been identified. The sequence allows for the early elimination of SWMUs that pose minimal risks to potential receptors via a comparison of site data to risk-based screening levels. The sequence of decisions is, as follows:

1) If SWMU data collected during the historical field investigations exceed applicable, current risk-based screening levels, chemicals present at concentrations in excess of the screening levels and potentially associated with past site operations are identified as detected chemicals of interest. These chemicals are included in the sampling and analysis design. Otherwise, no chemicals of interest are identified and a comprehensive sampling and analysis design is conducted for the SWMU to confirm the absence or presence of chemicals of interest.

2) If SWMU data collected during the proposed field investigations exceed applicable, current risk-based screening levels, the SWMU is identified as having the potential to pose increased ("unacceptable") risks. Chemicals present at concentrations in excess of screening levels are identified as COPCs, and the SWMU is further evaluated in the risk assessments. Otherwise, the SWMU is eliminated from further evaluation and is identified as posing minimal ("acceptable") risks to potential human and ecological receptors. No further action is recommended for the site.

3) For those SWMUs carried through the risk assessment following the initial risk-based screening, if the cumulative HI for a potential receptor (or target organ) across all exposure pathways exceeds 1.0 (unity) for noncarcinogenic effects and/or if the cumulative ILCR for a receptor across all exposure pathways exceeds 1E-4 (the upper limit of the U.S. EPA's target risk level), a declaration of "unacceptable" risks for the receptor/SWMU is issued. In this instance, it will be recommended that a corrective measures study be prepared for the SWMU. Otherwise, the risks associated with site

media will be identified as minimal ("acceptable"). No environmental problem is considered to exist at the SWMU, and no further action will be warranted.

A flowchart illustrating the decision rule sequences for the project is presented in Figure 4-1. The methodologies and techniques used to estimate the risks (HIs and ILCRs) for potential receptors are defined in the risk assessment methodology sections of this Work Plan, Sections 10.0 (human health) and 11.0 (ecological).

4.2.6 Potential Errors Associated with the Decision Rule

Potential errors associated with each of the decision rules are presented in this section.

4.2.6.1 Hazard Identification

The proposed field investigation is based in part on the identification of detected parameters of interest (i.e., hazard identification). Several uncertainties are associated with the use of the historical data, including the associated chemical-specific reporting limits and the quality of the historical data.

Reporting limits for some constituents in the historical data sets were greater than current risk-based screening criteria. If a constituent was not detected, it was assumed that the constituent was not of concern at the SWMU. However, there can be no certainty that such eliminations are valid because the data were censored at the reporting limit. Furthermore, limited quality control data were available for the historical data; therefore, the validity of the data could not be confirmed. These uncertainties could result in potential constituents of interest going undetected and unidentified.

It is possible that some chemicals that were identified as detected parameters of interest are not actually present in the site media at concentrations of potential concern. For instance, various contaminants were detected in the field QC and laboratory blanks associated with the historical data. Although chemicals typically regarded as blank contaminants, such as methylene chloride and phthalates, were not identified as detected parameters of interest, other chemicals potentially attributable to blank contamination may have been identified as site-related contaminants (detected chemicals of interest). Additionally, the background samples collected during the previous investigations were not always representative of background conditions. Consequently, the actual inorganic constituents released to the environment from past operations may not be accurately identified. Finally, constituents that are ubiquitous may have been identified as a concern at the site.

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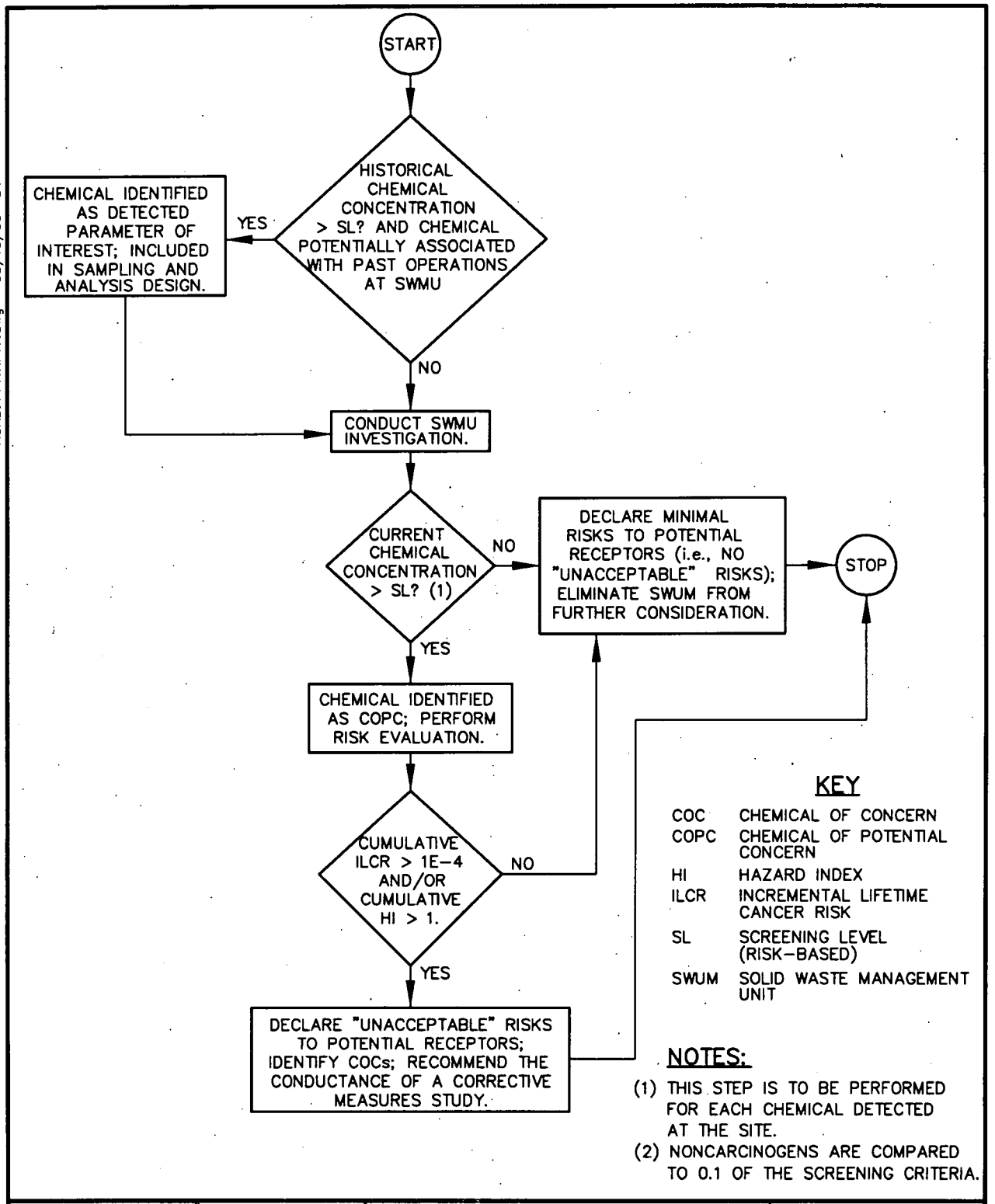

KEY

COC	CHEMICAL OF CONCERN
COPC	CHEMICAL OF POTENTIAL CONCERN
HI	HAZARD INDEX
ILCR	INCREMENTAL LIFETIME CANCER RISK
SL	SCREENING LEVEL (RISK-BASED)
SWUM	SOLID WASTE MANAGEMENT UNIT

NOTES:

(1) THIS STEP IS TO BE PERFORMED FOR EACH CHEMICAL DETECTED AT THE SITE.

(2) NONCARCINOGENS ARE COMPARED TO 0.1 OF THE SCREENING CRITERIA.

DRAWN BY DLT	DATE 8/10/00	DECISION RULE FLOWCHART SWMUs 4, 5, 9 AND 10 NSWC CRANE, INDIANA	CONTRACT NO. 7141
CHECKED BY	DATE 8/24/00		APPROVED BY	DATE 8/24/00
COST/SCHED-AREA			APPROVED BY	DATE
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Although it is true that hazardous constituents have been detected at the SWMUs, some chemicals may not be present as a result of releases from past site operations. For example, pesticides and herbicides were detected in almost every monitoring well at SWMU 10, Rockeye. The past operations at SWMU 10 dealt strictly with explosives manufacturing and handling. Pesticides and herbicides, although present at the site, are not associated with explosives operations conducted at SWMU 10. Most likely the pesticides/herbicides are a result of insect control practices that were conducted throughout the entire Facility.

4.2.6.2 Reporting Limits for Proposed Investigation

Similar to issues associated with the reporting limits for the historical data, the reporting limits for some of the constituents for the proposed field investigation also exceed current risk-based screening criteria. To limit the adverse effects of data censoring, to the greatest maximum extent possible, analytical methods were selected with reporting limits (RLs) at concentrations less than or equal to the risk-based target levels. If analytical methods were selected with associated RLs in excess of risk-based screening criteria, it is only because attainment of lower limits is not practicable. Details of the efforts undertaken establish lower RLs are provided in Section 1.4 of the QAPP.

To prevent the contamination problems previously identified with the historical data, various QA/QC measures will be taken to ensure that cross-contamination of samples and other contamination introduced during sampling and analysis do not occur. Also, all data will be independently validated to identify whether such problems have occurred. Any verifiable problems will be taken into consideration when using the data. As explained in Sections 10.0 and 11.0 of this Work Plan, the interpretation of the data for human health and ecological risk evaluations will address the potential for constituents to be present in the site media for reasons other than past site operations. These chemicals may be present because of background conditions (inorganics), as well as anthropogenic sources (pesticides, herbicides, polycyclic aromatic hydrocarbons [PAHs], etc.).

4.2.6.3 Risk Assessment

As noted in Sections 10.0 and 11.0 of this Work Plan, uncertainty in risk assessment may arise from a variety of sources (e.g., analytical data, toxicity data, exposure assumptions, etc.). These uncertainties may lead to the overestimation or underestimation of risks. These uncertainties will be explicitly identified in the risk assessments.

4.2.7 Sampling and Analysis Design

To be conservative (i.e., estimation of maximum representative risks for a SWMU) and consistent with past sampling activities, a biased, random sampling design will be used to sample those locations that are most likely to be contaminated. This will build in added conservatism in the decision-making process, providing protection against failure to identify an environmental problem (or "unacceptable" risk).

The sampling and analysis design for each SWMU is based on the CSM and historical data for that SWMU. In general, the historical analytical data for each SWMU consists of ground water monitoring data from approximately 1981 to 1992. At least one round of a comprehensive analytical list of constituents (e.g., Appendix IX parameters) was completed for each SWMU. Typically, the ground water monitoring data consisted of water quality parameters and a limited list of chemicals parameters. Surface and subsurface soil data were also collected in 1990 for each SWMU. These samples were analyzed for the Appendix IX list of parameters. Explosives also were included in the analytical program for SWMUs 4 and 10.

As noted in Section 4.2.6.1, a potential for committing errors exists in evaluating the historical data associated with each SWMU. To ensure that these errors do not adversely affect the quality of this investigation, the analytical program for this sampling effort will be comprehensive for SWMUs 4, 5, and 9. It will include Appendix IX constituents plus additional metals, explosives, and miscellaneous parameters. For SWMU 10, the historical data better defines the nature of the environmental problem; therefore, samples collected at this SWMU will be analyzed for a focused list of constituents (i.e., explosives and inorganics for all samples and a limited analysis for volatile and semivolatile organic compounds). Specific analytical programs for each SWMU are presented in Sections 5.5 (SWMU 4), 6.5 (SWMU 5), 7.5 (SWMU 9), and 8.5 (SWMU 10).

The risks posed to human and ecological receptors for each SMWU will be calculated solely on the data collected from this field investigation. As a result of the uncertainty associated with the historical data, these data will be used to focus the field investigation and in a qualitative manner to support risk conclusions drawn from the current data. Further details on the use of the current and historical data in the human health and ecological risk assessments are presented in the risk assessment methodology sections of this Work Plan, Sections 10.0 (human health) and 11.0 (ecological).

Proposed sample locations were selected in areas of known contamination to verify and further delineate the nature and extent of contamination and to better quantify the level of the constituents. In addition, locations to be sampled were dispersed throughout a SWMU to provide adequate coverage for potential

receptors (i.e., to support the calculation of a representative concentration for exposure to the entire site). Figures illustrating historical sampling locations where chemical concentrations exceeded risk-based screening levels are presented in Sections 5.0 through 8.0. Proposed sample location maps for each SWMU are presented as Figures 5-8 (SWMU 4), 6-8 (SWMU 5), 7-8 (SWMU 9), and 8-10 (SWMU 10).

4.3 SUMMARY

The proposed sampling and analysis designs for SWMUs 4, 5, 9, and 10 were developed based on available historical data and site-specific CSMs. U.S. EPA's DQO Process was used during the development of the proposed field investigations to ensure that the data collected are sufficient for the attainment of the objective of the project, which is the completion of risk assessments for the SWMUs.

5.0 SWMU 4 – MCCOMISH GORGE

The proposed field investigation for SWMU 4, McComish Gorge, needed to fulfill the overall objectives of this CTO (i.e., the completion of human health and ecological risk assessments), is provided in this section.

Section 5.1 presents a brief background of activities, which have occurred at the site. The physical setting (geology, hydrology, topography, etc.) is contained in Section 5.2. A brief synopsis of the previous site investigations and hazard identification based on the historical site data are presented in Sections 5.3 and 5.4, respectively. Section 5.5 summarizes the proposed field investigation for the site.

Two geophysical surveys were performed at SWMU 4 as part of risk assessment activities conducted under this CTO. Reports summarizing the geophysical investigations are provided in Appendix I of this Work Plan. Several figures contained in this section include the color contours generated for the first geophysical investigation. Only figures 5-1 and 5-8 include the results of the second survey. The contours were included to assist in the evaluation of historical site data and the selection of proposed sample locations.

5.1 BACKGROUND

McComish Gorge was used as a dumpsite for an unknown period of time between 1942 and 1972. Unknown amounts and types of garbage and trash, such as construction debris, office trash, plaster filled warheads, and metal shavings, were buried in a gorge at the site. Reportedly, small arms ammunition may also have been buried at the site (U.S. ACE WES, September 1998a). Currently, the site is inactive (i.e., not used for waste disposal activities) and has been revegetated.

5.2 PHYSICAL SETTING

McComish Gorge is located in the northwest corner of NSWC Crane approximately 500 feet south of Crane Gate No. 4. The site occupies approximately 5 acres. McComish Gorge is bounded on the north by Culpepper Branch Creek and on the east by Highway 140. The site map for SWMU 4, McComish Gorge, is presented as Figure 5-1. Estimated boundaries of the site are provided. The boundaries presented are based on results of the geophysical investigation, which was conducted in August 1999 and December 2000.

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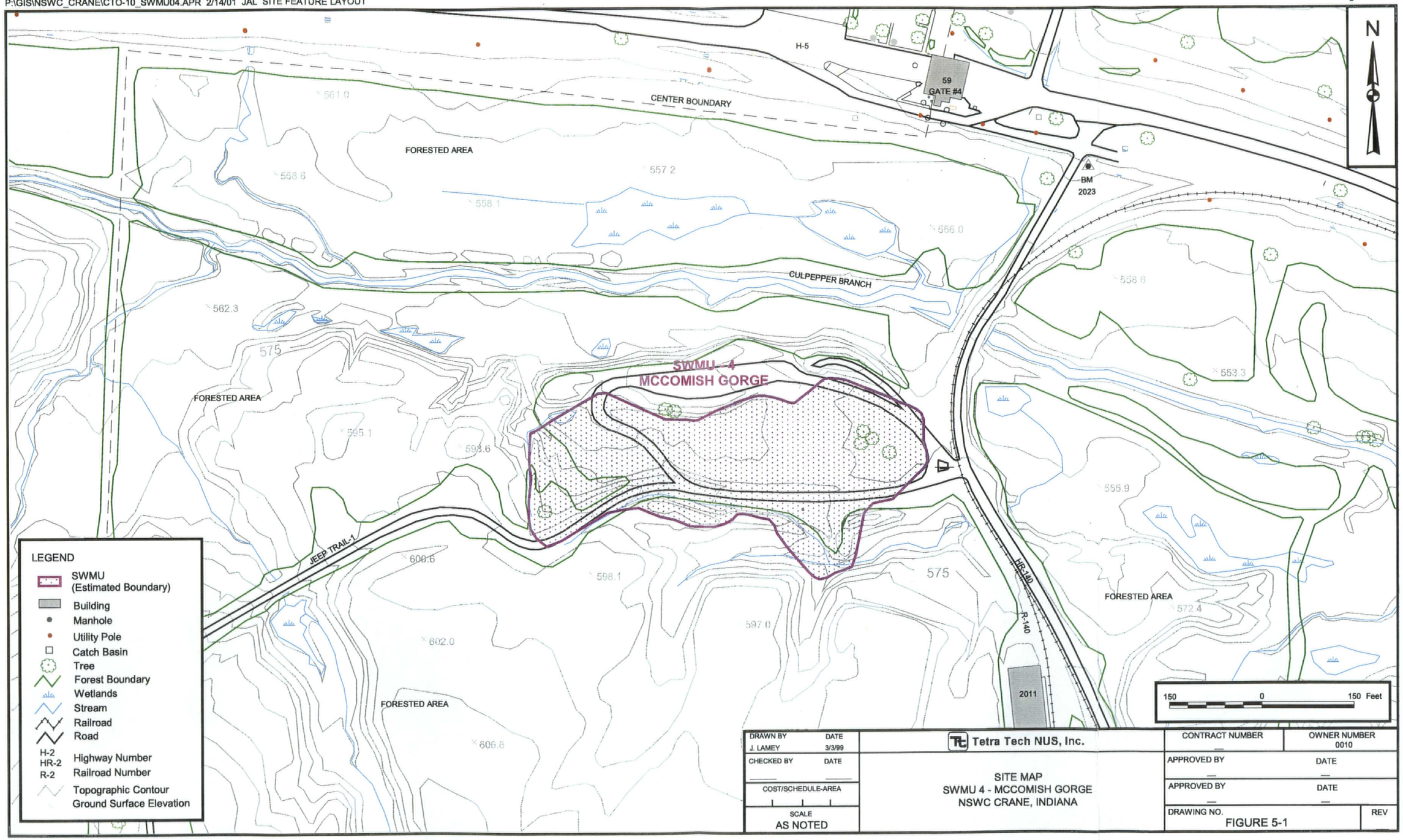


DRAWN BY J. LAMEY	DATE 3/3/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER — / OWNER NUMBER 0010
CHECKED BY	DATE	SITE MAP SWMU 4 - MCCOMISH GORGE NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 5-1 / REV

5.2.1 Topography/Hydrology

The topography at McComish Gorge consists of undulating terrain dissected by many small drainage ways. Surface runoff from McComish Gorge drains into Culpepper Branch Creek, which is a tributary of Furst Creek.

5.2.2 Geology

McComish Gorge is located on the Crawford Upland, a rugged, dissected plateau formed by differential erosion of Pennsylvanian- and Mississippian-age sedimentary rocks. The rock units underlying McComish Gorge and forming the surrounding hills consist of Mansfield Formation shales and sandstones of the Pennsylvania-age Raccoon Creek Group.

Most of the McComish Gorge site is situated in the dissected alluvial valley of Culpepper Branch Creek. Soils across the site ranged from 0 to 65 feet in thickness. Several processes formed the unconsolidated sediments found at McComish Gorge. During the Pleistocene, the site was filled with lacustrine (lake) deposits and alluvial (stream outwash) deposits that are facies included in the Artherton Formation. At this location, these deposits primarily consist of interbedded sand, silt, and clay indicating a heterogeneous nature to the subsurface soils. Only small amounts of coarse sand or gravel were encountered at the site during previous site investigations.

Colluvium derived from the hill slopes and soils reworked as a direct result of disposal activities also compose the soils found at the site. The part of the soil horizon that has been disrupted by human activity (estimated depth of 3 to 4 feet bgs) contains items such as plastic, rubber, metal, and wood wastes. In addition, staining of this horizon has also been observed (U.S. ACE WES, September 1998).

A linear, sandy zone of soil has been identified at the site. This sandy zone is interpreted as a paleostream channel deposit.

5.2.3 Hydrogeology

The ground water gradient at McComish Gorge is eastward. The elevation of Culpepper Branch Creek is approximately coincident with the elevation of the ground water table; therefore, it is likely that ground water discharges into Culpepper Branch Creek.

Ground water was encountered at shallow depths at McComish Gorge during previous site investigations. The depth to the ground water table ranged from approximately 15 feet bgs near the western edge of McComish Gorge to approximately 5 feet bgs near Culpepper Branch Creek.

Available evidence indicates that the ground water at McComish Gorge moves very slowly via downward vertical infiltration through clay and silts at the site. When rock is encountered, the ground water is expected to move laterally along the soil/rock interface until it reaches fractured rock, upon which it would enter the rock aquifer system. In the paleostream channel (sand rich zones), ground water would preferentially move laterally through the sand zone.

5.3 PREVIOUS INVESTIGATIONS

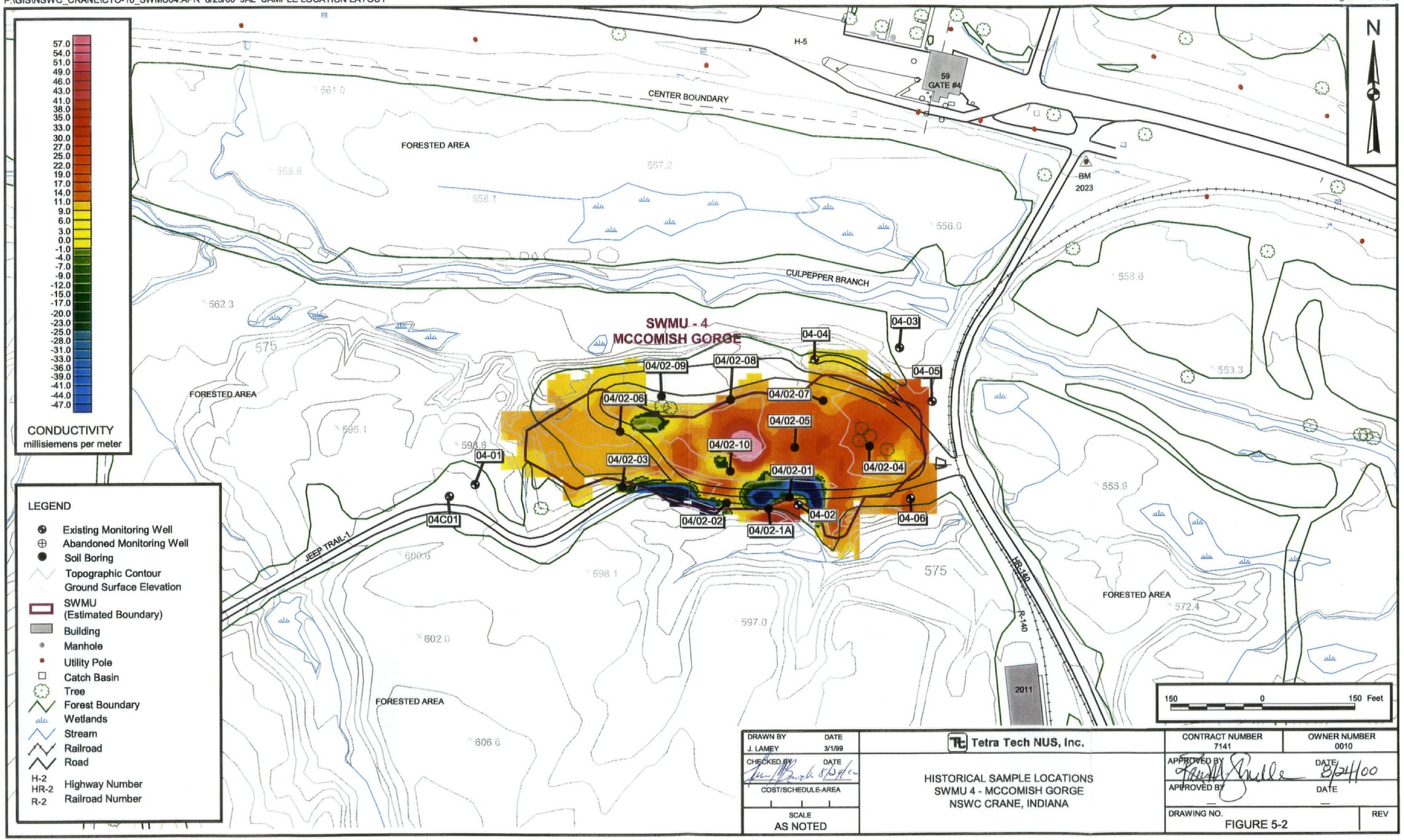
A brief description of the historical data collections activities conducted at SWMU 4, McComish Gorge, is contained in this section. Soil and ground water samples have been collected at locations illustrated in Figure 5-2. A tabular summary of the previous investigations completed for the site is presented in Table 5-1.

Various investigations were completed from 1981 to 1987 at McComish Gorge as part of several multi-site investigations. The first of which was the IAS (NEESA, 1983). The IAS was initiated in April 1981 in response to the NACIP Program. NEESA completed the IAS in May 1983 with assistance from the Ordnance Environmental Support Agency and the U.S. ACE WES. The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations.

The IAS consisted of the installation of six monitoring wells (04-01 through 04-06) along the perimeter of the site. During the installation of these wells, soil samples were collected and characterized. After the monitoring wells were installed, ground water samples were collected and analyzed for a comprehensive list of chemical constituents and RCRA water quality parameters. As part of the IAS, both quarterly and semi-annual sampling of the monitoring wells were initiated at McComish Gorge. The list of soil tests performed and the chemical constituents included in the ground water analytical program are identified in Table 5-1.

Based on the initial conclusions of the IAS, it was determined that disposal activities at McComish Gorge did not present an immediate human health or environmental threat. However, the site was recommended for further study to evaluate potential long-term impacts.

P:\GIS\NSWC_CRANE\CTO-10_SWMU04.APR 8/23/00 JAL SAMPLE LOCATION LAYOUT



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER 0010
J. LAMEY	3/1/99		APPROVED BY	DATE 8/24/00
CHECKED BY	DATE	HISTORICAL SAMPLE LOCATIONS SWMU 4 - MCCOMISH GORGE NSWC CRANE, INDIANA	APPROVED BY	DATE
COST/SCHEDULE-AREA			DRAWING NO. FIGURE 5-2	REV
SCALE AS NOTED				

TABLE 5-1

SUMMARY OF HISTORICAL SITE INVESTIGATIONS
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA

INVESTIGATION (REPORT/REFERENCE)	EXTENT OF INVESTIGATION			RESULTS OF INVESTIGATION	
	SUMMARY	DATE OF SAMPLING	ANALYTICAL PROGRAM (PARAMETER/ANALYTICAL METHOD)	DETECTED PARAMETERS OF INTEREST	CONCLUSIONS
General Basewide Investigations[1] (1981-1987)	Installation of 6 monitoring wells from September - October 1981 along the suspected perimeter of the site. Physical soil testing to define hydrogeological characteristics.	January - April 1982	Miscellaneous Physical Soil Testing (cation exchange capacity, grain size, Atterberg limits, density, water content, and permeability tests) -- Various Methods	NA	Geology consists of unconsolidated lacustrine deposits (sand, silt, and clay). Heterogeneous nature of subsurface soil was identified. Ground water flow direction was determined to be eastward, toward Culpepper Branch Creek. Depth to water table varied from 5 to 15 feet bgs.
	Quarterly/semiannual ground water monitoring instituted to identify the presence or absence of contamination.	December - October 1982[2] February 1983 - June 1986[3]	RCRA Group I - III Parameters[4] - Various Methods	Pesticides (toxaphene and gamma-BHC) and several inorganics (As, Cr, Fe, Mn, Hg, Ag, and Ba), chloride, and sulfide	Contamination detected in one well at the eastern site boundary (well 04-01) and one well at the western site boundary (well 04-05), concluding that two possible contaminant sources may be present. Strong sewage odor was noted at one well (well 04-03) during sample collection.
RFI Phase II Soils Release Characterization for SWMU 04/02 McComish Gorge, Naval Surface Warfare Center Crane, Indiana (U.S. ACE WES, 1998a)	Installation of 11 soil borings. Surface and subsurface soil sampling performed to determine whether a chemical release has occurred at the site (i.e., identify residual contaminant concentrations in soil).	October - November 1990	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Organochlorine Pesticides/PCBs -- SW-846 Method 8080 Organophosphorus Pesticides -- SW-846 Method 8140 Herbicides -- SW-846 Method 8150 Explosives -- SW-846 Method 8330 Inorganics + CN[5] -- SW-846 Methods 6010/7060/7471/7740	Surface Soil - 4,4'-DDT and various inorganics (Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Tl, and Zn) Subsurface Soil - explosives (2,6- and 2,4-dinitrotoluenes), N-nitrosodiphenylamine) and various inorganics (mainly Sb, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Pb, Se, Tl, and Zn)	A paleostream channel deposit (linear, sandy zone of soil) was identified at the site. Estimated permeabilities of the sand unit are expected to be higher than the silty sandy soil present at the site, indicating that the sand unit would act as a conduit for ground water flow. Surface drainage is to Culpepper Branch Creek. Site boundaries have not been defined. The area south of the Jeep Trail was thought to be outside the site limits; however, waste was encountered in soil borings in this area. The presence of residual contamination was observed in the soil. Detects of acetone, methylene chloride, and phthalates are thought to be laboratory contaminants.
RFI Phase III Ground Water Work Plan for Naval Weapons Support Center, Crane, Indiana, McComish Gorge and Old Burn Pit (U.S. ACE WES, June 1991)[6]	Collection of a round of ground water samples from 6 existing monitoring wells to determine rate and extent of migration of contaminated ground water.	July 1992	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Organochlorine Pesticides/PCBs -- SW-846 Method 8080 Inorganics + CN -- SW-846 Methods 6010/7060/7471/7740 Nitrate, Nitrite, Sulfide	VOCs (benzene, cis- and trans-1,3-dichloropropenes), pesticides (alpha-chlordane and heptachlor), Aroclor-1254, and various inorganics (mainly Ba, Co, Fe, Pb, and Mn) and sulfide	Contamination observed in the ground water at the site. Elevated detections of some inorganics (Cr and Hg) previously noted during historical investigations were not confirmed during this investigation. Detections of BEHP are thought to be a result of laboratory contamination.

As	Arsenic	BEHP	Bis(2-ethylhexyl)phthalate	Cu	Copper	NA	Not applicable	Sb	Antimony
Ag	Silver	bgs	Below ground surface	CN	Cyanide	Pb	Lead	Se	Selenium
Ba	Barium	Cd	Cadmium	Fe	Iron	PCBs	Polychlorinated Biphenyls	SVOCs	Semivolatile Organic Compounds
Be	Beryllium	Co	Cobalt	Hg	Mercury	RFI	RCRA Facility Investigation	SWMU	Solid Waste Management Unit
		Cr	Chromium	Mn	Manganese	RCRA	Resource Conservation and Recovery Act	Tl	Thallium
								Zn	Zinc

1 Includes, but is not limited to, Hydrogeologic Investigations at Waste Disposal Sites (U.S. ACE WES, 1982) and Navy Assessment and Control of Installation Pollutants, Confirmation Study (HMTC, June 1985).
2 Quarterly monitoring.
3 Semiannual monitoring.
4 Includes select inorganics, pesticides, herbicides, radionuclides, phenol, chloride, fluoride, nitrate, nitrite, sulfate, and total bacteria.
5 Includes phosphorus and tin.
6 Only a portion of the work proposed in the work plan was conducted. Additional proposed monitoring wells were not installed; a geophysical survey was not conducted; and not all ground water samples collected were analyzed for all proposed chemical constituents or for the same list of constituents. A Ground Water Release Characterization Report was not generated for the sampling effort because of funding issues.

In response to the recommendation presented in the IAS, a RFI Phase II Soils Release Characterization was performed at McComish Gorge in 1990 (U.S. ACE WES, 1998a). The objective of the study was to determine soil conditions at the site, to identify and characterize the hazardous waste disposed at the site (including an identification of site boundaries), and to find the potential for release of hazardous constituents to the surrounding environment. Eleven soil borings (04/02-1A and 04/02-01 through 04/02-10) were installed. Both surface and subsurface samples were collected from these borings and analyzed for a comprehensive list of chemical parameters, outlined in Table 5-1. The boundaries of the site were not identified, as originally planned, because waste was encountered at locations (04/02-1A and 04/02-02) perceived to be outside of the limits of disposal activities.

In 1991 a draft Work Plan for a RFI Phase III Ground Water Release Characterization was prepared by U.S. ACE WES (June 1991). The objective of the sampling effort was to determine the extent of hazardous constituents present in the ground water, as well as the rate of migration. The proposed ground water study included the collection of samples from the existing six monitoring wells located at the site, plus the installation of additional wells. The completion of a geophysical survey was also recommended to identify the boundaries of the site.

Because of funding constraints, only a portion of the work proposed in the plan was conducted in 1992. Additional proposed monitoring wells were not installed and not all ground water samples collected were analyzed for all proposed chemical constituents or for the same list of constituents per sample. The geophysical survey was also not performed. A Release Characterization Report was not generated for the sampling effort because of funding issues.

5.4 HAZARD IDENTIFICATION

The hazard identification characterizes those constituents that may be attributable to historical operations at the site. Based on knowledge of site practices and an interpretation of the historical data (i.e., comparison of detected constituents to risk-based screening criteria), a list of detected chemicals of interest was developed for McComish Gorge. Detected chemicals of interest are defined as those chemicals, excluding blank contaminants, present at concentrations greater than risk-based screening criteria. Discussions of those constituents detected at concentrations in excess of current human health and ecological screening criteria are provided in Sections 5.4.1 (organics) and 5.4.2 (inorganics). A summary of the detected parameters of interest is contained in Section 5.4.3.

Historical site data were compared to human health and ecological criteria to identify chemicals of interest. Summaries of the comparison of historical site data to human health and ecological risk-based

criteria are presented in Tables 5-2 (surface soil), 5-3 (subsurface soil), and 5-4 (ground water, unconsolidated aquifers). A brief description of the screening criteria used was provided in Section 4.2 of this Work Plan.

Figures 5-3 through 5-6 depict those locations where exceedances of human health and ecological risk-based criteria have been noted during previous investigations. Separate figures are provided for soil (surface soil and subsurface soil combined) and ground water. For each sample matrix, separate figures are presented to illustrate human health and ecological exceedances.

Because shallow ground water at the site discharges to Culpepper Branch Creek and surface water/sediment samples have not been collected from the site, historical ground water data were compared to ecological screening criteria for surface water. The comparison is considered to be conservative, because it does not include the dilution of contaminants in the creek. Thus, those chemicals identified as detected chemicals of interest based solely on the comparison of ground water data to surface water criteria may not actually be present in the surface water at concentrations of potential concern.

5.4.1 Organic Constituents

Benzene, 1,3-dichloropropenes (cis- and trans-), and Aroclor-1254 were detected in the environmental samples collected from SWMU 4, McComish Gorge. These chemicals were detected in one ground water sample collected during the 1992 sampling event, but they have never been detected in the soils at the site. These chemicals may be present at low levels (i.e., less than 5 µg/L) in the ground water as a result of historical Basewide maintenance practices. Historically, it was common practice to treat areas alongside roadways with a mixture of herbicides and waste fuel oils. This practice was performed for insect control and dust suppression purposes. Benzene, 1,3-dichloropropenes (cis- and trans-), and Aroclor-1254 have also been detected at low levels in the ground water at SWMU 5, 9, and 10, which implies that these chemicals may not be site-related constituents. However, these chemicals were conservatively identified as detected chemicals of interest for the site.

Acetone, methylene chloride, and some phthalates were detected in the soil and/or ground water samples collected at the site. Several reported concentrations of these chemicals exceeded risk-based criteria, as illustrated on Figures 5-3 through 5-6. These chemicals were detected in the laboratory and field QC blanks associated with the site samples. Therefore, they are not considered to be site-related constituents and were eliminated as parameters of interest for McComish Gorge. These chemicals were also reported at similar concentrations in environmental samples collected at SWMUs 5, 9, and 10,

TABLE 5-2

SUMMARY OF HISTORICAL DATA - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
PAGE 1 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
Volatile Organics (mg/kg)												
1,1,1-TRICHLOROETHANE	0/11	---	0.0053-0.0099	---	0	---	1200	0.1	770	2400	1.9	29.8
1,1,2,2-TETRACHLOROETHANE	0/11	---	0.0053-0.0099	---	0	3	0.6	0.0002	0.38	5.4	0.007	0.12722
1,1,2-TRICHLOROETHANE	0/11	---	0.0053-0.0099	---	0	11	1	0.0009	0.84	10	0.03	28.6
1,1-DICHLOROETHANE	0/11	---	0.0053-0.0099	---	0	7800	1300	1	590	1400	5.6	20.1
1,1-DICHLOROETHENE	0/11	---	0.0053-0.0099	---	0	1	0.07	0.003	0.054	0.73	0.058	8.28
1,2-DICHLOROETHANE	0/11	---	0.0053-0.0099	---	0	7	0.4	0.001	0.35	4	0.024	21.2
1,2-DICHLOROPROPANE	0/11	---	0.0053-0.0099	---	0	9	15	0.001	0.35	5	0.03	32.7
2-BUTANONE	0/11	---	0.11-0.2	---	0	---	---	---	7300	20000	10	89.6
2-HEXANONE	0/11	---	0.053-0.099	---	0	---	---	---	---	---	---	12.6
4-METHYL-2-PENTANONE	0/11	---	0.053-0.099	---	0	---	---	---	790	---	---	443
ACETONE	11/11	0.013-0.12	---	04/02-10-90 #1 (90)	0	7800	100000	0.8	1600	4200	3.1	2.5
BENZENE	0/11	---	0.0053-0.0099	---	0	22	0.8	0.002	0.67	9	0.34	0.25462
BROMODICHLOROMETHANE	0/11	---	0.0053-0.0099	---	0	10	3000	0.03	1.0	11	0.63	0.53978
BROMOFORM	0/11	---	0.0053-0.0099	---	0	81	53	0.04	62	290	0.75	15.9
BROMOMETHANE	0/11	---	0.011-0.02	---	0	110	10	0.01	3.9	11	0.052	0.23516
CARBON DISULFIDE	0/11	---	0.0053-0.0099	---	0	7800	720	2	360	990	10	0.09412
CARBON TETRACHLORIDE	0/11	---	0.0053-0.0099	---	0	5	0.3	0.003	0.24	3.6	0.066	2.98
CHLOROBENZENE	0/11	---	0.0053-0.0099	---	0	1600	130	0.07	1.0	150	1.3	13.1
CHLOROETHANE	0/11	---	0.011-0.02	---	0	---	---	---	3.0	---	---	---
CHLOROFORM	0/11	---	0.0053-0.0099	---	0	100	0.3	0.03	0.24	3.3	0.59	1.19
CHLOROMETHANE	0/11	---	0.011-0.02	---	0	---	---	---	1.2	---	---	10.4
CIS-1,2-DICHLOROETHENE	0/11	---	0.0053-0.0099	---	0	780	1200	0.02	43	119	0.4	0.78373[8]
CIS-1,3-DICHLOROPROPENE	0/11	---	0.0053-0.0099	---	0	4	0.1	0.0002	---	---	---	0.39786
DIBROMOCHLOROMETHANE	0/11	---	0.0053-0.0099	---	0	8	1300	0.02	1.1	---	---	2.05
ETHYLBENZENE	0/11	---	0.0053-0.0099	---	0	7800	400	0.7	230	5000	13	5.16
METHYLENE CHLORIDE	11/11	0.029-0.54	---	04/02-08-90 #1 (90)	11	85	13	0.001	8.9	120	0.023	4.05
STYRENE	0/11	---	0.0053-0.0099	---	0	16000	1500	0.2	1.0	12000	3.5	4.69
TETRACHLOROETHENE	0/11	---	0.0053-0.0099	---	0	12	11	0.003	5.7	50	0.058	9.92
TOLUENE	0/11	---	0.0053-0.0099	---	0	16000	650	0.8	520	1800	12	5.45
TRANS-1,2-DICHLOROETHENE	0/11	---	0.0053-0.0099	---	0	1600	3100	0.03	63	190	0.68	0.78373
TRANS-1,3-DICHLOROPROPENE	0/11	---	0.0053-0.0099	---	0	4	0.1	0.0002	---	---	---	0.39786
TRICHLOROETHENE	0/11	---	0.0053-0.0099	---	0	58	5	0.003	2.8	48	0.057	12.4
VINYL ACETATE	0/11	---	0.053-0.099	---	0	78000	1000	8	430	1200	2.3	12.7
VINYL CHLORIDE	0/11	---	0.011-0.02	---	0	0.3	0.03	0.0007	0.022	0.31	0.013	0.64614
XYLENES, TOTAL	1/11	0.0021	0.0053-0.0099	04/02-01-90 #1 (90)	0	160000	410[8]	9[8]	210	5300	190	10
Semivolatile Organics (mg/kg)												
1,2,4-TRICHLOROBENZENE	0/11	---	0.66-0.92	---	0	780	3200	0.3	6.0	1800	5.3	11.1
1,2-DICHLOROBENZENE	0/11	---	0.66-0.92	---	0	7000	560	0.9	370	3000	17	2.96
1,2-DIPHENYLHYDRAZINE	0/11	---	0.66-0.92	---	0	---	---	---	0.61	---	---	---
1,3-DICHLOROBENZENE	0/11	---	0.66-0.92	---	0	---	---	---	13	114	0.42	37.7
1,4-DICHLOROBENZENE	0/11	---	0.66-0.92	---	0	27	---	0.1	3.0	42	2.2	0.54559
2,4,5-TRICHLOROPHENOL	0/11	---	0.66-0.92	---	0	7800	---	14	6100	18000	250	14.1
2,4,6-TRICHLOROPHENOL	0/11	---	0.66-0.92	---	0	58	200	0.008	44	390	1.5	9.94
2,4-DICHLOROPHENOL	0/11	---	0.66-0.92	---	0	230	---	0.05	1.0	550	1.1	87.5
2,4-DIMETHYLPHENOL	0/11	---	0.66-0.92	---	0	1600	---	0.4	1.0	3600	9	0.01
2,4-DINITROPHENOL	0/11	---	3.3-4.6	---	0	160	---	0.01	120	360	0.29	0.06086
2,6-DINITROTOLUENE	0/11	---	0.66-0.92	---	0	0.9	---	0.00003	61	---	---	0.03283
2-CHLORONAPHTHALENE	0/11	---	0.66-0.92	---	0	---	---	---	4900	---	---	0.01218
2-CHLOROPHENOL	0/11	---	0.66-0.92	---	0	390	53000	0.2	6.0	380	0.75	0.24266
2-METHYL-4,6-DINITROPHENOL	0/11	---	3.3-4.6	---	0	---	---	---	---	---	---	---

TABLE 5-2

SUMMARY OF HISTORICAL DATA - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
PAGE 2 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
2-METHYLNAPHTHALENE	1/11	0.062	0.66-0.76	04/02-02-90 #1 (90)	0	---	---	---	---	---	---	3.24
2-METHYLPHENOL	0/11	---	0.66-0.92	---	0	3900	---	0.8	3100	7600	14	40.4
2-NITROANILINE	0/11	---	3.3-4.6	---	0	---	---	---	3.5	---	---	74.1
2-NITROPHENOL	0/11	---	0.66-0.92	---	0	---	---	---	---	---	---	1.6
3,3'-DICHLOROBENZIDINE	0/11	---	1.3-1.8	---	0	1	---	0.0003	1.1	9.5	0.062	0.64636
3-NITROANILINE	0/11	---	3.3-4.6	---	0	---	---	---	---	---	---	3.16
4-BROMOPHENYL PHENYL ETHER	0/11	---	0.66-0.92	---	0	---	---	---	---	---	---	---
4-CHLORO-3-METHYLPHENOL	0/11	---	1.3-1.8	---	0	---	---	---	---	---	---	7.95
4-CHLOROANILINE	0/11	---	1.3-1.8	---	0	310	---	0.03	240	730	0.97	1.1
4-CHLOROPHENYL PHENYL ETHER	0/11	---	0.66-0.92	---	0	---	---	---	---	---	---	---
4-METHYLPHENOL	0/11	---	0.66-0.92	---	0	---	---	---	310	---	---	163
4-NITROANILINE	0/11	---	3.3-4.6	---	0	---	---	---	---	---	---	21.9
4-NITROPHENOL	0/11	---	3.3-4.6	---	0	---	---	---	490	---	---	5.12
ACENAPHTHENE	0/11	---	0.66-0.92	---	0	4700	---	29	3700	9500	130	682
ACENAPHTHYLENE	0/11	---	0.66-0.92	---	0	---	---	---	---	---	---	682
ANILINE	0/11	---	1.3-1.8	---	0	---	---	---	85	---	---	0.05678
ANTHRACENE	0/11	---	0.66-0.92	---	0	23000	---	590	22000	47000	51	1480
BENZIDINE	0/11	---	3.3-4.6	---	0	---	---	---	0.0021	---	---	---
BENZO(A)ANTHRACENE	0/11	---	0.66-0.92	---	0	0.9	---	0.08	0.62	5	5	5.21
BENZO(A)PYRENE	0/11	---	0.66-0.92	---	0	0.09	---	0.4	0.062	0.5	0.5	1.52
BENZO(B)FLUORANTHENE	0/11	---	0.66-0.92	---	0	0.9	---	0.2	0.62	5	5	59.8
BENZO(G,H,I)PERYLENE	0/11	---	0.66-0.92	---	0	---	---	---	---	---	---	119
BENZO(K)FLUORANTHENE	0/11	---	0.66-0.92	---	0	9	---	2	6.2	50	39	1480
BENZOIC ACID	0/11	---	3.3-4.6	---	0	310000	---	20	100000	730000	590	---
BENZYL ALCOHOL	0/11	---	1.3-1.8	---	0	---	---	---	18000	---	---	65.8
BIS(2-CHLOROETHOXY)METHANE	0/11	---	0.66-0.92	---	0	---	---	---	---	---	---	0.30209
BIS(2-CHLOROETHYL)ETHER	0/11	---	0.66-0.92	---	0	0.6	0.2	0.00002	0.21	1.6	0.0007	23.7
BIS(2-CHLOROISOPROPYL) ETHER	0/11	---	0.66-0.92	---	0	---	---	---	6.9	31	0.027	---
BIS(2-ETHYLHEXYL)PHTHALATE	10/11	0.036-0.25	0.74	04/02-07-90 #1 (90)-AVG	0	46	31000	180	35	300	300	0.92594
BUTYLBENZYL PHTHALATE	1/11	0.036	0.66-0.92	04/02-06-90 #1 (90)	0	16000	930	810	12000	36000	930	0.23889
CHRYSENE	0/11	---	0.66-0.92	---	0	88	---	8	62	500	26	4.73
DI-N-BUTYL PHTHALATE	6/11	0.0585-0.15	0.66-0.74	04/02-09-90 #1 (90)	1	7800	2300	270	6100	18000	2300	0.14979
DI-N-OCTYL PHTHALATE	2/11	0.026-0.088	0.66-0.92	04/02-06-90 #1 (90)	0	1600	10000	10000	1200	3700	2000	709
DIBENZO(A,H)ANTHRACENE	0/11	---	0.66-0.92	---	0	0.09	---	0.08	0.062	0.5	0.5	18.4
DIBENZOFURAN	0/11	---	0.66-0.92	---	0	---	---	---	290	---	---	---
DIETHYL PHTHALATE	7/11	0.03-0.05	0.73-0.92	04/02-06-90 #1 (90)	0	63000	2000	23	49000	150000	450	24.8
DIMETHYL PHTHALATE	0/11	---	0.66-0.92	---	0	---	---	---	100000	---	---	734
FLUORANTHENE	0/11	---	0.66-0.92	---	0	3100	---	210	2300	6300	880	122
FLUORENE	0/11	---	0.66-0.92	---	0	3100	---	28	2600	6300	170	122
HEXACHLOROBENZENE	0/11	---	0.66-0.92	---	0	0.4	1	0.1	3.0	2.7	2.2	0.19678
HEXACHLOROBUTADIENE	0/11	---	0.66-0.92	---	0	8	8	0.1	6.0	36	16	0.03976
HEXACHLOROCYCLOPENTADIENE	0/11	---	0.66-0.92	---	0	550	10	20	420	1300	400	0.75537
HEXACHLOROETHANE	0/11	---	0.66-0.92	---	0	46	55	0.02	35	183	2.8	0.59634
INDENO(1,2,3-CD)PYRENE	0/11	---	0.66-0.92	---	0	0.9	---	0.7	0.62	5	3	109
ISOPHORONE	0/11	---	0.66-0.92	---	0	670	4600	0.03	510	4500	5.3	139
N-NITROSO-DI-N-PROPYLAMINE	0/11	---	0.66-0.92	---	0	0.09	---	0.000002	0.069	0.61	0.0006	0.54368
N-NITROSODIMETHYLAMINE	0/11	---	0.66-0.92	---	0	---	---	---	0.0095	---	---	0.0000321
N-NITROSODIPHENYLAMINE	0/11	---	0.66-0.92	---	0	130	---	0.06	9.0	810	9.7	0.54514
NAPHTHALENE	0/11	---	0.66-0.92	---	0	3100	---	4	56	3200	0.7	0.09939
NITROBENZENE	0/11	---	0.66-0.92	---	0	39	92	0.007	20	91	0.028	1.31
PENTACHLOROPHENOL	0/11	---	3.3-4.6	---	0	3	---	0.001	3.0	20	0.028	0.11927

TABLE 5-2

SUMMARY OF HISTORICAL DATA - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
PAGE 3 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
PHENANTHRENE	0/11	---	0.66-0.92	---	0	---	---	---	---	---	---	45.7
PHENOL	0/11	---	0.66-0.92	---	0	47000	---	5	37000	89000	110	120
PYRENE	0/11	---	0.66-0.92	---	0	2300	---	210	2300	5500	570	78.5
Pesticides/PCBs/Herbicides (mg/kg)												
2,4,5-T	0/11	---	0.052-0.76	---	0	---	---	---	610	---	---	0.59634
2,4,5-TP (SILVEX)	0/10	---	0.06-0.079	---	0	---	---	---	490	---	---	0.1088
2,4-D	0/11	---	0.42-0.56	---	0	---	---	---	690	---	---	0.02725
4,4'-DDD	0/11	---	0.00735-0.01	---	0	3	---	0.8	2.4	28	28	0.75815
4,4'-DDE	2/11	0.0018-0.029	0.0027-0.0037	04/02-10-90 #1 (90)	0	2	---	3	1.7	20	20	0.59587
4,4'-DDT	1/11	0.1	0.008-0.011	04/02-10-90 #1 (90)	1	2	---	2	1.7	20	20	0.0175
ALDRIN	0/11	---	0.0027-0.0037	---	0	0.04	3	0.02	0.029	0.25	0.25	0.00332
ALPHA-BHC	0/11	---	0.002-0.0028	---	0	0.1	0.8	0.00003	0.090	0.99	0.0072	0.09939
ALPHA-CHLORDANE	5/11	0.00016-0.0024	0.0033-0.0046	04/02-06-90 #1 (90)	0	0.5[10]	20[10]	0.5[10]	---	---	---	0.224[10]
AROCLOR-1016	0/11	---	0.043-0.06	---	0	1[11]	---	---	3.9	---	---	0.000322[11]
AROCLOR-1221	0/11	---	0.043-0.06	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1232	0/11	---	0.043-0.06	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1242	0/11	---	0.043-0.06	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1248	0/11	---	0.043-0.06	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1254	0/11	---	0.0865-0.12	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1260	0/11	---	0.0865-0.12	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
BETA-BHC	0/11	---	0.004-0.0055	---	0	0.4	---	0.0001	0.32	3.5	0.026	0.00398
DIAZINON	0/11	---	0.0995-0.14	---	0	---	---	---	55	---	---	---
DELTA-BHC	0/11	---	0.006-0.0083	---	0	---	---	---	---	---	---	9.94
DIELDRIN	0/11	---	0.0013-0.0018	---	0	0.04	1	0.0002	0.030	0.27	0.046	0.00238
ENDOSULFAN I	0/11	---	0.00935-0.013	---	0	470[12]	---	0.9[12]	370	1100	20	0.11927
ENDOSULFAN II	0/11	---	0.0027-0.0037	---	0	470[12]	---	0.9[12]	---	---	---	0.11927
ENDOSULFAN SULFATE	0/11	---	0.044-0.061	---	0	---	---	---	---	---	---	0.03578
ENDRIN	2/11	0.00036-0.0016	0.004-0.0055	04/02-06-90 #1 (90)	0	23	---	0.05	18	54	0.99	0.0101
ENDRIN ALDEHYDE	0/11	---	0.015-0.021	---	0	---	---	---	---	---	---	0.0105
ETHION	0/11	---	0.026-0.036	---	0	---	---	---	31	---	---	---
ETHYL PARATHION	0/11	---	0.03-0.041	---	0	---	---	---	370	---	---	---
ETHYL TRITHION	0/11	---	0.032-0.044	---	0	---	---	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/11	---	0.0027-0.0037	---	0	0.5	---	0.0005	0.44	4.8	0.0094	0.005
GAMMA-CHLORDANE	0/11	---	0.0033-0.0046	---	0	0.5[10]	20[10]	0.5[10]	1.6	---	---	0.224[10]
HEPTACHLOR	4/11	0.00021-0.0028	0.002-0.0028	04/02-08-90 #1 (90)	0	0.1	0.1	1	0.11	0.56	0.56	0.00598
HEPTACHLOR EPOXIDE	0/11	---	0.055-0.076	---	0	0.07	5	0.03	0.053	0.46	0.46	0.15188
MALATHION	0/11	---	0.055-0.076	---	0	---	---	---	1200	---	---	---
METHOXYCHLOR	0/11	---	0.12-0.16	---	0	390	---	8	310	900	160	0.01988
METHYL PARATHION	0/11	---	0.06-0.082	---	0	---	---	---	15	---	---	0.000292
TOXAPHENE	0/11	---	0.16-0.22	---	0	0.6	89	2	0.44	3.9	3.9	0.11927
Energetics (mg/kg)												
2,4,6-TRINITROTOLUENE	0/11	---	0.25	---	0	---	---	---	16	---	---	---
2,4-DINITROTOLUENE	0/11	---	0.25	---	0	0.9	---	0.00004	120	---	---	1.28
1,3,5-TRINITROBENZENE	0/11	---	0.25	---	0	---	---	---	1800	---	---	---
1,3-DINITROBENZENE	0/11	---	0.25	---	0	---	---	---	6.1	---	---	0.6547
HMX	0/11	---	2.2	---	0	---	---	---	3100	---	---	---
RDX	0/11	---	1	---	0	---	---	---	4.4	---	---	---
TETRYL	0/11	---	0.65	---	0	---	---	---	610	---	---	---
Inorganics (mg/kg)												
ALUMINUM	11/11	11100-27800	---	04/02-02-90 #1 (90)	0	---	---	---	76000	---	---	---

TABLE 5-2

SUMMARY OF HISTORICAL DATA - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
PAGE 4 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
ANTIMONY	8/11	0.89-13.2	1.5	04/02-09-90 #1 (90)	8	31	---	0.3	31	138	5.4	0.1423
ARSENIC	11/11	6.13-9.27	---	04/02-05-90 #1 (90)	11	0.4	750	1	0.39	3.9	3.9	5.7
BARIUM	11/11	62.4-36500	---	04/02-02-90 #1 (90)	11	5500	690000	82	5400	24000	1600	1.04
BERYLLIUM	11/11	1.3-2.3	---	04/02-05-90 #1 (90)	11	0.1	1300	3	150	1.9	1.9	1.06
CADMIUM	8/11	0.65-3.3	0.4	04/02-10-90 #1 (90)	8	78	1800	0.4	37	12	7.5	0.00222
CALCIUM	11/11	618-4410	---	04/02-10-90 #1 (90)	0	---	---	---	---	---	---	---
CHROMIUM (TOTAL)	11/11	14.6-28.7	---	04/02-03-90 #1 (90)	11	390	270	2	210	470	38	0.4
COBALT	11/11	5.7-9.2	---	04/02-03-90 #1 (90)	11	---	---	---	4700	---	---	0.14033
COPPER	11/11	10.7-38.1	---	04/02-02-90 #1 (90)	11	---	---	---	2900	13000	580	0.3132
IRON	11/11	17400-31400	---	04/02-02-90 #1 (90)	5	---	---	---	23000	---	---	---
LEAD	11/11	12.1-75.6	---	04/02-02-90 #1 (90)	11	400[14]	---	---	400	350	81	0.05373
MAGNESIUM	11/11	937-15200	---	04/02-02-90 #1 (90)	0	---	---	---	---	---	---	---
MANGANESE	11/11	321-745	---	04/02-03-90 #1 (90)	0	---	---	---	1800	---	---	---
MERCURY	0/11	---	0.1	---	0	23	10	0.1	---	55	2.1	0.1
SELENIUM	1/11	0.31	0.3	04/02-05-90 #1 (90)	1	390	---	0.3	390	1700	5.2	0.02765
SILVER	0/11	---	0.1	---	0	390	---	2	390	1700	31	4.04
SODIUM	11/11	41-66.9	---	04/02-08-90 #1 (90)	0	---	---	---	---	---	---	---
THALLIUM	8/11	0.21-0.38	0.2	04/02-10-90 #1 (90)	8	---	---	0.04	---	31	2.9	0.05692
ZINC	11/11	42.7-152	---	04/02-02-90 #1 (90)	11	23000	---	620	23000	104000	10000	6.62
Miscellaneous Parameter (mg/kg)												
TOTAL PHOSPHORUS	11/11	50-91.1	---	04/02-10-90 #1 (90)	11	---	---	---	1.6	---	---	---

--- Not applicable/Not available.

BGS Below ground surface
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
OSWER Office of Solid Waste and Emergency Response
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SSL Soil Screening Level
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S.EPA, May 1996.
2 Because of karst geologic conditions present at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
3 U.S. EPA, Region 9, May 1998.
4 IDEM, October 1997.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 trans-1,2-Dichloroethene.
7 1,3-Dichloropropene.
8 o-Xylene.
9 m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Hexavalent chromium.
14 OSWER soil screening level for residential land use (U.S. EPA, July 1994).
15 Thallium carbonate.

TABLE 5-3

SUMMARY OF HISTORICAL DATA - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 4 - McCOMISH GORGE
NSEC CRANE, INDIANA
PAGE 1 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
Volatile Organics (mg/kg)												
1,1,1-TRICHLOROETHANE	0/9	---	0.0056-0.015	---	0	---	1200	0.1	770	2400	1.9	29.8
1,1,2,2-TETRACHLOROETHANE	0/9	---	0.0056-0.015	---	0	3	0.6	0.0002	0.38	5.4	0.007	0.12722
1,1,2-TRICHLOROETHANE	0/9	---	0.0056-0.015	---	0	11	1	0.0009	0.84	10	0.03	28.6
1,1-DICHLOROETHANE	0/9	---	0.0056-0.015	---	0	7800	1300	1	590	1400	5.6	20.1
1,1-DICHLOROETHENE	0/9	---	0.0056-0.015	---	0	1	0.07	0.003	0.054	0.73	0.058	8.28
1,2-DICHLOROETHANE	0/9	---	0.0056-0.015	---	0	7	0.4	0.001	0.35	4	0.024	21.2
1,2-DICHLOROPROPANE	0/9	---	0.0056-0.015	---	0	9	15	0.001	0.35	5	0.03	32.7
2-BUTANONE	0/9	---	0.11-0.3	---	0	---	---	---	7300	20000	10	89.6
2-HEXANONE	0/9	---	0.056-0.15	---	0	---	---	---	---	---	---	12.6
4-METHYL-2-PENTANONE	0/9	---	0.056-0.15	---	0	---	---	---	790	---	---	443
ACETONE	9/9	0.01-1.7	---	04/02-01-90 #2 (90)	1	7800	100000	0.8	1600	4200	3.1	2.5
BENZENE	0/9	---	0.0056-0.015	---	0	22	0.8	0.002	0.67	9	0.34	0.25462
BROMODICHLOROMETHANE	0/9	---	0.0056-0.015	---	0	10	3000	0.03	1.0	11	0.63	0.53978
BROMOFORM	0/9	---	0.0056-0.015	---	0	81	53	0.04	62	290	0.75	15.9
BROMOMETHANE	0/9	---	0.011-0.03	---	0	110	10	0.01	3.9	11	0.052	0.23516
CARBON DISULFIDE	0/9	---	0.0056-0.015	---	0	7800	720	2	360	990	10	0.09412
CARBON TETRACHLORIDE	0/9	---	0.0056-0.015	---	0	5	0.3	0.003	0.24	3.6	0.066	2.98
CHLOROBENZENE	0/9	---	0.0056-0.015	---	0	1600	130	0.07	1.0	150	1.3	13.1
CHLOROETHANE	0/9	---	0.011-0.03	---	0	---	---	---	3.0	---	---	---
CHLOROFORM	0/9	---	0.0056-0.015	---	0	100	0.3	0.03	0.24	3.3	0.59	1.19
CHLOROMETHANE	0/9	---	0.011-0.03	---	0	---	---	---	1.2	---	---	10.4
CIS-1,2-DICHLOROETHENE	0/9	---	0.0056-0.015	---	0	780	1200	0.02	43	119	0.4	0.78373[6]
CIS-1,3-DICHLOROPROPENE	0/9	---	0.0056-0.015	---	0	4	0.1	0.0002	---	---	---	0.39786
DIBROMOCHLOROMETHANE	0/9	---	0.0056-0.015	---	0	8	1300	0.02	1.1	---	---	2.05
ETHYLBENZENE	0/9	---	0.0056-0.015	---	0	7800	400	0.7	230	5000	13	5.16
METHYLENE CHLORIDE	9/9	0.038-0.118	---	04/02-07-90 #2 (90)-AVG	9	85	13	0.001	8.9	120	0.023	4.05
STYRENE	0/9	---	0.0056-0.015	---	0	16000	1500	0.2	1.0	12000	3.5	4.69
TETRACHLOROETHENE	0/9	---	0.0056-0.015	---	0	12	11	0.003	5.7	50	0.058	9.92
TOLUENE	0/9	---	0.0056-0.015	---	0	16000	650	0.6	520	1800	12	5.45
TRANS-1,2-DICHLOROETHENE	0/9	---	0.0056-0.015	---	0	1600	3100	0.03	63	190	0.68	0.78373
TRANS-1,3-DICHLOROPROPENE	0/9	---	0.0056-0.015	---	0	4	0.1	0.0002	---	---	---	0.39786
TRICHLOROETHENE	0/9	---	0.0056-0.015	---	0	58	5	0.003	2.8	48	0.057	12.4
VINYL ACETATE	0/9	---	0.056-0.15	---	0	78000	1000	8	430	1200	2.3	12.7
VINYL CHLORIDE	0/9	---	0.011-0.03	---	0	0.3	0.03	0.0007	0.022	0.31	0.013	0.64614
XYLENES, TOTAL	0/9	---	0.0056-0.015	---	0	160000	410[6]	9[6]	210	5300	190	10
Semivolatile Organics (mg/kg)												
1,2,4-TRICHLOROBENZENE	0/9	---	0.68-7.5	---	0	780	3200	0.3	6.0	1800	5.3	11.1
1,2-DICHLOROBENZENE	0/9	---	0.68-7.5	---	0	7000	560	0.9	370	3000	17	2.96
1,2-DIPHENYLHYDRAZINE	0/9	---	0.68-7.5	---	0	---	---	---	0.61	---	---	---
1,3-DICHLOROBENZENE	0/9	---	0.68-7.5	---	0	---	---	---	13	114	0.42	37.7
1,4-DICHLOROBENZENE	0/9	---	0.68-7.5	---	0	27	---	0.1	3.0	42	2.2	0.54559
2,4,5-TRICHLOROPHENOL	0/9	---	0.68-7.5	---	0	7800	---	14	6100	18000	250	14.1
2,4,6-TRICHLOROPHENOL	0/9	---	0.68-7.5	---	0	58	200	0.008	44	390	1.5	9.94
2,4-DICHLOROPHENOL	0/9	---	0.68-7.5	---	0	230	---	0.05	1.0	550	1.1	87.5
2,4-DIMETHYLPHENOL	0/9	---	0.68-7.5	---	0	1600	---	0.4	1.0	3600	9	0.01
2,4-DINITROPHENOL	0/9	---	3.4-38	---	0	160	---	0.01	120	360	0.29	0.06086
2,6-DINITROTOLUENE	1/9	4.4	0.68-6.6	04/02-1A-90 #2 (90)	1	0.9	---	0.00003	61	---	---	0.03283
2-CHLORONAPHTHALENE	0/9	---	0.68-7.5	---	0	---	---	---	4900	---	---	0.01218
2-CHLOROPHENOL	0/9	---	0.68-7.5	---	0	390	53000	0.2	6.0	380	0.75	0.24266
2-METHYL-4,6-DINITROPHENOL	0/9	---	3.4-38	---	0	---	---	---	---	---	---	---

TABLE 5-3

SUMMARY OF HISTORICAL DATA - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 4 - McCOMISH GORGE
NSEC CRANE, INDIANA
PAGE 2 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
2-METHYLNAPHTHALENE	0/9	---	0.68-7.5	---	0	---	---	---	---	---	---	3.24
2-METHYLPHENOL	0/9	---	0.68-7.5	---	0	3900	---	0.8	3100	7600	14	40.4
2-NITROANILINE	0/9	---	3.4-38	---	0	---	---	---	3.5	---	---	74.1
2-NITROPHENOL	0/9	---	0.68-7.5	---	0	---	---	---	---	---	---	1.6
3,3'-DICHLOROBENZIDINE	0/9	---	1.4-15	---	0	1	---	0.0003	1.1	9.5	0.062	0.64636
3-NITROANILINE	0/9	---	3.4-38	---	0	---	---	---	---	---	---	3.16
4-BROMOPHENYL PHENYL ETHER	0/9	---	0.68-7.5	---	0	---	---	---	---	---	---	---
4-CHLORO-3-METHYLPHENOL	0/9	---	1.4-15	---	0	---	---	---	---	---	---	7.95
4-CHLOROANILINE	0/9	---	1.4-15	---	0	310	---	0.03	240	730	0.97	1.1
4-CHLOROPHENYL PHENYL ETHER	0/9	---	0.68-7.5	---	0	---	---	---	---	---	---	---
4-METHYLPHENOL	0/9	---	0.68-7.5	---	0	---	---	---	310	---	---	163
4-NITROANILINE	0/9	---	3.4-38	---	0	---	---	---	---	---	---	21.9
4-NITROPHENOL	0/9	---	3.4-38	---	0	---	---	---	490	---	---	5.12
ACENAPHTHENE	0/9	---	0.68-7.5	---	0	4700	---	29	3700	9500	130	682
ACENAPHTHYLENE	0/9	---	0.68-7.5	---	0	---	---	---	---	---	---	682
ANILINE	0/9	---	1.4-15	---	0	---	---	---	85	---	---	0.05678
ANTHRACENE	0/9	---	0.68-7.5	---	0	23000	---	590	22000	47000	51	1480
BENZIDINE	0/9	---	3.4-38	---	0	---	---	---	0.0021	---	---	---
BENZO(A)ANTHRACENE	0/9	---	0.68-7.5	---	0	0.9	---	0.08	0.62	5	5	5.21
BENZO(A)PYRENE	0/9	---	0.68-7.5	---	0	0.09	---	0.4	0.062	0.5	0.5	1.52
BENZO(B)FLUORANTHENE	0/9	---	0.68-7.5	---	0	0.9	---	0.2	0.62	5	5	59.8
BENZO(G,H,I)PERYLENE	0/9	---	0.68-7.5	---	0	---	---	---	---	---	---	119
BENZO(K)FLUORANTHENE	0/9	---	0.68-7.5	---	0	9	---	2	6.2	50	39	1480
BENZOIC ACID	0/9	---	3.4-38	---	0	310000	---	20	100000	730000	590	---
BENZYL ALCOHOL	0/9	---	1.4-15	---	0	---	---	---	18000	---	---	65.8
BIS(2-CHLOROETHOXY)METHANE	0/9	---	0.68-7.5	---	0	---	---	---	---	---	---	0.30209
BIS(2-CHLOROETHYL)ETHER	0/9	---	0.68-7.5	---	0	0.6	0.2	0.00002	0.21	1.6	0.0007	23.7
BIS(2-CHLOROISOPROPYL) ETHER	0/9	---	0.68-7.5	---	0	---	---	---	6.9	31	0.027	---
BIS(2-ETHYLHEXYL)PHTHALATE	6/9	0.034-0.84	0.74-7.5	04/02-07-90 #2 (90)-AVG	0	46	31000	180	35	300	300	0.92594
BUTYLBENZYL PHTHALATE	0/9	---	0.68-7.5	---	0	16000	930	810	12000	36000	930	0.23889
CHRYSENE	0/9	---	0.68-7.5	---	0	88	---	8	62	500	26	4.73
DI-N-BUTYL PHTHALATE	6/9	0.034-30	0.68-0.74	04/02-1A-90 #2 (90)	3	7800	2300	270	6100	18000	2300	0.14979
DI-N-OCTYL PHTHALATE	4/9	0.027-0.054	0.74-7.5	04/02-09-90 #2 (90)	0	1600	10000	10000	1200	3700	2000	709
DIBENZO(A,H)ANTHRACENE	0/9	---	0.68-7.5	---	0	0.09	---	0.08	0.062	0.5	0.5	18.4
DIBENZOFURAN	0/9	---	0.68-7.5	---	0	---	---	---	290	---	---	---
DIETHYL PHTHALATE	4/9	0.041-0.054	0.74-7.5	04/02-03-90 #2 (90)	0	63000	2000	23	49000	150000	450	24.8
DIMETHYL PHTHALATE	0/9	---	0.68-7.5	---	0	---	---	---	100000	---	---	734
FLUORANTHENE	0/9	---	0.68-7.5	---	0	3100	---	210	2300	6300	880	122
FLUORENE	0/9	---	0.68-7.5	---	0	3100	---	28	2600	6300	170	122
HEXACHLOROBENZENE	0/9	---	0.68-7.5	---	0	0.4	1	0.1	3.0	2.7	2.2	0.19678
HEXACHLOROBUTADIENE	0/9	---	0.68-7.5	---	0	8	8	0.1	6.0	36	16	0.03976
HEXACHLOROCYCLOPENTADIENE	0/9	---	0.68-7.5	---	0	550	10	20	420	1300	400	0.75537
HEXACHLOROETHANE	0/9	---	0.68-7.5	---	0	46	55	0.02	35	183	2.8	0.59634
INDENO(1,2,3-CD)PYRENE	0/9	---	0.68-7.5	---	0	0.9	---	0.7	0.62	5	3	109
ISOPHORONE	0/9	---	0.68-7.5	---	0	670	4600	0.03	510	4500	5.3	139
N-NITROSO-DI-N-PROPYLAMINE	0/9	---	0.68-7.5	---	0	0.09	---	0.000002	0.069	0.61	0.0006	0.54368
N-NITROSODIMETHYLAMINE	0/9	---	0.68-7.5	---	0	---	---	---	0.0095	---	---	0.0000321
N-NITROSODIPHENYLAMINE	1/9	3.6	0.68-6.6	04/02-1A-90 #2 (90)	1	130	---	0.06	9.0	810	9.7	0.54514
NAPHTHALENE	0/9	---	0.68-7.5	---	0	3100	---	4	56	3200	0.7	0.09939
NITROBENZENE	0/9	---	0.68-7.5	---	0	39	92	0.007	20	91	0.028	1.31
PENTACHLOROPHENOL	0/9	---	3.4-38	---	0	3	---	0.001	3.0	20	0.028	0.11927
PHENANTHRENE	0/9	---	0.68-7.5	---	0	---	---	---	---	---	---	45.7

TABLE 5-3

SUMMARY OF HISTORICAL DATA - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 4 - McCOMISH GORGE
NSEC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
PHENOL	0/9	---	0.68-7.5	---	0	47000	---	5	37000	89000	110	120
PYRENE	0/9	---	0.68-7.5	---	0	2300	---	210	2300	5500	570	78.5
Pesticides/PCBs/Herbicides (mg/kg)												
2,4,5-T	0/9	---	0.072-0.73	---	0	---	---	---	610	---	---	0.59634
2,4,5-TP (SILVEX)	0/8	---	0.062-0.068	---	0	---	---	---	490	---	---	0.1088
2,4-D	1/9	0.018137848	0.44-0.48	04/02-06-90 #2 (90)	0	---	---	---	690	---	---	0.02725
4,4'-DDD	1/9	0.0031	0.0032-0.0084	04/02-01-90 #2 (90)	0	3	---	0.8	2.4	28	28	0.75815
4,4'-DDE	0/9	---	0.0027-0.0032	---	0	2	---	3	1.7	20	20	0.59587
4,4'-DDT	0/9	---	0.008-0.0095	---	0	2	---	2	1.7	20	20	0.0175
ALDRIN	0/9	---	0.0027-0.0032	---	0	0.04	3	0.02	0.029	0.25	0.25	0.00332
ALPHA-BHC	0/9	---	0.002-0.0024	---	0	0.1	0.8	0.00003	0.090	0.99	0.0072	0.09939
ALPHA-CHLORDANE	3/9	0.00017-0.00043	0.0033-0.004	04/02-03-90 #2 (90)	0	0.5[10]	20[10]	0.5[10]	---	---	---	0.224[10]
AROCLOR-1016	0/9	---	0.043-0.052	---	0	1[11]	---	---	3.9	---	---	0.000322[11]
AROCLOR-1221	0/9	---	0.043-0.052	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1232	0/9	---	0.043-0.052	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1242	0/9	---	0.043-0.052	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1248	0/9	---	0.043-0.052	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1254	0/9	---	0.087-0.1	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
AROCLOR-1260	0/9	---	0.087-0.1	---	0	1[11]	---	---	0.22	---	---	0.000322[11]
BETA-BHC	0/9	---	0.004-0.0048	---	0	0.4	---	0.0001	0.32	3.5	0.026	0.00398
DIAZINON	1/9	0.016	0.0995-0.12	04/02-05-90 #2 (90)	0	---	---	---	55	---	---	---
DELTA-BHC	0/9	---	0.006-0.0071	---	0	---	---	---	---	---	---	9.94
DIELDRIN	0/9	---	0.0013-0.0016	---	0	0.04	1	0.0002	0.030	0.27	0.046	0.00238
ENDOSULFAN I	0/9	---	0.0011-0.011	---	0	470[12]	---	0.9[12]	370	1100	20	0.11927
ENDOSULFAN II	0/9	---	0.0027-0.0032	---	0	470[12]	---	0.9[12]	---	---	---	0.11927
ENDOSULFAN SULFATE	0/9	---	0.044-0.052	---	0	---	---	---	---	---	---	0.03578
ENDRIN	0/9	---	0.004-0.0048	---	0	23	---	0.05	18	54	0.99	0.0101
ENDRIN ALDEHYDE	0/9	---	0.015-0.018	---	0	---	---	---	---	---	---	0.0105
ETHION	0/9	---	0.026-0.031	---	0	---	---	---	31	---	---	---
ETHYL PARATHION	0/9	---	0.03-0.036	---	0	---	---	---	370	---	---	---
ETHYL TRITHION	0/9	---	0.032-0.038	---	0	---	---	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/9	---	0.0027-0.0032	---	0	0.5	---	0.0005	0.44	4.8	0.0094	0.005
GAMMA-CHLORDANE	0/9	---	0.0033-0.004	---	0	0.5[10]	20[10]	0.5[10]	1.6	---	---	0.224[10]
HEPTACHLOR	3/9	0.00017-0.00024	0.002-0.0023	04/02-03-90 #2 (90)	0	0.1	0.1	1	0.11	0.56	0.56	0.00598
HEPTACHLOR EPOXIDE	0/9	---	0.055-0.066	---	0	0.07	5	0.03	0.053	0.46	0.46	0.15188
MALATHION	0/9	---	0.055-0.065	---	0	---	---	---	1200	---	---	---
METHOXYCHLOR	0/9	---	0.12-0.14	---	0	390	---	8	310	900	160	0.01988
METHYL PARATHION	0/9	---	0.06-0.071	---	0	---	---	---	15	---	---	0.000292
TOXAPHENE	0/9	---	0.16-0.19	---	0	0.6	89	2	0.44	3.9	3.9	0.11927
Energetics (mg/kg)												
1,3,5-TRINITROBENZENE	0/9	---	0.25	---	0	---	---	---	16	---	---	---
1,3-DINITROBENZENE	0/9	---	0.25	---	0	---	---	---	120	---	---	0.6547
2,4,6-TRINITROTOLUENE	0/9	---	0.25	---	0	---	---	---	1800	---	---	---
2,4-DINITROTOLUENE	1/9	0.178	0.25	04/02-1A-90 #2 (90)	1	0.9	---	0.00004	6.1	---	---	1.28
HMX	0/9	---	2.2	---	0	---	---	---	3100	---	---	---
RDX	0/9	---	1	---	0	---	---	---	4.4	---	---	---
TETRYL	0/9	---	0.65	---	0	---	---	---	610	---	---	---
Inorganics (mg/kg)												
ALUMINUM	9/9	6650-25900	---	04/02-06-90 #2 (90)	0	---	---	---	76000	---	---	---
ANTIMONY	6/9	1-4.1	1.5	04/02-09-90 #2 (90)	6	31	---	0.3	31	138	5.4	0.1423
ARSENIC	9/9	5.22-23.7	---	04/02-03-90 #2 (90)	9	0.4	750	1	0.39	3.9	3.9	5.7

TABLE 5-3

SUMMARY OF HISTORICAL DATA - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 4 - McCOMISH GORGE
NSEC CRANE, INDIANA
PAGE 4 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
BARIUM	9/9	34.6-8640	---	04/02-02-90 #2 (90)	9	5500	690000	82	5400	24000	1600	1.04
BERYLLIUM	9/9	0.799-2.5	---	04/02-06-90 #2 (90)	9	0.1	1300	3	150	1.9	1.9	1.06
CADMIUM	4/9	0.799-5.8	0.4-0.7	04/02-1A-90 #2 (90)	4	78	1800	0.4	37	12	7.5	0.00222
CALCIUM	9/9	317-49700	---	04/02-1A-90 #2 (90)	0	---	---	---	---	---	---	---
CHROMIUM (TOTAL)	9/9	12-54.1	---	04/02-05-90 #2 (90)	9	390	270	2	210	470	38	0.4
COBALT	9/9	2.1-16.6	---	04/02-03-90 #2 (90)	9	---	---	---	4700	---	---	0.14033
COPPER	9/9	6.39-45.4	---	04/02-1A-90 #2 (90)	9	---	---	---	2900	13000	580	0.3132
IRON	9/9	6300-38000	---	04/02-03-90 #2 (90)	6	---	---	---	23000	---	---	---
LEAD	9/9	8.29-133	---	04/02-1A-90 #2 (90)	9	400[14]	---	---	400	350	81	0.05373
MAGNESIUM	9/9	640-12500	---	04/02-1A-90 #2 (90)	0	---	---	---	---	---	---	---
MANGANESE	9/9	68.8-537	---	04/02-06-90 #2 (90)	0	---	---	---	1800	---	---	---
MERCURY	0/9	---	0.1	---	0	23	10	0.1	---	55	2.1	0.1
SELENIUM	1/9	0.33	0.3	04/02-05-90 #2 (90)	1	390	---	0.3	390	1700	5.2	0.02765
SILVER	0/9	---	0.1	---	0	390	---	2	390	1700	31	4.04
SODIUM	9/9	44.7-82.7	---	04/02-06-90 #2 (90)	0	---	---	---	---	---	---	---
THALLIUM	5/9	0.15-0.32	0.2	04/02-04-90 #2 (90)	5	---	---	0.04	---	31	2.9	0.05692
ZINC	9/9	18.1-1150	---	04/02-1A-90 #2 (90)	9	23000	---	620	23000	104000	10000	6.62
Miscellaneous Parameters (mg/kg)												
TOTAL PHOSPHORUS	9/9	42.2-178	---	04/02-03-90 #2 (90)	9	---	---	---	1.6	---	---	---

--- Not applicable/Not available.

BGS Below ground surface
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
OSWER Office of Solid Waste and Emergency Response
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SSL Soil Screening Level
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, May 1996.
2 Because of karst geologic conditions present at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
3 U.S. EPA, Region 9, May 1998.
4 IDEM, October 1997.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 trans-1,2-Dichloroethene.
7 1,3-Dichloropropene.
8 o-Xylene.
9 m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Hexavalent chromium.
14 OSWER soil screening level for residential land use (U.S. EPA, July 1994).
15 Thallium carbonate.

TABLE 5-4

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUND WATER, UNCONSOLIDATED AQUIFERS
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
PAGE 1 OF 5

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/5	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/5	---	5	---	0	---	0.055	0.9	---	13
1,1,2-TRICHLOROETHANE	0/5	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/5	---	5	---	0	---	810	990	---	47
1,1-DICHLOROETHENE	0/5	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/5	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/5	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/5	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/5	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/5	---	50	---	0	---	160	---	---	3680
ACETONE	5/5	4-11	---	04-02 (92) (07/14/92)	0	---	610	770	---	78000
BENZENE	1/5	2	5	04-04 (92) (07/14/92)	1	5	0.41	5	---	114
BROMODICHLOROMETHANE	0/5	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/5	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/5	---	10	---	0	---	8.7	11	---	---
CARBON DISULFIDE	0/5	---	5	---	0	---	1000	1300	---	84.1
CARBON TETRACHLORIDE	0/5	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/5	---	5	---	0	100	110	100	20[7]	10
CHLOROETHANE	0/5	---	10	---	0	---	4.6	---	---	230000
CHLOROFORM	0/5	---	5	---	0	80[6]	0.16	100	---	79
CHLOROMETHANE	0/5	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/5	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	1/5	1	5	04-06 (92) (07/14/92)	1	---	0.081(8)	---	---	7.9
DIBROMOCHLOROMETHANE	0/5	---	5	---	0	80[6]	0.13	---	---	6400
ETHYLBENZENE	0/5	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	5/5	3-4	---	04-01 (92) (07/14/92)	0	5	4.3	5	---	430
STYRENE	0/5	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/5	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	0/5	---	5	---	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/5	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	1/5	2	5	04-06 (92) (07/14/92)	1	---	0.081(8)	---	---	7.9
TRICHLOROETHENE	0/5	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/5	---	50	---	0	---	410	550	---	248.03
VINYL CHLORIDE	0/5	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	0/5	---	5	---	0	10000	1400(9)	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/5	---	10-15	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/5	---	10-15	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/5	---	10-15	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/5	---	10-15	---	0	600	5.5	22	---	87
1,4-DICHLOROBENZENE	0/5	---	10-15	---	0	75	0.50	75	---	43
2,4,5-TRICHLOROPHENOL	0/5	---	10-15	---	0	---	3600	3600	---	---
2,4,6-TRICHLOROPHENOL	0/5	---	10-15	---	0	---	6.1	77	1[7]	2
2,4-DICHLOROPHENOL	0/5	---	10-15	---	0	---	110	110	2[7]	18
2,4-DIMETHYLPHENOL	0/5	---	10-15	---	0	---	730	730	0.3[7]	100.17

TABLE 5-4

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUND WATER, UNCONSOLIDATED AQUIFERS
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
2,4-DINITROPHENOL	0/5	---	50-74	---	0	---	73	73	400[7]	4.07
2,4-DINITROTOLUENE	0/5	---	10-15	---	0	---	73	---	---	230
2,6-DINITROTOLUENE	0/5	---	10-15	---	0	---	37	---	---	42
2-CHLORONAPHTHALENE	0/5	---	10-15	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/5	---	10-15	---	0	---	30	38	---	8.8
2-METHYL-4,6-DINITROPHENOL	0/5	---	50-74	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/5	---	10-15	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/5	---	10-15	---	0	---	1800	1800	---	---
2-NITROANILINE	0/5	---	50-74	---	0	---	2.1	---	---	---
2-NITROPHENOL	0/5	---	10-15	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/5	---	20-30	---	0	---	0.15	1.9	---	99.75
3-NITROANILINE	0/5	---	50-74	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/5	---	10-15	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/5	---	20-30	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/5	---	20-30	---	0	---	150	150	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/5	---	10-15	---	0	---	---	---	---	---
4-METHYLPHENOL	0/5	---	10-15	---	0	---	180	---	---	---
4-NITROANILINE	0/5	---	50-74	---	0	---	---	---	---	---
4-NITROPHENOL	0/5	---	50-74	---	0	---	290	---	---	35
ACENAPHTHENE	0/5	---	10-15	---	0	---	370	460	---	9.9
ACENAPHTHYLENE	0/5	---	10-15	---	0	---	---	---	---	4840
ANILINE	0/5	---	20-30	---	0	---	12	---	---	0.44
ANTHRACENE	0/5	---	10-15	---	0	---	1800	43	---	0.029
BENZIDINE	0/5	---	50-74	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/5	---	10-15	---	0	---	0.092	1.2	---	0.839
BENZO(A)PYRENE	0/5	---	10-15	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/5	---	10-15	---	0	---	0.092	1.2	---	9.07
BENZO(G,H,I)PERYLENE	0/5	---	10-15	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/5	---	10-15	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/5	---	50-74	---	0	---	150000	150000	---	---
BENZYL ALCOHOL	0/5	---	20-30	---	0	---	11000	---	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/5	---	10-15	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/5	---	10-15	---	0	---	0.0098	0.15	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/5	---	10-15	---	0	---	0.96	4.2	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	2/5	11-63	10-14	04-01 (92) (07/14/92)	2	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/5	---	10-15	---	0	---	7300	2700	---	49
CHRYSENE	0/5	---	10-15	---	0	---	9.2	1.6	---	0.033
DI-N-BUTYL PHTHALATE	0/5	---	10-15	---	0	---	3600	3600	---	3
DI-N-OCTYL PHTHALATE	0/5	---	10-15	---	0	---	730	20	---	30
DIBENZO(A,H)ANTHRACENE	0/5	---	10-15	---	0	---	0.0092	0.12	---	0.0016
DIBENZOFURAN	0/5	---	10-15	---	0	---	24	---	---	20
DIETHYL PHTHALATE	0/5	---	10-15	---	0	---	29000	29000	---	3
DIMETHYL PHTHALATE	0/5	---	10-15	---	0	---	360000	---	---	73
FLUORANTHENE	0/5	---	10-15	---	0	---	1500	210	---	8.1
FLUORENE	0/5	---	10-15	---	0	---	240	310	---	3.9
HEXACHLOROBENZENE	0/5	---	10-15	---	0	1	0.042	1	---	0.00024

TABLE 5-4

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUND WATER, UNCONSOLIDATED AQUIFERS
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
HEXACHLOROBUTADIENE	0/5	---	10-15	---	0	---	0.86	7.3	1[7]	0.134
HEXACHLOROCYCLOPENTADIENE	0/5	---	10-15	---	0	50	260	50	---	77.04
HEXACHLOROETHANE	0/5	---	10-15	---	0	---	4.8	36	---	30.5
INDENO(1,2,3-CD)PYRENE	0/5	---	10-15	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/5	---	10-15	---	0	---	71	900	---	900
N-NITROSO-DI-N-PROPYLAMINE	0/5	---	10-15	---	0	---	0.0096	0.12	---	---
N-NITROSODIMETHYLAMINE	0/5	---	10-15	---	0	---	0.0013	---	---	---
N-NITROSODIPHENYLAMINE	0/5	---	10-15	---	0	---	14	170	---	13
NAPHTHALENE	0/5	---	10-15	---	0	---	6.2	8.3	---	44
NITROBENZENE	0/5	---	10-15	---	0	---	3.4	4.3	30[7]	740
PENTACHLOROPHENOL	0/5	---	50-74	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/5	---	10-15	---	0	---	---	---	---	2.1
PHENOL	0/5	---	10-15	---	0	---	22000	22000	300[7]	100
PYRENE	0/5	---	10-15	---	0	---	180	140	---	0.3
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-TP (SILVEX)	0/23	---	0.5	---	0	50	290	---	---	326.64
2,4-D	0/23	---	3.8	---	0	70	360	---	---	---
4,4'-DDD	0/2	---	0.11	---	0	---	0.28	3.6	---	0.0011
4,4'-DDE	0/2	---	0.04	---	0	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/2	---	0.12	---	0	---	0.2	2.5	0.001	0.001
ALDRIN	0/2	---	0.04	---	0	---	0.004	0.05	---	0.0185
ALPHA-BHC	0/2	---	0.03	---	0	---	0.011	0.14	---	12.38
ALPHA-CHLORDANE	2/2	0.05	---	04-04 (92) (07/14/92)	2	2[10]	0.19(10)	0.0043(10)	0.0043[10]	0.00029[10]
AROCLOR-1016	0/2	---	0.62-0.66	---	0	0.5[11]	0.96	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1221	0/2	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1232	0/2	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1242	0/2	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1248	0/2	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1254	2/2	0.41-0.49	---	04-04 (92) (07/14/92)	2	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1260	0/2	---	1.3	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
BETA-BHC	0/2	---	0.06	---	0	---	0.037	0.47	---	0.495
DELTA-BHC	0/2	---	0.09	---	0	---	---	---	---	666.67
DIELDRIN	0/2	---	0.02	---	0	---	0.0042	0.053	0.056	0.000026
DISULFOTON	0/2	---	0.67-0.71	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/2	---	0.13-0.14	---	0	---	220	220	0.056	0.003
ENDOSULFAN II	0/2	---	0.04	---	0	---	220(12)	220(12)	0.056	0.003
ENDOSULFAN SULFATE	1/2	0.07	0.63	04-04 (92) (07/14/92)	0	---	---	---	---	2.22
ENDRIN	0/25	---	0.04-0.06	---	0	2	11	2	0.036	0.002
ENDRIN ALDEHYDE	0/2	---	0.22-0.23	---	0	---	---	---	---	0.15
ETHYL PARATHION	0/2	---	0.58-0.61	---	0	---	---	---	---	---
FAMPHUR	0/2	---	1.2	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	1/25	0.19	0.04-0.08	04-03 (81) (12/07/81)	1	0.2	0.052	0.2	---	0.01
GAMMA-CHLORDANE	0/2	---	0.05	---	0	2[10]	0.19(10)	---	0.0043[10]	0.00029[10]
HEPTACHLOR	2/2	0.04-0.24	---	04-04 (92) (07/14/92)	2	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/2	---	0.8-0.84	---	0	0.2	0.0074	0.2	0.0038	0.00048

TABLE 5-4

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUND WATER, UNCONSOLIDATED AQUIFERS
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
KEPONE	0/2	---	5.8-6.1	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/25	---	1.6-1.8	---	0	40	180	40	0.03	0.005
METHYL PARATHION	0/2	---	1.2	---	0	---	9.1	---	---	---
PHORATE	0/2	---	0.38-0.4	---	0	---	7.3	---	---	3.62
TOXAPHENE	1/25	1.6	1.6-2.4	04-01 (82a) (03/23/82)	1	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	0/3	---	30	---	0	50 to 200[7,13]	36000	---	87	---
ANTIMONY	0/3	---	3	---	0	6	15	6	---	31
ARSENIC	1/26	10	2-10	04-01 (81) (12/07/81)	1	50	0.045	50	150	53
BARIUM	5/26	100-279	20-100	04-04 (92) (07/14/92)	5	2000	2600	2000	---	5000
BERYLLIUM	0/3	---	1	---	0	4	73	4	---	7.6
CADMIUM	1/26	0.24	0.2-5	---	0	5	18	5	2.2	0.66
CALCIUM	3/3	65600-101000	---	---	0	---	---	---	---	---
CHROMIUM (TOTAL)	3/26	10-100	5-10	04-05 (82d) (10/05/82)	2	100	180(14)	100	11[14]	42
COBALT	1/3	72	20	04-04 (92) (07/14/92)	1	---	2200	---	---	5
COPPER	0/3	---	5	---	0	1300[15]	1400	1300	9	5
CYANIDE	0/5	---	5	---	0	200	730(16)	---	5.2[16]	5.2[16]
IRON	43/54	20-32300	10-40	04-05(82d) (10/05/82)	35	300[7,13]	11000	---	---	---
LEAD	1/26	8.2	1-10	04-04 (92) (07/14/92)	1	15[15]	4	15	2.5	1.3
MAGNESIUM	3/3	17400-30700	---	04-04 (92) (07/14/92)	0	---	---	---	---	---
MANGANESE	48/55	10-12800	5-1090	04-04 (92) (07/14/92)	43	50[7,13]	880	---	---	---
MERCURY	5/26	0.5-77	0.2	04-01 (82d) (10/05/82)	5	2	11	2	0.77	0.0013
NICKEL	0/3	---	5	---	0	100	730	100	52	29
POTASSIUM	3/3	400-8790	---	04-04 (92) (07/14/92)	0	---	---	---	---	---
SELENIUM	0/26	---	2-5	---	0	50	180	50	5	5
SILVER	2/26	10-20	1-10	04-03 (82b) (06/22/82)	2	100[7,13]	180	180	---	1
SODIUM	42/43	2300-37000	0	04-01 (82a) (03/23/82)	0	---	---	---	---	---
THALLIUM	0/3	---	2	---	0	2	2.9(17)	2	---	0.56
TIN	0/3	---	50	---	0	---	22000	---	---	73
VANADIUM	1/3	11	10	04-04 (92) (07/14/92)	0	---	260	---	---	19
ZINC	3/3	17-27	---	04-04 (92) (07/14/92)	0	5000[7,13]	11000	11000	120	58.9
Radionuclides (pCi/L)										
GROSS ALPHA	2/23	1.96-2.98	1.3-5.08	04-05(82d) (10/05/82)	0	15	---	---	---	---
GROSS BETA	17/23	1.15-3.55	1.3-1.64	04-04 (81) (12/07/81)	0	---	---	---	---	---
Miscellaneous Parameters (ug/L, unless otherwise noted)										
CHLORIDE	28/40	1000-13000	0-1000	04-05 (82b) (06/22/82), 04-06 (82b) (06/22/82)	28	250000[7,13]	---	---	230	---
FLUORIDE	19/23	100-150	100	04-01 (82b) (06/22/82)	0	4000	2200	---	---	---
NITRATE, AS NITROGEN	3/5	20-68	20	04-02 (92) (07/14/92)	0	10000	10000	---	---	---
NITRATE/NITRITE	18/23	60-1100	50	04-02 (81) (12/07/81)	0	10000	1000(18)	---	---	---
NITRITE, AS NITROGEN	1/5	9	5	04-04 (92) (07/14/92)	0	1000	1000	---	---	---
ORGANIC BROMINE	2/12	4-11	2-10	04-03 (84) (02/04/84)	0	---	---	---	---	---
ORGANIC CHLORINE	6/12	10-40	10	04-01 (84) (02/04/84)	0	---	---	---	---	---
ORGANIC IODINE	7/12	3-14	2-10	04-05 (84) (02/04/84)	0	---	---	---	---	---
pH (standard units)	62/62	5.7-8.1	---	04-02 (85b) (06/18/85)	0	---	---	---	6.5 - 9	---
PHENOLS	9/40	4-100	4-50	04-01 (82b) (06/22/82)	0	---	---	---	---	---

TABLE 5-4

SUMMARY OF HISTORICAL ANALYTICAL RESULTS - GROUND WATER, UNCONSOLIDATED AQUIFERS
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA
PAGE 5 OF 5

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
SPECIFIC CONDUCTIVITY (umho/cm)	55/55	250-880	---	04-04 (81) (12/07/81)	0	---	---	---	---	---
SULFATE	36/39	2000-220000	5000	04-01 (85a) (01/09/85)	0	500000	---	---	---	---
SULFIDE	3/5	21-29	20	04-02 (92) (07/14/92)	36	2	---	---	2	---
TOTAL COLIFORM (phm)	1/6	45	0-1	04-05 (81) (12/07/81)	0	---	---	---	---	---
TOTAL ORGANIC CARBON	52/57	600-88000	1000	04-05 (82b) (06/22/82)	0	---	---	---	---	---
TOTAL ORGANIC HALOGENS	26/45	5.6-112	5-10	04-04 (81) (12/07/81)	0	---	---	---	---	---

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable by not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

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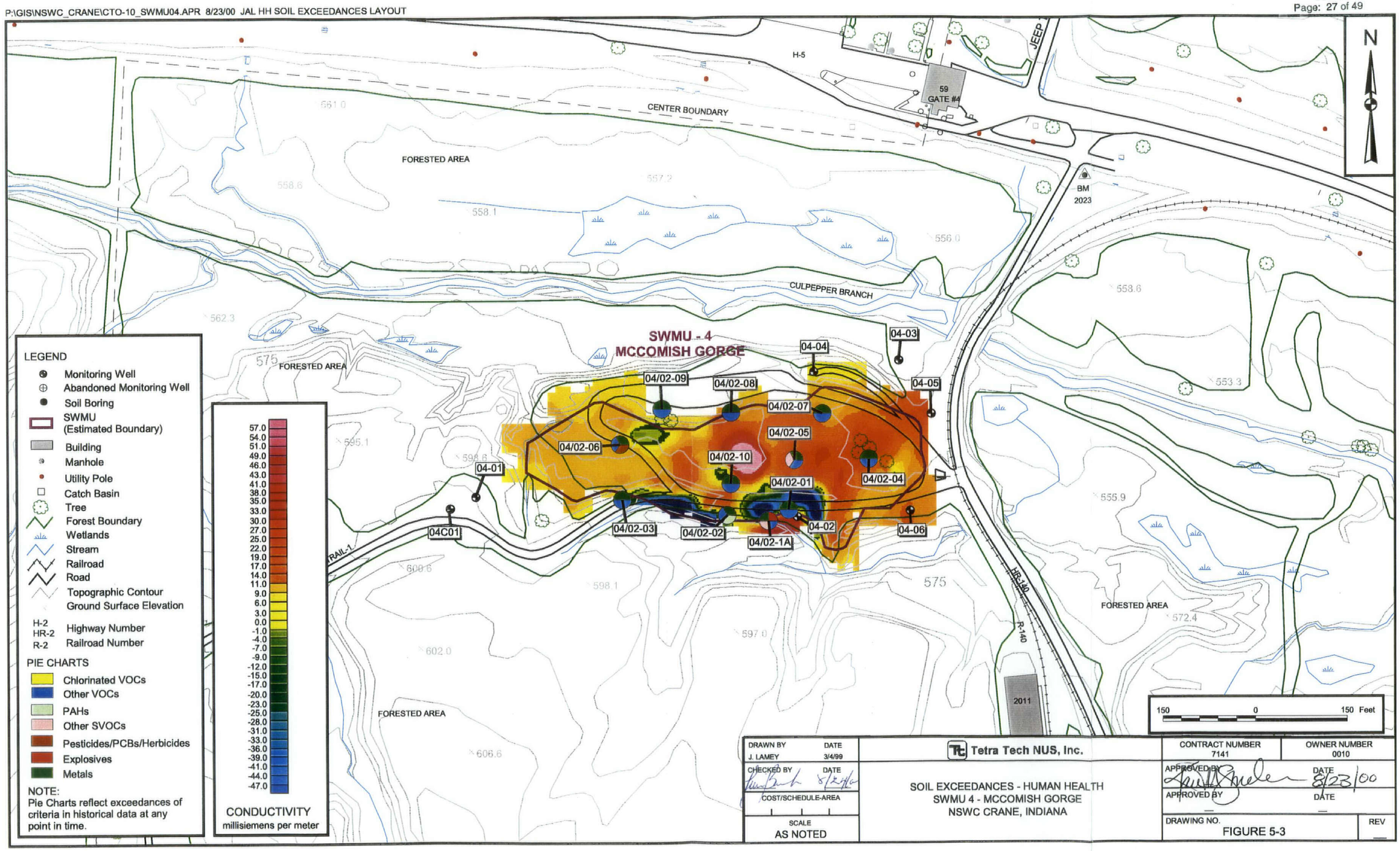

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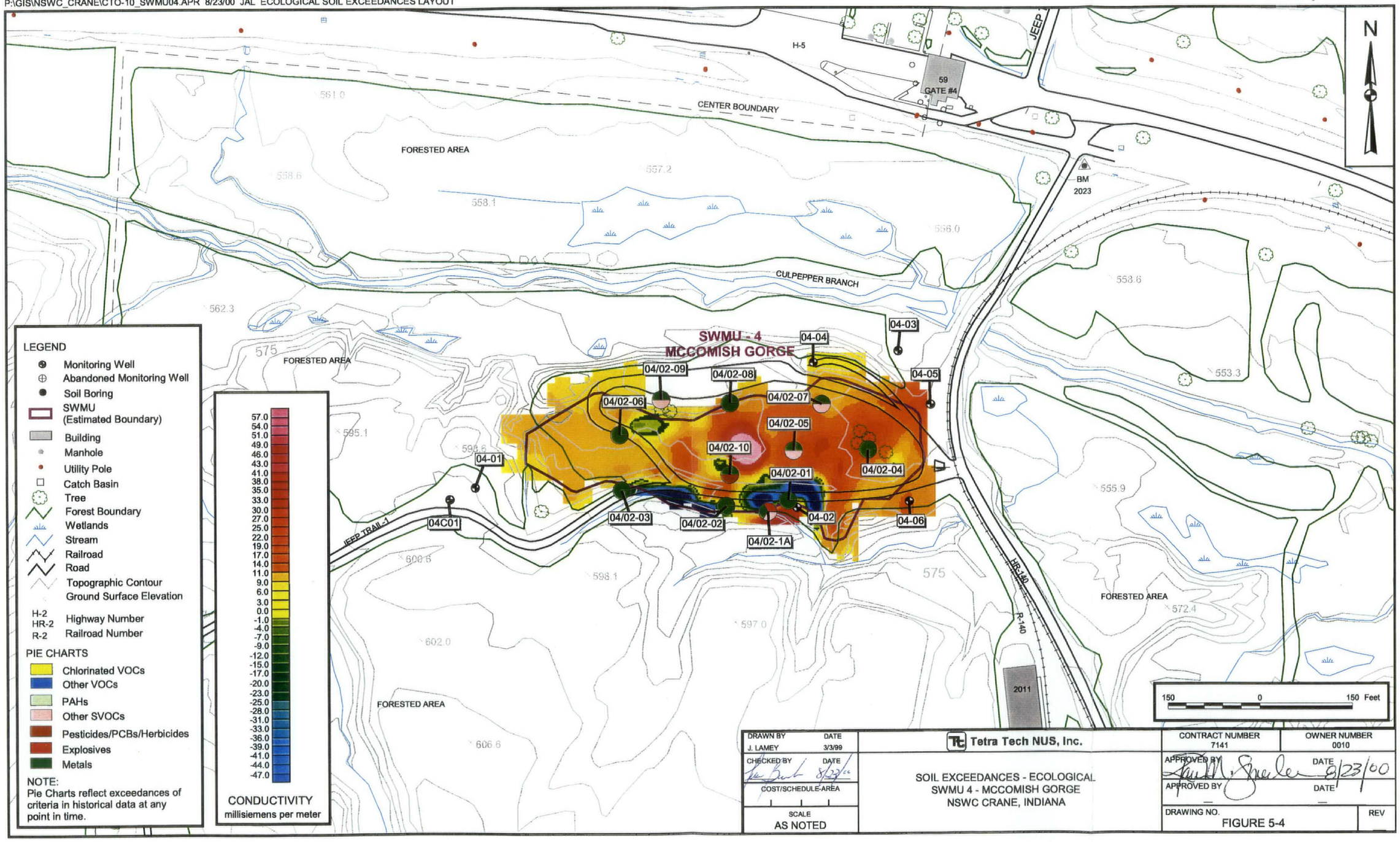

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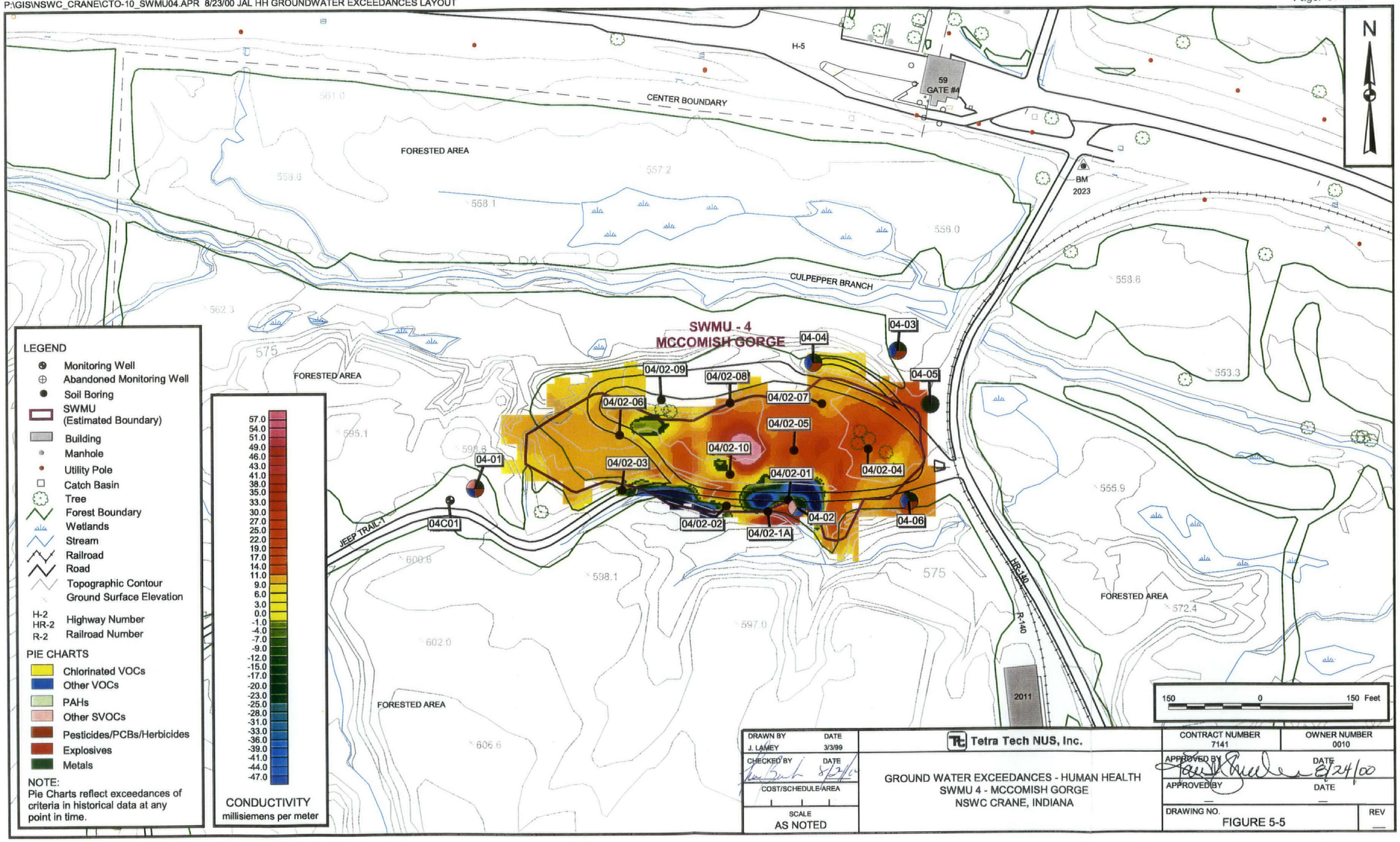

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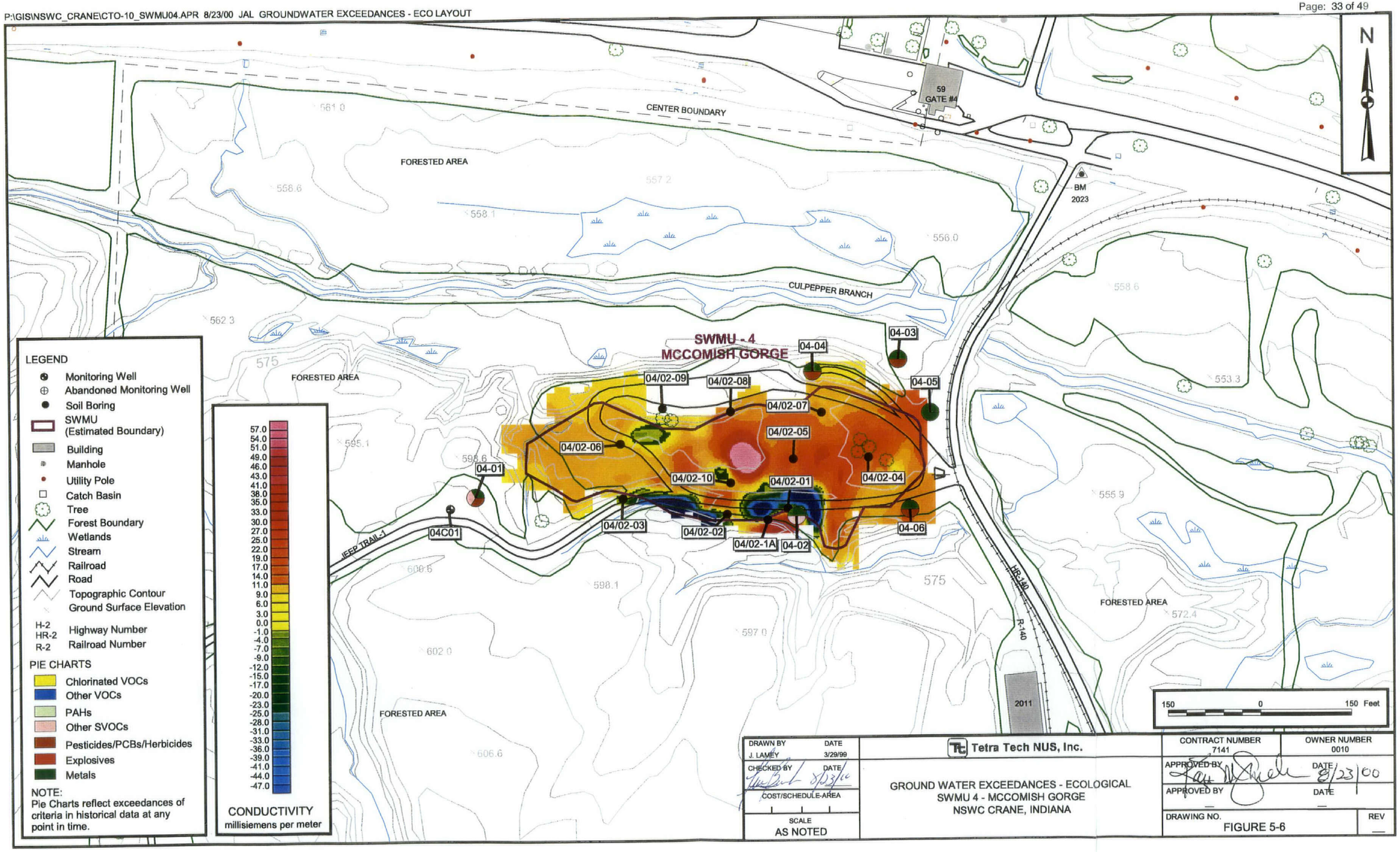

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supporting the conclusion that the presence of these chemicals are attributable to contamination introduced through sampling (decontamination or ambient conditions) or laboratory analysis.

Two explosives, 2,4-dinitrotoluene and 2,6-dinitrotoluene, and N-Nitrosodiphenylamine were found in subsurface soils at concentrations greater than the lowest screening criteria. The presence of these chemicals may be attributable to small arms munitions disposed at the site. Migration of these constituents from soil to ground water is not supported by the historical data, because they were not detected in the ground water samples collected from the site.

One pesticide, 4,4'-DDT, was detected in only one surface soil location (04/02-10-90) at a concentration in excess of the screening criteria. In the ground water samples collected from the unconsolidated aquifers at the site, several pesticides were reported at concentrations greater than the lowest screening criteria (ground water or surface water criteria). The pesticides exceeding criteria in ground water include alpha-chlordane, gamma-BHC (lindane), heptachlor, and toxaphene. Pesticides may not be site-related constituents, but may, in fact, be attributable to Basewide insect control measures. For conservative purposes, these chemicals were identified as detected parameters of interest of McComish Gorge.

Alpha-chlordane was identified as a parameter of interest for ground water solely on the basis that reported concentrations exceeded surface water screening criteria for ecological receptors. As mentioned previously, this is a conservative comparison and serves to overestimate potential impacts to surface water as a result of ground water discharge. This chemical may not be present in the surface water at the site, but it is identified as a chemical of interest for the site for conservative purposes.

5.4.2 Inorganic Constituents

A variety of inorganics was found in the soil and ground water at McComish Gorge. Those inorganics detected at concentrations in excess of the lowest screening criteria are, as follows:

- Soil: Antimony, arsenic, barium, beryllium, cadmium, chromium (total), cobalt, copper, iron, lead, phosphorus, selenium, thallium, and zinc

- Ground Water: Arsenic, barium, chromium (total), cobalt, iron, lead, manganese, mercury, silver, chloride, and sulfide

Mercury was reported in one ground water sample (from well 04-01) at a concentration (77 µg/L) in excess of the Federal MCL (2 µg/L). The ground water sample was collected in October 1982. This

exceedance may be an anomaly because ground water samples collected from this well prior to October 1982 did not contain detectable levels of mercury. In addition, concentrations of mercury in other monitoring wells at the site were either nondetect or less than 2 µg/L.

A similar anomaly was also noted in the ground water for chromium. This chemical was detected in one ground water sample (from well 04-05) at a concentration equal to the Federal MCL of 100 µg/L. This exceedance was also noted in the ground water sample collected during October 1982. However, ground water samples collected from this well prior to October 1982 were either at or less than the limit of detection (10 µg/L).

Based solely on the comparison that reported concentrations exceeded ecological screening criteria for surface water, chromium, cobalt, lead, mercury, silver, and chloride were identified as parameters of interest for ground water. As mentioned previously, this is a conservative comparison and serves to overestimate potential impacts to surface water as a result of ground water discharge. These chemicals may not be present in the surface water at the site, but they are identified as chemicals of interest for the site for conservative purposes.

5.4.3 Summary of Detected Chemicals of Interest

The following constituents are detected chemicals of interest for soil and ground water at McComish Gorge (i.e., chemicals reported at concentrations in excess of risk-based screening criteria):

- Soil: 2,4-Dinitrotoluene, 2,6-dinitrotoluene, N-nitrosodiphenylamine, 4,4'-DDT, and various inorganics

- Ground Water: Benzene, cis-1,3-dichloropropene, trans-1,3-dichloropropene, alpha-chlordane, gamma-BHC, heptachlor, toxaphene, Aroclor-1254, and various inorganics

Because of the uncertainty associated with the historical analytical data, all constituents reported at concentrations in excess of risk-based criteria were included in the list of detected chemicals of interest for the site. This list was used to develop appropriate chemical categories to be included in the analytical program for the proposed field investigation, which is presented in the following section.

5.5 PROPOSED INVESTIGATION

The proposed field investigation for SWMU 4, McComish Gorge was developed based on a site-specific CSM. The general methodology used to develop the proposed investigation (and CSM) was presented in

Section 4.0. This section of the Work Plan provides the rationale for the proposed site-specific investigation.

5.5.1 Conceptual Site Model

The CSM for McComish Gorge, which defines the contaminant source, transport mechanisms, exposure routes, and potential receptors for the site is presented as Figure 5-7. Based on a review of the existing data for the site, a release of hazardous constituents to the surrounding soil has occurred as a result of historical site operations (i.e., the disposal of garbage, trash, and debris in a gorge at the site). The historical data also indicate that residual contaminants in the soil have migrated to ground water via infiltration/percolation. Additional release mechanisms, which are also expected to contribute to the contaminant transport, include discharge of ground water to surface water/sediment (Culpepper Branch Creek), deposition via surface water runoff, and generation of fugitive dust and volatile emissions from soil.

Current and likely future land use at McComish Gorge is expected to be limited. As mentioned previously, the site is currently inactive; no waste disposal activities occur at McComish Gorge under current land use. All hazardous waste generated by NSWC Crane operations is disposed accordingly. All nonhazardous refuse is disposed in the Facility's sanitary landfill.

Based on the general scenarios and receptor classes identified in Section 4.0, the following potential receptors may be exposed to contaminated media at the site:

- Trespassers (ages 6 to 17 years) – Likely receptor under current and future land use. Although access to the Base is controlled, once inside the Base access to the site is not limited by any physical constraints (i.e., the site is not patrolled or enclosed by a fence). In addition, hunting activities are permitted at the Base. Since the site is near a forested area, hunters may trespass onto the site. This receptor may be exposed to potentially contaminated surface soil, air, and surface water and sediment in Culpepper Branch Creek.

- Maintenance Workers – Likely receptor under future land use. This receptor may be exposed to potentially contaminated surface soil and air. Exposure to ground water at the site and surface water and sediment in Culpepper Branch Creek is not expected to occur.

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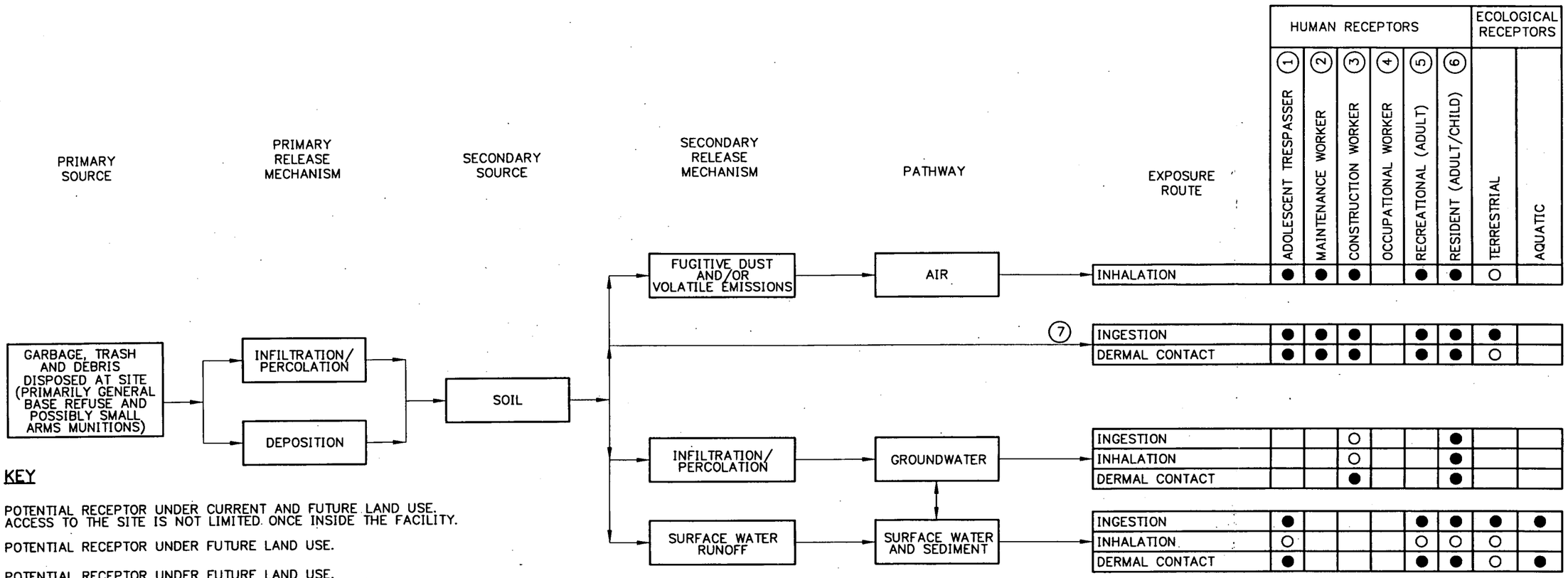

KEY

1. POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. ACCESS TO THE SITE IS NOT LIMITED ONCE INSIDE THE FACILITY.
2. POTENTIAL RECEPTOR UNDER FUTURE LAND USE.
3. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. A SHORT-TERM PROJECT (I.E. UTILITY INSTALLATION) MAY OCCUR.
4. UNLIKELY RECEPTOR. SITE IS NOT LIKELY TO BE DEVELOPED.
5. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. BASE COULD CLOSE AND BE TURNED INTO A STATE PARK.
6. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. EVALUATED FOR DECISION-MAKING PURPOSES.
7. FOODCHAIN MODELING WILL BE CONDUCTED FOR ECOLOGICAL RECEPTORS.

● EXPOSURE PATHWAY TO BE EVALUATED IN RISK ASSESSMENT.

○ RELATIVELY INSIGNIFICANT POTENTIAL EXPOSURE PATHWAY COMPARED TO OTHER PATHWAYS EVALUATED IN THE RISK ASSESSMENT. RISKS NOT EVALUATED QUANTITATIVELY.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY KW DATE 3/29/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE NONE

CONCEPTUAL SITE MODEL
SWMU 4-McCOMISH GORGE
NSWC CRANE, INDIANA

CONTRACT NO. 7141
APPROVED BY DATE 10/13/99
APPROVED BY DATE
DRAWING NO. FIGURE 5-7
REV. 0

FORM CADD NO. SDV_BH12.DGN - REV 0 - 1/20/98

- Construction Workers – Potential receptor under future land use. No construction activities are currently planned at the site. In addition, the shallow depth to ground water (as shallow as 3 feet bgs) and the nature of the site (dumpsite) would likely preclude development of the area. However, a small, short-term construction project, such as a utility installation, could result in exposure to potentially contaminated media. This receptor may be exposed to surface and subsurface soil, air and ground water.

- Recreational Users – Potential receptor under future land use. If the Facility were to close, the most likely scenario is that the property would be converted into a state park. This receptor may be exposed to potentially contaminated surface soil, air and surface water and sediment in Culpepper Branch Creek. However, it is highly unlikely that NSWC Crane would close because principal Base operations, the demilitarization of munitions, are critical to the support of the U.S. Naval fleet.

- Residents - Potential receptor under future land use. As mentioned previously, development of the site would be unlikely because of the shallow depth to ground water and the nature of the site. However, other areas of the Facility could be developed for residential purposes, if the Facility were to close. Future residents may be exposed to potentially contaminated surface soil, air, ground water, and surface water and sediment in Culpepper Branch Creek. Although this scenario is highly unlikely, a future residential scenario is typically evaluated in the risk assessment for decision-making purposes. For example, the need for deed restrictions at a site may be eliminated, prior to site closure, if minimal risks are estimated for residential receptors.

- Ecological Receptors - Under current and future land use, various ecological receptors, terrestrial and aquatic, are also likely to come in contact with site media. Terrestrial receptors may contact potentially contaminated surface soil and ingest contaminated prey items and/or surface water. Aquatic receptors may be exposed to potentially contaminated surface water, prey, and sediment.

Details regarding the assumed receptor characteristics (intake rate, frequency and duration of exposure, body weight, etc.) are defined in Sections 10.0 and 11.0 of this Work Plan, which present the methodologies for the human health and ecological risk assessments.

5.5.2 Proposed Sampling and Analysis

The primary objective of the proposed field investigation is to collect field and laboratory data needed to evaluate the potential risks for those human and ecological receptors identified in the CSM. Figure 5-8 identifies the proposed sample locations. Table 5-5 summarizes the proposed sampling and analysis for

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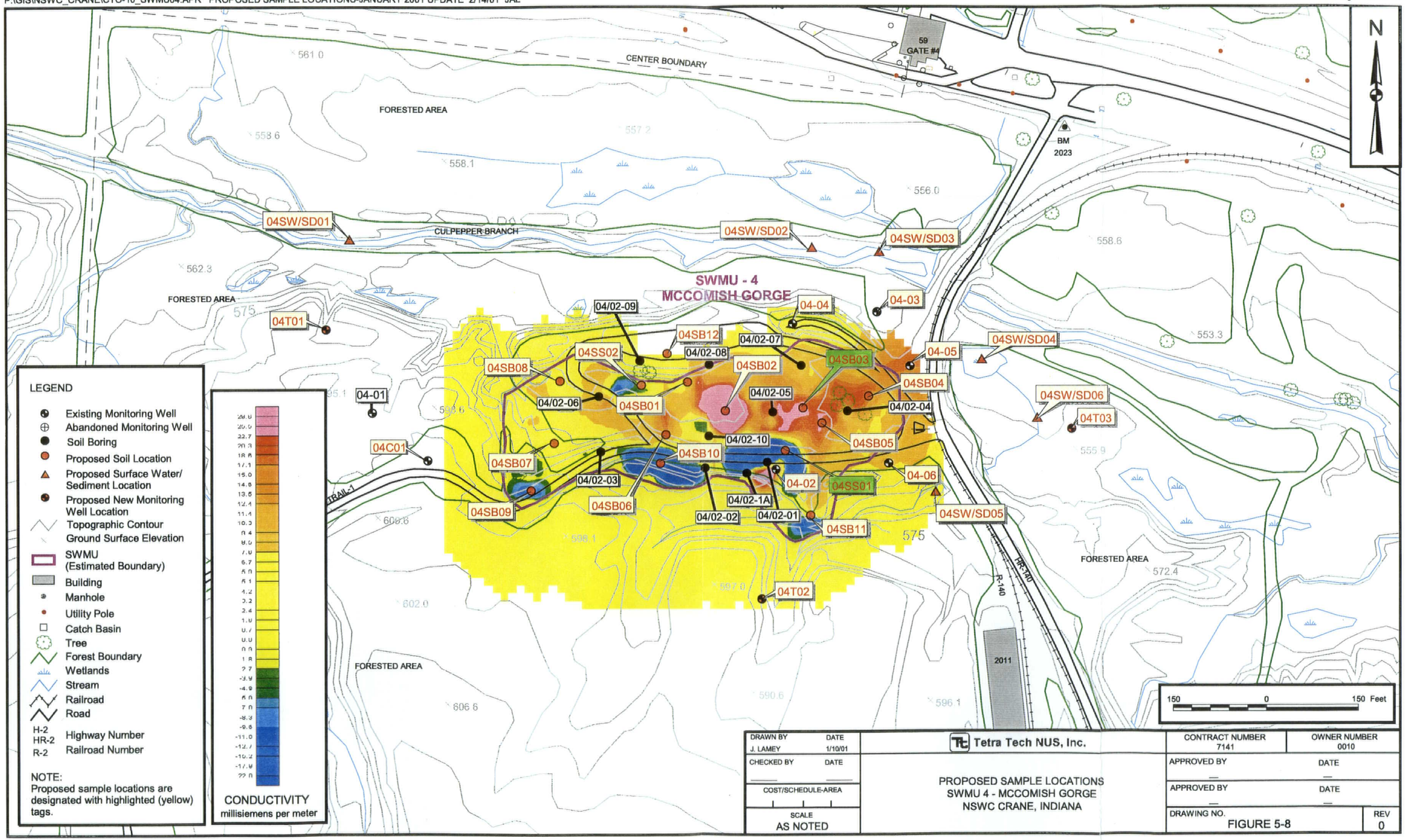

TABLE 5-5

SUMMARY OF OBJECTIVES/PROPOSED SAMPLING
SWMU 4 - McCOMISH GORGE
NSWC CRANE, INDIANA

OVERALL OBJECTIVES FOR SAMPLING PROGRAM

TYPE OF PROGRAM / SAMPLING OBJECTIVE	PARAMETER TYPE	TARGET CONSTITUENTS[1]	OBJECTIVE FOR ANALYSIS	LIMIT OF DETECTION	EVALUATIONS TO BE PERFORMED
Type: RCRA Risk Assessment to fulfill requirements of RCRA Part B permit. Objectives: Determine human health and ecological risks for potential receptors exposed to site media under current and future land use. Determine if there has been a release of hazardous constituents to off-SWMU surface water and sediment.	Field (Soil, Ground Water, and Surface Water)	Dissolved Oxygen Oxidation Reduction Potential pH Specific Conductivity Temperature Turbidity PID Reading[2]	Evaluate general water quality. Determine if well water is equivalent to formation water (i.e., stability). To determine the correct subsurface soil sample interval (PID reading only).	As per selected field instrumentation. Instrumentation will be calibrated according to the manufacturer's manuals.	Qualitatively used to evaluate general water quality.
	Laboratory (Soil, Ground Water, Surface Water, and Sediment)	Appendix IX VOCs Appendix IX SVOCs Appendix IX Pesticides/PCBs Appendix IX Herbicides Appendix IX Inorganics (total and dissolved[3]) Cyanide (total and dissolved[3]) Miscellaneous Inorganics[4] (total and dissolved[3])	To obtain a representative presentation of the nature and quantity of constituents that were released to media by past operational activities.	Reporting limit low enough to meet Federal/State ARARs/TBCs and evaluate adverse human health and environmental impacts.	Comparison of constituents found in site media to risk-based screening criteria to determine if these media were affected by past operations. Comparison of inorganic site soil data to established Basewide background levels for similar soil types. Estimate human health risks, as outlined in Section 10.0, Figure 10-1. Estimate ecological risks, as outlined in Section 11.0, Figure 11-1.
		Hardness[5] TSS[5]	Evaluate surface water conditions.	As per chosen laboratory methods.	To be used to assess potential risks for ecological receptors.
		CEC[6] pH[6] TOC[6][7]	Evaluate soil and/or sediment conditions.	As per chosen laboratory methods.	For soil, evaluate the potential for contaminant migration from the site and the potential for risks outside the site boundaries. For sediment, to be used to assess potential risks for ecological receptors.

SPECIFIC OBJECTIVES FOR SAMPLING LOCATIONS

MEDIUM	SAMPLE COLLECTION TECHNIQUE	SAMPLING POINT[8]		
		SAMPLE LOCATION	COMMENT	OBJECTIVE OF LOCATION
Surface/Subsurface Soil	Grab surface soil sample; specific collection technique identified in FSP, Section 2.4.2.1. Grab subsurface soil sample; specific collection technique identified in FSP, Section 2.4.2.3.	04SS01 and 04SS02	Locations based on field observations.	Evaluate contaminant concentrations at the ground surface where debris is noted.
		04SB01 through 04SB06	Site locations based on anomalies identified by geophysical survey. One sample collected at ground surface (0 to 2 feet bgs) and one sample collected at a discrete depth from 2 to 10 feet bgs (interval based on PID reading). If the water table is encountered prior to 10 feet bgs, the sample will be collected at a depth above the water table. Two samples per boring for a total of 12 samples.	Evaluate contaminant concentrations at locations where geophysical anomalies are observed.
		04SB07 through 04SB08	Two borings spatially distributed along the western portion of the site. One sample collected at ground surface (0 to 2 feet bgs) and one sample collected at a discrete depth from 2 to 10 feet bgs (interval based on PID reading). If the water table is encountered prior to 10 feet bgs, the sample will be collected at a depth above the water table. Two samples per boring for a total of 4 samples.	Evaluate contaminant concentrations along the western portion of the site at varying depths.
		04SB09 through 04SB12	Four boring locations based on geophysical survey conducted during December 2000. One sample collected at ground surface (0 to 2 feet bgs) and one sample collected at a discrete depth from 2 to 10 feet bgs (interval based on PID reading). If the water table is encountered prior to 10 feet bgs, the sample will be collected at a depth above the water table. Two samples per boring for a total of 8 samples.	Evaluate contaminant concentrations at locations where geophysical anomalies are observed.
Ground Water	Grab sample; specific collection technique identified in FSP, Section 2.4.1.	04-01 through 04-06	With the exception of well 04C01, sample 6 existing monitoring wells. All wells are within site boundaries.	Evaluate ground water quality at locations affected by site activities.
		04T01	Install and sample new monitoring well at western site boundary.	Evaluate ground water quality at a location immediately upgradient of the site.
		04T02	Install and sample new monitoring well at southern site boundary.	Evaluate ground water quality at a location immediately cross-gradient of the site.
		04T03	Install and sample new monitoring well at eastern site boundary.	Evaluate ground water quality at a location immediately downgradient of the site.
Surface Water/Sediment[9]	Grab sample; specific collection technique identified in FSP, Section 2.4.3 (surface water) and 2.4.4 (sediment).	04SW/SD01 through 04SW/SD03	One location in Culpepper Branch Creek outside the limit of western site boundary and two other locations near the site.	Evaluate surface water/sediment quality in creek at upstream and downstream locations; downstream locations to monitor site impacts.
		04SW/SD04	Location at a wetland/marsh area east of the site.	Evaluate surface water/sediment quality at a marsh area downstream of the site.
		04SW/SD05 and 04SW/SD06	Locations in an unnamed tributary south-southeast of the site. One located within suspected site boundaries and one downstream of the entire site.	Evaluate surface water/sediment quality at a location affected by site activities and immediately down stream of the site.

ARARs Applicable, Relevant, and Appropriate Requirements
CEC Cation Exchange Capacity
FSP Field Sampling Plan
QAPP Quality Assurance Project Plan
PCBs Polychlorinated biphenyls
PID Photoionization detector
SVOCs Semivolatile Organic Compounds
TBCs To Be Considered Values
TOC Total Organic Carbon
TSS Total Suspended Solids
VOCs Volatile Organic Compounds

1 The list of specific chemicals included as target constituents is identified in the QAPP, Section 1.0, Table 1-1. Constituents to be analyzed for all samples, all matrices collected, unless otherwise noted.
2 Soil samples only will be monitored with a PID. The other identified field parameters will be collected for ground water and surface water.
3 Total and dissolved inorganic analyses will be performed for surface water samples.
4 Miscellaneous inorganics include calcium, iron, magnesium, manganese, potassium, and sodium.
5 Analyses performed on surface water samples only.
6 Analyses to be performed on 30 percent of the soil samples collected.
7 TOC analyses will be conducted on all sediment samples.
8 Most of the proposed sampling locations are identified on Figure 5-8. To further refine the southern boundary of the site, additional geophysical work has been conducted. Additional surface/subsurface soil locations were added based on the results of this future boundary delinertion activities.
9 Due to the intermittent flow, surface water may not be available at all the proposed sample locations.

SWMU 4, McComish Gorge, including overall objectives and objectives for the selection of a particular sampling point. The remainder of this section provides the rationale for proposed sampling and analysis program.

As depicted on Table 5-5, environmental samples collected from the site will be analyzed for a comprehensive field and laboratory analytical program. Field parameters will be collected for ground water and surface water samples. Typical water quality indicator parameters, such as turbidity, will be collected in the field. Soil samples will be screened for VOCs using monitoring equipment (a PID).

The analytical program for McComish Gorge was developed based on the chemical categories represented by the list of detected chemicals of interest identified for the site in Section 5.6. Soil, sediment, surface water, and ground water samples will be collected and analyzed for the full list of Appendix IX constituents (VOCs, SVOCs, pesticides, polychlorinated biphenyls (PCBs), inorganics), as well as other miscellaneous inorganics. Surface water samples also will be analyzed for total and dissolved inorganics, hardness, and total dissolved solids (TSS) and sediment samples will be analyzed for TOC to assist in assessing the potential risks for ecological receptors. Additionally, soil characteristic parameters (CEC, pH, and TOC) will be collected to determine the likelihood of the potential fate and transport of contaminants at the site (and the potential for risks outside the site boundaries). Ground water samples will not be analyzed for dissolved inorganics since low flow sampling procedures will be used to eliminate turbidity concerns.

As noted previously, Figure 5-8 illustrates the proposed sampling locations for the field investigation at McComish Gorge. The rationale for the collection of these samples is, as follows:

- Surface Soil (2): Two surface soil samples will be collected at locations (04SS01 and 04SS02) where surface debris is present to assess the potential risks associated with residual soil contamination. Samples, which will be collected from a depth of 0 to 2 feet bgs, will be collected from soil adjacent to surface debris (drums, cylinders, etc.). Surface debris was noted to be present at the site during the August 1999 geophysical investigation. Exposed drums were found in two areas and metallic cylinders were observed at one location, as discussed in Appendix I of this Work Plan.

- Surface/Subsurface Soils (Borings) (24): To assess the potential risks associated with residual soil contamination, twelve soil borings will be installed and sampled based on the results of a geophysical survey, which will be used to identify site boundaries. Collocated surface and subsurface soil samples will be obtained for a total of 24 soil samples. A sample will be obtained from the surface (0 to 2 feet bgs) and at a subsurface depth (not greater than 10 feet bgs) to be determined in the field

- using screening techniques (i.e., from a depth correlated with the highest PID readings). Six locations (04SB01 through 04SB06) where geophysical anomalies were observed will be sampled. The other two locations (04SB07 and 04SB08) to be sampled will be placed along the western portion of the site to provide even coverage over the entire area. Four locations to be sampled are based on the results of geophysical surveys conducted during December, 2000. Proposed locations are presented on Figure 5-8. Further work is needed to define the southern boundary of the site. This will include additional geophysical work using a hand-held magnotometer to survey the mounded areas south of the site.

- Ground Water (9): Six existing monitoring wells (04-01 through 04-06) at the site will be sampled to assess the potential risks associated with the migration of soil constituents to ground water. Three new monitoring wells will be installed and sampled during this field effort. One well, 04T01, will be located outside the western boundary of the site and will be installed to establish water quality conditions immediately upgradient of the site. Well 04T02 will be installed to monitor conditions at the southern edge of the site. An additional well (04T03) from a location east of the access road leading to site will be used to monitor downgradient conditions.

  Originally, the primary purpose of well 04C01 was to determine stratigraphy in the area. Historically, analyitcal results from well 04C01 were below human and ecological screening criteria (refer to Figures 5-5 and 5-6). Also, as shown on Figure 5-8, the location of this well is outside the boundary of the SWMU. Therefore, this well is not proposed to be sampled during the risk assessment field investigation.

- Surface Water and Sediment (12) – To assess the potential risks associated with migration (ground water discharge and surface runoff) of ground water and soil chemicals to surface water and sediment, collocated surface water and sediment samples will be collected from six locations. Three sampling points will be located in Culpepper Branch Creek. A location in the creek (04SW/SD01) outside the western boundary of the site will be sampled to evaluate upstream conditions; locations 04SW/SD02 and SW/SD03 will be used to monitor the stream at locations potentially affected by surface water runoff and/or ground water discharge. Surface water and sediment samples will be collected from a marsh/wet area (04SW/SD04) and an unnamed tributary (04SW/SD05). Information from 04SW/SD04 will be used to confirm that the western boundary of the SWMU does not extend to this area. Information from sample 04SW/SD05 will be used to determine the southern boundary of the site extends to this area. Location 04SW/SD06 will be sampled to evaluate downstream conditions in the unnamed tributary south-southeast of the site.

The associated FSP, presented in Appendix A, provides details on the field sampling procedures (installation of soil borings and monitoring wells and collection of samples) to be used at the site. The associated HASP is contained in Appendix B. The QAPP, located in Appendix C, provides details on the analytical methodologies to be used for the proposed field investigation.

The data collected during the proposed field investigation will be used to assess potential risks for human and ecological receptors exposed to site media under current and/or future land use. A description of how the data obtained during the proposed field investigation will be managed prior to use in the risk assessment is presented in Section 9.0. General methodologies and techniques used to calculate potential risks for the site are provided in Sections 10.0 (human health) and 11.0 (ecological).

6.0 SWMU 5 – OLD BURN PIT

The proposed field investigation for SWMU 5, Old Burn Pit, needed to fulfill the overall objectives of this CTO (i.e., the completion of human health and ecological risk assessments), is provided in this section.

Section 6.1 presents a brief background of activities, which have occurred at the site. The physical setting (geology, hydrology, topography, etc.) is contained in Section 6.2. A brief synopsis of the previous site investigations and hazard identification based on the historical site data are presented in Sections 6.3 and 6.4, respectively. Section 6.5 summarizes the proposed field investigation for the site.

6.1 BACKGROUND

SWMU 5 is an inactive site that was used from 1942 to 1972. Undefined amounts of rubbish including wood, paper, construction material and industrial wastes were burned at the site in the burn pit area. Reportedly, no explosive materials or wastes were burned at the Old Burn Pit. Residual ash and metal debris from the burning activities were buried in the gully to the north of the burn pit area. This area currently contains miscellaneous metal debris, including decomposed drums and other metal objects, which are partially buried or exposed. Currently, the burn pit area of the site has been covered with gravel and is used as a parking area for delivery trailers. The gully north of the former burn pit area has been revegetated.

6.2 PHYSICAL SETTING

The Old Burn Pit site is located in the northwest corner of the NSWC Crane, approximately 2,000 feet east of the Crane Gate No. 4. The site occupies approximately 25 acres and is bounded on the west by Highway 5, on the south by the gravel lot south of the burn pit, and on the east by the power line running along a ridge north of Lake Oberline. The northern boundary (at the gully) is undetermined. The site map for SWMU 5, Old Burn Pit, is presented as Figure 6-1. Approximate boundaries of the site are provided.

6.2.1 Topography/Hydrology

The topography at the Old Burn Pit consists of undulating terrain dissected by many small drainage ways. Surface runoff from the Old Burn Pit drains into Culpepper Branch Creek, a tributary of Furst Creek.

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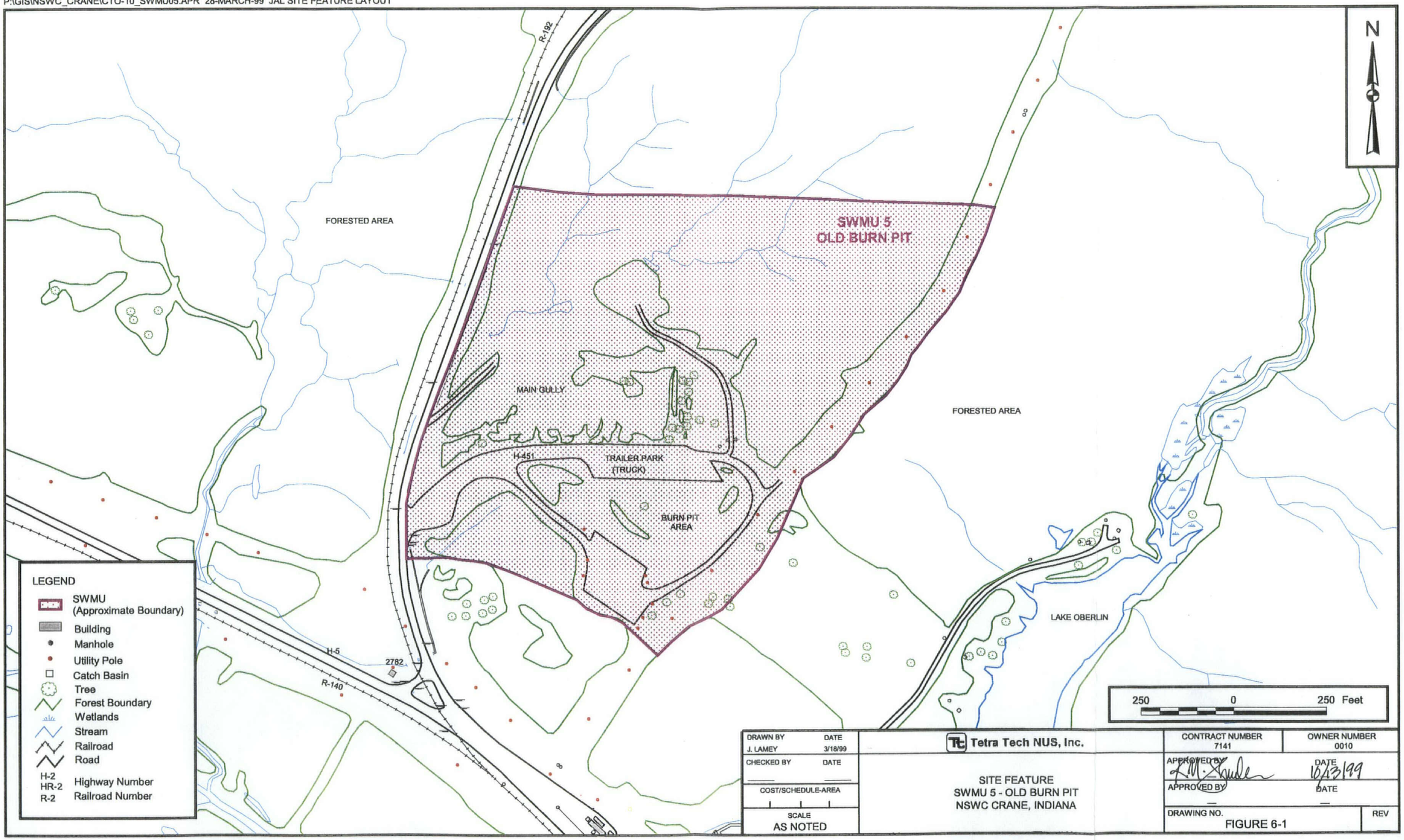

6.2.2 Geology

The Old Burn Pit is located on the Crawford Upland, a rugged, dissected plateau formed by differential erosion of Pennsylvanian- and Mississippian-age sedimentary rocks. The rock units underlying the site and forming the surrounding hills, consist of Mansfield Formation shales and sandstones of the Pennsylvania-age Raccoon Creek Group.

Most of the SWMU 5 is situated in the dissected alluvial valley of Culpepper Branch Creek. Soils across the site ranged from 0 to 60 feet in thickness. Several processes formed the unconsolidated sediments of the site. Residual soils were formed by weathering of the underlying parent rock. During the Pleistocene, the site was filled with lacustrine (lake) deposits and alluvial (outwash) deposits that are facies included in the Artherton Formation. At this location, these deposits primarily consist of interbedded deposits of sand, silt, and clay indicating a heterogeneous nature to the subsurface soils. The gravel portion of the clay is primarily sandstone fragments.

Colluvium derived from the hill slopes and soils reworked by man in association with burning activities also compose the site. During previous investigations, this unit of modified soils was found to contain items such as rusty nails, metal, glass, and burnt wood. A strong odor was present when black ash was encountered at the site.

A sandy zone of soil was also found at the site near the burn pit area. This sand zone was interpreted as a paleostream (sand) channel deposit.

6.2.3 Hydrogeology

In general, the ground water gradient at SWMU 5 is north-northwest. During previous site investigations, ground water was encountered at shallow depths ranging from 4 to 6 feet.

Available evidence indicates that ground water moves by downward vertical infiltration through the clay and silts of the site very slowly. When rock is encountered, ground water would then move laterally along the soil/rock interface until it reaches fractured rock and enters the rock aquifer system. In the paleostream channel (sand rich zones), ground water would preferentially move laterally through the sand body. The presence of the paleostream channel suggests that the ground water at the burn pit area may flow westward, whereas the ground water elevations indicate a northwestern flow.

6.3 PREVIOUS INVESTIGATIONS

A brief description of the historical data collection activities conducted at SWMU 5, Old Burn Pit, is contained in this section. Soil and ground water samples have been collected at locations illustrated in Figure 6-2. A tabular summary of the previous investigations completed for the site is presented in Table 6-1.

Various investigations were completed from 1981 to 1987 at the Old Burn Pit as part of several multi-site investigations. The first of which was the IAS (NEESA, 1983). The IAS was initiated in April 1981 in response to the NACIP Program. The NEESA completed the IAS in May 1983 with assistance from the Ordnance Environmental Support Agency and the USACE WES. The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations.

The IAS consisted of the installation of a total of 19 monitoring wells (wells 05-01 through 05-19) throughout the site. The first round of wells that were installed consisted of one upgradient (05-01) and two down gradient (05-02 and 05-03) of the site. Upon identification of constituents in the ground water, additional wells were installed along the anticipated perimeter of the site. During the installation of these wells, soil samples were collected and tested for various soil characteristics. After installation of the wells, ground water samples were collected and analyzed for a comprehensive list of constituents and RCRA water quality parameters. As part of the IAS, quarterly and semi-annual sampling of the monitoring wells were conducted at the Old Burn Pit. The list of soil tests performed and the chemical constituents included in the ground water analytical program are identified in Table 6-1.

Based on the initial conclusions of this ground water study, SWMU 5 was not determined to represent an immediate human health and environmental threat. However, the site was recommended for further study to evaluate potential long-term impacts.

In response to the recommendation from the IAS, a RFI Phase II Soils Release Characterization was performed at the Old Burn Pit in 1990 (U.S. ACE WES, 1998b). The objective of this study was to determine soil conditions around the site, identify and characterize the material burned in the pit and the residual material buried in the gully north of the burn pit, and characterize the potential for release of hazardous constituents into the surrounding environment. Nine soil borings (05/03-01 through 05/03-09) were installed. Both surface and subsurface samples were collected from these borings and analyzed for a comprehensive analytical program outlined in Table 6-1.

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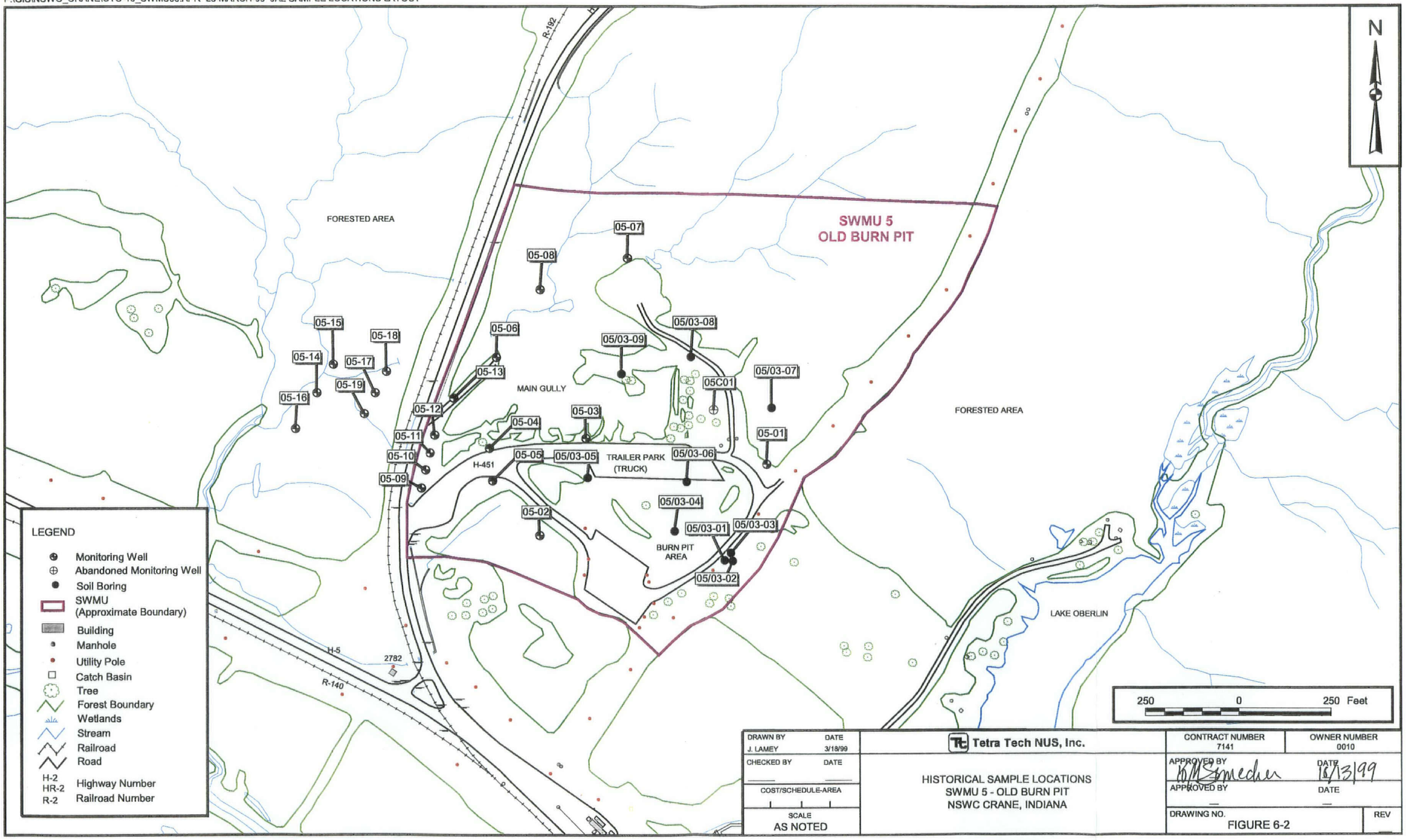

DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER 0010
J. LAMEY	3/18/99		APPROVED BY	DATE 10/13/99
CHECKED BY	DATE	HISTORICAL SAMPLE LOCATIONS SWMU 5 - OLD BURN PIT NSWC CRANE, INDIANA	APPROVED BY	DATE
COST/SCHEDULE-AREA			DRAWING NO. FIGURE 6-2	REV
SCALE AS NOTED				

TABLE 6-1

SUMMARY OF HISTORICAL SITE INVESTIGATIONS
SMWU 5 - OLD BURN PIT
NSWC CRANE, INDIANA

INVESTIGATION (REPORT/REFERENCE)	EXTENT OF INVESTIGATION			RESULTS OF INVESTIGATION	
	SUMMARY	DATE OF SAMPLING	ANALYTICAL PROGRAM (PARAMETER/ANALYTICAL METHOD)	DETECTED PARAMETERS OF INTEREST	CONCLUSIONS
General Basewide Investigations[1] (1981-1987)	Installation of 8 monitoring wells in 1981. One well was upgradient of the site. The other wells were downgradient along the anticipated perimeter of the site. Physical soil testing to define hydrogeological characteristics.	January - April 1982	Miscellaneous Physical Soil Testing (cation exchange capacity, grain size, Atterberg limits, density, water content, and permeability tests) -- Various Methods	NA	Geology consists of unconsolidated lacustrine deposits, sand, silt and clay. Heterogeneous nature of subsurface soil was identified. Ground water direction was determined to be north-northwest. Depth to water table ranged from 4 to 6 feet bgs.
	Installation of 11 monitoring wells in October through December 1982 and January through February 1983. These wells were placed at the anticipated perimeter of the site. Quarterly/ semiannual ground water monitoring was instituted to identify the presence or absence of contamination.	December - October 1982[2] February 1983 - June 1986[3]	RCRA Group I - III Parameters[4] - Various Methods	VOCs (1,1-DCE, benzene, chloroform, trans-1,2-DCE, TCE, and vinyl chloride), 2,4,5-TP (Silvex), several inorganics mainly As, Ag, Cr, Fe, Hg, and Pb), and Sulfide	The contaminated ground water plume is irregular in shape. The plume is moving north-northwest in the direction of ground water flow. A paleostream channel deposit (linear, sandy zone of soil) was identified at the site near the burn pit area. This sand zone is thought to act as a preferential migration pathway for ground water. Therefore, ground water at the burn pit is expected to flow in a westwardly direction. The highest levels of VOCs were detected in wells 05-04 and 05-12, while wells 05-03, 05-06, and 05-08 have the highest reported levels of inorganics. Detects of acetone and methylene chloride are considered to be attributable to laboratory blank contamination.
RFI Phase II Soils Release Characterization for SWMU 05/03 Old Burn Pit, Naval Surface Warfare Center Crane, Indiana (U.S. ACE WES, 1998b)	Installation of 9 soil borings and collection of 16 soil samples. Surface and subsurface soil sampling performed to determine whether a chemical release has occurred at the site (i.e., identify residual contaminant concentrations in soil).	October 1990	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Organochlorine Pesticides/PCBs -- SW-846 Method 8080 Organophosphorus Pesticides -- SW-846 Method 8140 Herbicides -- SW-846 Method 8150 Inorganics -- SW-846 Methods 6010/7060/7471/7740	Surface soil - TCE, PAHs, pesticides dieldrin and endrin) and various inorganics (mainly Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Hg, Ni, Se, Ag, Tl, and Zn) Subsurface soil - VOCs (1,1,2,2-PCA, chloroform, and cis-1,2-DCE), PAHs, pesticides (dieldrin and 4,4'-DDT), and various inorganics (same as those found in the surface soil)	The presence of a paleostream channel deposit at the burn pit area was confirmed. Estimated permeabilities of the sand unit are expected to be higher than the silty sandy soil present at the site, indicating that the sand unit would act as a conduit for ground water flow. In general, surface drainage at the site is to Culpepper Branch Creek. Based on the data there is clearly a case for the release of inorganics and PAHs. Although VOCs and pesticides were found, there was not a clear pattern as to their release and presence. However, some of the same chemicals were detected in the soils and in the ground water samples. Detects of acetone, methylene chloride, and phthalates are thought to be laboratory contaminants.
RFI Phase III Groundwater Work Plan for Naval Weapons Support Center, Crane, Indiana, McComish Gorge and Old Burn Pit (U.S. ACE WES, June 1991)[6]	Collection of a round of ground water samples from 19 existing monitoring wells to determine rate and extent of migration of contaminated ground water.	July 1992	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Organochlorine Pesticides/PCBs -- SW-846 Method 8080 Organophosphorus Pesticides -- SW-846 Method 8140 Herbicides -- SW-846 Method 8150 Inorganics + CN[5]-- SW-846 Methods 6010/7060/7471/7740 Water Quality Parameters - Various EPA Methods	VOCs (1,2-dichloropropane, cis-1,2-DCE, and TCE), pesticides (4,4'-DDD, 4,4'-DDE, chlordane, beta-BHC, endosulfan II, endrin, endrin aldehyde, and heptachlor), Aroclor-1254, various inorganics (mainly Sb, As, Co, and Fe), and Sulfide	The results of this monitoring program did not confirm the parameters of interest identified in previous ground water sampling. In previous sampling programs, wells in the sand zone showed the highest levels of constituents, indicating a westerly flow of ground water. Conversely, in this sampling program, the highest levels of constituents were found in wells outside the sand zone indicating a north-northwest flow of ground water. Understanding the presence and orientation of the sand zone is important in monitoring the site. Detections of acetone, methylene chloride and BEHP are thought to be a result of laboratory contamination.
Interim Measure Sampling of the Old Burn Pit, SWMU 05/03 for Naval Weapons Support Center, Crane, Indiana (Engineering-Science, Inc., June 1991)	Collection of ten soil samples: eight from the surface soil surrounding drums and from soil inside drums disposed of in the gully at the site. The results of the analysis were used to determine whether the material inside and around the drums were RCRA hazardous wastes.	October 1990	TCLP VOCs -- SW-846 1311/8240 TCLP SVOCs -- SW-846 Method 1311/8270 TCLP Pesticides/PCBs -- SW-846 Method 1311/8080 TCLP Herbicides -- SW-846 Method 1311/8150 TCLP Inorganics -- SW-846 Methods 1311/6010/7060/7470/7740 Explosives -- LW02 (HPLC) Reactive CN -- SW-846 Section 7.3.3.2 Reactive Sulfide -- SW-846 7.3.4.1 Soil pH -- SW-846 Method 9045	The several constituents detected were reported at concentrations less than the regulatory levels for classification as a RCRA hazardous waste. Therefore, there are no parameters of interest.	Analytical results indicate that the material in the drums and the surrounding soil is not classified as a RCRA hazardous waste. The TCLP is a leaching procedure used to simulate the potential for leaching of constituents from soil. The non-detects of constituents in the analytical results indicate that the constituents in the soil surrounding soil and in the drums are not likely to leach to the ground water at significant concentrations.

As Arsenic
Ag Silver
Ba Barium
Be Beryllium
BEHP Bis(2-ethylhexyl)phthalate
bgs Below ground surface
Cd Cadmium
CN Cyanide
Co Cobalt
Cr Chromium
Cu Copper
DCE Dichloroethene
Fe Iron
Hg Mercury
HPLC High Performance Liquid Chromatography
NA Not applicable
Ni Nickel
PAHs Polynuclear Aromatic Hydrocarbons
Pb Lead
PCA Tetrachloroethane
PCBs Polychlorinated Biphenyls
RCRA Resource Conservation and Recovery Act
RFI RCRA Facility Investigation
Sb Antimony
Se Selenium
SVOCs Semivolatile Organic Compounds
SWMU Solid Waste Management Unit
TCE Trichloroethene
TCLP Toxicity Characteristic Leaching Procedure
Tl Thallium
VOCs Volatile Organic Compounds
Zn Zinc

1 Includes, but is not limited to, Hydrogeologic Investigations at Waste Disposal Sites (U.S. ACE WES, 1982), Initial Assessment Study of the Naval Weapons Support Center, Crane, Indiana (NEESA, 1983) and Definition of Contaminated Ground-Water Plumes at Selected Waste Disposal Sites (U.S. ACE WES, 1984).
2 Quarterly monitoring.
3 Semiannual monitoring.
4 Includes select inorganics, pesticides, herbicides, radionuclides, phenol, chloride, fluoride, nitrate, nitrite, sulfate, and total bacteria.
5 Includes phosphorus and tin.
6 Only a portion of the work proposed in the work plan was conducted. Additional proposed monitoring wells were not installed and not all ground water samples collected were analyzed for all proposed chemical constituents or for the same list of constituents. A Groundwater Release Characterization Report was not generated for the sampling effort because of funding issues.

In 1991 a draft Work Plan for a RFI Phase III Ground Water Release Characterization was prepared by USACE (June 1991). The objective of this sampling effort was to determine the rate and extent of constituent migration in the ground water. This study included the collection of samples from the existing 19 monitoring wells and the installation of additional wells.

Because of funding constraints, only a portion of the work proposed in the Work Plan was conducted in 1992. Additional proposed monitoring wells were not installed and not all ground water samples collected were analyzed for all proposed chemical constituents or for the same list of constituents per sample. A Release Characterization Report was not generated for the sampling effort because of funding issues.

Various drums have been found at the site in the gully north of the burn pit. In response to this finding, an interim measures sampling program was conducted in 1990 (Engineering-Science, Inc., June 1991). The field investigation consisted of the collection of eight soil samples from the surficial soil surrounding the drums and two samples from the material within the drums. As presented on Table 6-1, the samples were analyzed to determine whether the soil and material in the drums would be considered RCRA hazardous wastes. Toxicity Characteristic Leaching Procedure (TCLP) results for these samples were less than regulatory limits, indicating that the material in the drums was not classified as a RCRA hazardous waste.

6.4 HAZARD IDENTIFICATION

The hazard identification characterizes those constituents that may be attributable to historical operations at the site. Based on knowledge of site practices and an interpretation of the historical data (i.e., comparison of detected constituents to risk-based screening criteria), a list of detected chemicals of interest was developed for the Old Burn Pit. Detected chemicals of interest are defined as those chemicals, excluding blank contaminants, present at concentrations greater than risk-based screening criteria. Discussions of those constituents detected at concentrations in excess of current human health and ecological screening criteria are provided in Sections 6.4.1 (organics) and 6.4.2 (inorganics). A summary of the detected parameters of interest for SWMU 5 is contained in Section 6.4.3.

Historical site data were compared to human health and ecological criteria to identify chemicals of interest. Summaries of the comparison of historical site data to human health and ecological risk-based criteria are presented in Tables 6-2 (surface soil), 6-3 (subsurface soil), and 6-4 (ground water, unconsolidated aquifers). A brief description of the screening criteria used was provided in Section 4.2 of this Work Plan.

TABLE 6-2

HISTORICAL DATA SUMMARY - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 5 - OLD BURN PIT
NSWC CRANE, INDIANA
PAGE 1 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
Volatile Organics (mg/kg)												
1,1,1-TRICHLOROETHANE	0/9	---	0.0053-0.006	---	0	---	1200	0.1	770	2400	1.9	29.8
1,1,2,2-TETRACHLOROETHANE	0/9	---	0.0053-0.006	---	0	3	0.6	0.0002	0.38	5.4	0.007	0.12722
1,1,2-TRICHLOROETHANE	0/9	---	0.0053-0.006	---	0	11	1	0.0009	0.84	10	0.03	28.6
1,1-DICHLOROETHANE	0/9	---	0.0053-0.006	---	0	7800	1300	1	590	1400	5.6	20.1
1,1-DICHLOROETHENE	0/9	---	0.0053-0.006	---	0	1	0.07	0.003	0.054	0.73	0.058	8.28
1,2-DICHLOROETHANE	0/9	---	0.0053-0.006	---	0	7	0.4	0.001	0.35	4	0.024	21.2
1,2-DICHLOROPROPANE	0/9	---	0.0053-0.006	---	0	9	15	0.001	0.35	5	0.03	32.7
2-BUTANONE	0/9	---	0.11-0.12	---	0	---	---	---	7300	20000	10	89.6
2-HEXANONE	0/9	---	0.053-0.06	---	0	---	---	---	---	---	---	12.6
4-METHYL-2-PENTANONE	0/9	---	0.053-0.06	---	0	---	---	---	790	---	---	443
ACETONE	9/9	0.0046-0.48	---	05/03-07-90 #1 (90)	0	7800	100000	0.8	1600	4200	3.1	2.5
BENZENE	0/9	---	0.0053-0.006	---	0	22	0.8	0.002	0.67	9	0.34	0.25462
BROMODICHLOROMETHANE	0/9	---	0.0053-0.006	---	0	10	3000	0.03	1.0	11	0.63	0.53978
BROMOFORM	0/9	---	0.0053-0.006	---	0	81	53	0.04	62	290	0.75	15.9
BROMOMETHANE	0/9	---	0.011-0.012	---	0	110	10	0.01	3.9	11	0.052	0.23516
CARBON DISULFIDE	0/9	---	0.0053-0.006	---	0	7800	720	2	360	990	10	0.09412
CARBON TETRACHLORIDE	0/9	---	0.0053-0.006	---	0	5	0.3	0.003	0.24	3.6	0.066	2.98
CHLOROBENZENE	0/9	---	0.0053-0.006	---	0	1600	130	0.07	1.0	150	1.3	13.1
CHLOROETHANE	0/9	---	0.011-0.012	---	0	---	---	---	3.0	---	---	---
CHLOROFORM	0/9	---	0.0053-0.006	---	0	100	0.3	0.03	0.24	3.3	0.59	1.19
CHLOROMETHANE	0/9	---	0.011-0.012	---	0	---	---	---	1.2	---	---	10.4
CIS-1,2-DICHLOROETHENE	1/9	0.02	0.0053-0.006	05/03-06-90 #1 (90)	0	780	1200	0.02	43	119	0.4	0.78373[6]
CIS-1,3-DICHLOROPROPENE	0/9	---	0.0053-0.006	---	0	4	0.1	0.0002	---	---	---	0.39786
DIBROMOCHLOROMETHANE	0/9	---	0.0053-0.006	---	0	8	1300	0.02	1.1	---	---	2.05
ETHYLBENZENE	0/9	---	0.0053-0.006	---	0	7800	400	0.7	230	5000	13	5.16
METHYLENE CHLORIDE	8/9	0.014-0.036	0.0057	05/03-07-90 #1 (90)	8	85	13	0.001	8.9	120	0.023	4.05
STYRENE	0/9	---	0.0053-0.006	---	0	16000	1500	0.2	1.0	12000	3.5	4.69
TETRACHLOROETHENE	0/9	---	0.0053-0.006	---	0	12	11	0.003	5.7	50	0.058	9.92
TOLUENE	0/9	---	0.0053-0.006	---	0	16000	650	0.6	520	1800	12	5.45
TRANS-1,2-DICHLOROETHENE	0/9	---	0.0053-0.006	---	0	1600	3100	0.03	63	190	0.68	0.78373
TRANS-1,3-DICHLOROPROPENE	0/9	---	0.0053-0.006	---	0	4	0.1	0.0002	---	---	---	0.39786
TRICHLOROETHENE	2/9	0.0043-0.031	0.0053-0.0058	05/03-08-90 #1 (90)	2	58	5	0.003	2.8	48	0.057	12.4
VINYL ACETATE	0/9	---	0.053-0.06	---	0	78000	1000	8	430	1200	2.3	12.7
VINYL CHLORIDE	0/9	---	0.011-0.012	---	0	0.3	0.03	0.0007	0.022	0.31	0.013	0.64614
XYLENES, TOTAL	0/9	---	0.0053-0.006	---	0	160000	410[6]	9[6]	210	5300	190	10
Semivolatile Organics (mg/kg)												
1,2,4-TRICHLOROBENZENE	0/9	---	0.69-8.1	---	0	780	3200	0.3	6.0	1800	5.3	11.1
1,2-DICHLOROBENZENE	0/9	---	0.69-8.1	---	0	7000	560	0.9	370	3000	17	2.96
1,2-DIPHENYLHYDRAZINE	0/9	---	0.69-8.1	---	0	---	---	---	0.61	---	---	---
1,3-DICHLOROBENZENE	0/9	---	0.69-8.1	---	0	---	---	---	13	114	0.42	37.7
1,4-DICHLOROBENZENE	0/9	---	0.69-8.1	---	0	27	---	0.1	3.0	42	2.2	0.54559
2,4,5-TRICHLOROPHENOL	0/9	---	0.69-8.1	---	0	7800	---	14	6100	18000	250	14.1
2,4,6-TRICHLOROPHENOL	0/9	---	0.69-8.1	---	0	58	200	0.008	44	390	1.5	9.94
2,4-DICHLOROPHENOL	0/9	---	0.69-8.1	---	0	230	---	0.05	1.0	550	1.1	87.5
2,4-DIMETHYLPHENOL	0/9	---	0.69-8.1	---	0	1600	---	0.4	1.0	3600	9	0.01
2,4-DINITROPHENOL	0/9	---	3.4-40	---	0	160	---	0.01	120	360	0.29	0.06086
2,4-DINITROTOLUENE	0/9	---	0.69-8.1	---	0	0.9	---	0.00004	120	---	---	1.28
2,6-DINITROTOLUENE	0/9	---	0.69-8.1	---	0	0.9	---	0.00003	61	---	---	0.03283
2-CHLORONAPHTHALENE	0/9	---	0.69-8.1	---	0	---	---	---	4900	---	---	0.01218
2-CHLOROPHENOL	0/9	---	0.69-8.1	---	0	390	53000	0.2	6.0	380	0.75	0.24266
2-METHYL-4,6-DINITROPHENOL	0/9	---	3.4-40	---	0	---	---	---	---	---	---	---
2-METHYLNAPHTHALENE	3/9	0.052-0.36	0.69-1.13	05/03-08-90 #1 (90)	0	---	---	---	---	---	---	3.24
2-METHYLPHENOL	0/9	---	0.69-8.1	---	0	3900	---	0.8	3100	7600	14	40.4
2-NITROANILINE	0/9	---	3.4-40	---	0	---	---	---	3.5	---	---	74.1

TABLE 6-2

HISTORICAL DATA SUMMARY - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 5 - OLD BURN PIT
NSWC CRANE, INDIANA
PAGE 2 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
2-NITROPHENOL	0/9	---	0.69-8.1	---	0	---	---	---	---	---	---	1.6
3,3'-DICHLOROBENZIDINE	0/9	---	1.4-16	---	0	1	---	0.0003	1.1	9.5	0.062	0.64636
3-NITROANILINE	0/9	---	3.4-40	---	0	---	---	---	---	---	---	3.16
4-BROMOPHENYL PHENYL ETHER	0/9	---	0.69-8.1	---	0	---	---	---	---	---	---	---
4-CHLORO-3-METHYLPHENOL	0/9	---	1.4-16	---	0	---	---	---	---	---	---	7.95
4-CHLOROANILINE	0/9	---	1.4-8.1	---	0	310	---	0.03	240	730	0.97	1.1
4-CHLOROPHENYL PHENYL ETHER	0/9	---	0.69-8.1	---	0	---	---	---	---	---	---	---
4-METHYLPHENOL	0/9	---	0.69-8.1	---	0	---	---	---	310	---	---	163
4-NITROANILINE	0/9	---	3.4-40	---	0	---	---	---	---	---	---	21.9
4-NITROPHENOL	0/9	---	3.4-40	---	0	---	---	---	490	---	---	5.12
ACENAPHTHENE	1/9	0.19	0.69-2.3	05/03-08-90 #1 (90)	0	4700	---	29	3700	9500	130	682
ACENAPHTHYLENE	0/9	---	0.69-8.1	---	0	---	---	---	---	---	---	682
ANILINE	0/9	---	1.4-16	---	0	---	---	---	85	---	---	0.05678
ANTHRACENE	1/9	0.48	0.69-2.3	05/03-08-90 #1 (90)	0	23000	---	590	22000	47000	51	1480
BENZIDINE	0/9	---	3.4-40	---	0	---	---	---	0.0021	---	---	---
BENZO(A)ANTHRACENE	3/9	0.048-2.7	0.69-1.13	05/03-08-90 #1 (90)	2	0.9	---	0.08	0.62	5	5	5.21
BENZO(A)PYRENE	3/9	0.043-2.3	0.69-1.13	05/03-08-90 #1 (90)	2	0.09	---	0.4	0.062	0.5	0.5	1.52
BENZO(B)FLUORANTHENE	3/9	0.046-3.5	0.69-1.13	05/03-08-90 #1 (90)	2	0.9	---	0.2	0.62	5	5	59.8
BENZO(G,H,I)PERYLENE	2/9	0.33-1.2	0.69-1.13	05/03-08-90 #1 (90)	0	---	---	---	---	---	---	119
BENZO(K)FLUORANTHENE	3/9	0.042-1.9	0.69-1.13	05/03-08-90 #1 (90)	0	9	---	2	6.2	50	39	1480
BENZOIC ACID	0/9	---	3.4-40	---	0	310000	---	20	100000	730000	590	---
BENZYL ALCOHOL	0/9	---	1.4-16	---	0	---	---	---	18000	---	---	65.8
BIS(2-CHLOROETHOXY)METHANE	0/9	---	0.69-8.1	---	0	---	---	---	---	---	---	0.30209
BIS(2-CHLOROETHYL)ETHER	0/9	---	0.69-8.1	---	0	0.6	0.2	0.00002	0.21	1.6	0.0007	23.7
BIS(2-CHLOROISOPROPYL) ETHER	0/9	---	0.69-8.1	---	0	---	---	---	6.9	31	0.027	---
BIS(2-ETHYLHEXYL)PHTHALATE	6/9	0.043-0.94	0.69-0.71	05/03-08-90 #1 (90)	1	46	31000	180	35	300	300	0.92594
BUTYLBENZYL PHTHALATE	0/9	---	0.69-8.1	---	0	16000	930	810	12000	36000	930	0.23889
CHRYSENE	3/9	0.093-3.9	0.69-1.13	05/03-08-90 #1 (90)	0	88	---	8	62	500	26	4.73
DI-N-BUTYL PHTHALATE	3/9	0.04-0.2	0.69-8.1	05/03-09-90 #1 (90)	1	7800	2300	270	6100	18000	2300	0.14979
DI-N-OCTYL PHTHALATE	0/9	---	0.69-8.1	---	0	1600	10000	10000	1200	3700	2000	709
DIAZINON	0/9	---	0.11-0.12	---	0	---	---	---	0.062	0.5	0.5	---
DIBENZO(A,H)ANTHRACENE	0/9	---	0.69-8.1	---	0	0.09	---	0.08	290	---	---	18.4
DIBENZOFURAN	2/9	0.039-0.13	0.69-2.3	05/03-08-90 #1 (90)	0	---	---	---	49000	150000	450	---
DIETHYL PHTHALATE	4/9	0.08-0.21	0.69-8.1	05/03-09-90 #1 (90)	0	63000	2000	23	100000	---	---	24.8
DIMETHYL PHTHALATE	0/9	---	0.69-8.1	---	0	---	---	---	2300	6300	880	734
FLUORANTHENE	3/9	0.11-5.1	0.69-1.13	05/03-08-90 #1 (90)	0	3100	---	210	2600	6300	170	122
FLUORENE	1/9	0.18	0.69-2.3	05/03-08-90 #1 (90)	0	3100	---	28	3.0	2.7	2.2	122
HEXACHLOROBENZENE	0/9	---	0.69-8.1	---	0	0.4	1	0.1	6.0	36	16	0.19678
HEXACHLOROBUTADIENE	0/9	---	0.69-8.1	---	0	8	8	0.1	420	1300	400	0.03976
HEXACHLOROCYCLOPENTADIENE	0/9	---	0.69-8.1	---	0	550	10	20	35	183	2.8	0.75537
HEXACHLOROETHANE	0/9	---	0.69-8.1	---	0	46	55	0.02	0.62	5	3	0.59634
INDENO(1,2,3-CD)PYRENE	2/9	0.11-1.4	0.69-1.13	05/03-08-90 #1 (90)	2	0.9	---	0.7	510	4500	5.3	109
ISOPHORONE	0/9	---	0.69-8.1	---	0	670	4600	0.03	0.069	0.61	0.0006	139
N-NITROSO-DI-N-PROPYLAMINE	0/9	---	0.69-8.1	---	0	0.09	---	0.000002	0.0095	---	---	0.54368
N-NITROSODIMETHYLAMINE	0/9	---	0.69-8.1	---	0	---	---	---	9.0	810	9.7	0.0000321
N-NITROSODIPHENYLAMINE	0/9	---	0.69-8.1	---	0	130	---	0.06	56	3200	0.7	0.54514
NAPHTHALENE	4/9	0.043-0.29	0.071-0.78	05/03-08-90 #1 (90)	3	3100	---	4	20	91	0.028	0.09939
NITROBENZENE	0/9	---	0.69-8.1	---	0	39	92	0.007	3.0	20	0.028	1.31
PENTACHLOROPHENOL	0/9	---	3.4-40	---	0	3	---	0.001	---	---	---	0.11927
PHENANTHRENE	3/9	0.16-2.7	0.69-1.13	05/03-08-90 #1 (90)	0	---	---	---	37000	89000	110	45.7
PHENOL	0/9	---	0.69-8.1	---	0	47000	---	5	2300	5500	570	120
PYRENE	3/9	0.098-7.4	0.69-1.13	05/03-08-90 #1 (90)	0	2300	---	210				78.5
Pesticides/PCBs/Herbicides (mg/kg)									610	---	---	
2,4,5-T	0/9	---	0.07-0.081	---	0	---	---	---	490	---	---	0.59634
2,4,5-TP (SILVEX)	0/9	---	0.0595-0.069	---	0	---	---	---	690	---	---	0.1088

TABLE 6-2

HISTORICAL DATA SUMMARY - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 5 - OLD BURN PIT
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[7]		Surface Soil	Subsurface Soil	
2,4-D	0/9	---	0.42-0.48	---	0	---	---	---	2.4	28	28	0.02725
4,4'-DDD	2/9	0.0008-0.0053	0.008-0.09	05/03-06-90 #1 (90)	0	3	---	0.8	1.7	20	20	0.75815
4,4'-DDE	3/9	0.00019-0.0066	0.003-0.033	05/03-09-90 #1 (90)	0	2	---	3	1.7	20	20	0.59587
4,4'-DDT	5/9	0.0004-0.0061	0.0092-0.098	05/03-01-90#1(90)	0	2	---	2	0.029	0.25	0.25	0.0175
ALDRIN	0/9	---	0.0029-0.033	---	0	0.04	3	0.02	0.090	0.99	0.0072	0.00332
ALPHA-BHC	0/9	---	0.0022-0.024	---	0	0.1	0.8	0.00003	---	---	---	0.09939
ALPHA-CHLORDANE	6/9	0.001-0.003	0.0038-0.041	05/03-07-90 #1 (90)	0	0.5[10]	20[10]	0.5[10]	3.9	---	---	0.224[10]
AROCLOR-1016	0/9	---	0.047-0.53	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1221	0/9	---	0.047-0.53	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1232	0/9	---	0.047-0.53	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1242	0/9	---	0.047-0.53	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1248	0/9	---	0.047-0.53	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1254	0/9	---	0.01-1.1	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1260	0/9	---	0.01-1.1	---	0	1[11]	---	---	0.32	3.5	0.026	0.000332[11]
BETA-BHC	0/9	---	0.0043-0.049	---	0	0.4	---	0.0001	55	---	---	0.00398
DELTA-BHC	0/9	---	0.0065-0.073	---	0	---	---	---	---	---	---	9.94
DIELDRIN	4/9	0.0011-0.0044	0.0015-0.016	05/03-01-90#1(90)	4	0.04	1	0.0002	0.030	0.27	0.046	0.00238
ENDOSULFAN I	1/9	0.014	0.01-0.11	05/03-09-90 #1 (90)	0	470[12]	---	0.9[12]	370	1100	20	0.11927
ENDOSULFAN II	0/9	---	0.0029-0.033	---	0	470[12]	---	0.9[12]	---	---	---	0.11927
ENDOSULFAN SULFATE	0/9	---	0.048-0.54	---	0	---	---	---	---	---	---	0.03578
ENDRIN	2/9	0.013-0.015	0.0043-0.0047	05/03-08-90 #1 (90)	2	23	---	0.05	18	54	0.99	0.0101
ENDRIN ALDEHYDE	0/9	---	0.017-0.19	---	0	---	---	---	---	---	---	0.0105
ETHION	0/9	---	0.028-0.032	---	0	---	---	---	31	---	---	---
ETHYL PARATHION	0/9	---	0.032-0.036	---	0	---	---	---	370	---	---	---
ETHYL TRITHION	0/9	---	0.035-0.039	---	0	---	---	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/9	---	0.0029-0.033	---	0	0.5	---	0.0005	0.44	4.8	0.0094	0.005
GAMMA-CHLORDANE	1/7	0.00077	0.0037-0.041	05/03-01-90#1(90)	0	0.5[10]	20[10]	0.5[10]	1.6	---	---	0.224[10]
HEPTACHLOR	4/9	0.00018-0.00064	0.0022-0.024	05/03-05-90 #1-AVG (90)	0	0.1	0.1	1	0.11	0.56	0.56	0.00598
HEPTACHLOR EPOXIDE	1/9	0.00006	0.06-0.68	05/03-07-90 #1 (90)	0	0.07	5	0.03	0.053	0.46	0.46	0.15188
MALATHION	0/9	---	0.06-0.067	---	0	---	---	---	1200	---	---	---
METHOXYCHLOR	1/9	0.0019	0.13-1.4	05/03-04-90 #1 (90)	0	390	---	8	310	900	160	0.01988
METHYL PARATHION	0/9	---	0.065-0.073	---	0	---	---	---	15	---	---	0.000292
TOXAPHENE	0/9	---	0.17-1.95	---	0	0.6	89	2	0.44	3.9	3.9	0.11927
Inorganics (mg/kg)												
ALUMINUM	9/9	7640-27300	---	05/03-08-90 #1 (90)	0	---	---	---	76000	---	---	---
ANTIMONY	4/9	4.3-43	1.5	05/03-09-90 #1 (90)	4	31	---	0.3	31	138	5.4	0.1423
ARSENIC	9/9	4.86-35.7	---	05/03-09-90 #1 (90)	9	0.4	750	1	0.39	3.9	3.9	5.7
BARIUM	9/9	36.4-4960	---	05/03-08-90 #1 (90)	9	5500	690000	82	5400	24000	1600	1.04
BERYLLIUM	9/9	1.2-6.09	---	05/03-09-90 #1 (90)	9	0.1	1300	3	150	1.9	1.9	1.06
CADMIUM	7/9	0.5-46.6	0.4	05/03-08-90 #1 (90)	7	78	1800	0.4	37	12	7.5	0.00222
CALCIUM	9/9	291-26900	---	05/03-08-90 #1 (90)	0	---	---	---	---	---	---	---
CHROMIUM (TOTAL)	9/9	16.4-251	---	05/03-08-90 #1 (90)	9	390	270	2	210	470	38	0.4
COBALT	9/9	5.1-23.8	---	05/03-09-90 #1 (90)	9	---	---	---	4700	---	---	0.14033
COPPER	9/9	12.1-2010	---	05/03-08-90 #1 (90)	9	---	---	---	2900	13000	580	0.3132
IRON	9/9	18600-133000	---	05/03-09-90 #1 (90)	2	---	---	---	23000	---	---	---
LEAD	9/9	16-2720	---	05/03-09-90 #1 (90)	9	400[14]	---	---	400	350	81	0.05373
MAGNESIUM	9/9	732-6790	---	05/03-08-90 #1 (90)	0	---	---	---	---	---	---	---
MANGANESE	9/9	184-1420	---	05/03-09-90 #1 (90)	0	---	---	---	1800	---	---	---
MERCURY	6/9	0.117-1.06	0.1	05/03-08-90 #1 (90)	6	23	10	0.1	---	55	2.1	0.1
NICKEL	9/9	11.3-126	---	05/03-06-90 #1 (90)	9	1600	13000	7	1600	6900	130	13.6
SELENIUM	4/9	0.345-0.57	0.3	05/03-08-90 #1 (90)	4	390	---	0.3	390	1700	5.2	0.02765
SILVER	5/9	1.3-27.2	1.3	05/03-08-90 #1 (90)	3	390	---	2	390	1700+	31	4.04
SODIUM	9/9	29.2-1300	---	05/03-08-90 #1 (90)	0	---	---	---	---	---	---	---
THALLIUM	2/9	0.2-0.27	0.2	05/03-04-90 #1 (90)	2	---	---	0.04	---	31	2.9	0.05692

TABLE 6-2

HISTORICAL DATA SUMMARY - SURFACE SOIL (0 TO 2 FEET BGS)
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
ZINC	9/9	34.2-5080	---	05/03-09-90 #1 (90)	9	23000	---	620	23000	104000	10000	6.62
Miscellaneous Parameters (mg/kg)												
TOTAL PHOSPHORUS	9/9	41.4-1020	---	05/03-08-90 #1 (90)	9	---	---	---	1.6	---	---	---

--- Not applicable/Not available.

BGS Below ground surface
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
OSWER Office of Solid Waste and Emergency Response
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SSL Soil Screening Level
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, May 1996.
2 Because of karst geologic conditions present at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
3 U.S. EPA, Region 9, May 1998.
4 IDEM, October 1997.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 trans-1,2-Dichloroethene.
7 1,3-Dichloropropene.
8 o-Xylene.
9 m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Hexavalent chromium.
14 OSWER soil screening level for residential land use (U.S. EPA, July 1994).
15 Thallium carbonate.

TABLE 6-3

HISTORICAL DATA SUMMARY - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 5 - OLD BURN PIT
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
Volatile Organics (mg/kg)												
1,1,1-TRICHLOROETHANE	0/6	---	0.0054-0.026	---	0	---	1200	0.1	770	2400	1.9	29.8
1,1,2,2-TETRACHLOROETHANE	1/6	0.022	0.0054-0.0059	05/03-08-90 #2 (90)	1	3	0.6	0.0002	0.38	5.4	0.007	0.12722
1,1,2-TRICHLOROETHANE	0/6	---	0.0054-0.026	---	0	11	1	0.0009	0.84	10	0.03	28.6
1,1-DICHLOROETHANE	0/6	---	0.0054-0.026	---	0	7800	1300	1	590	1400	5.6	20.1
1,1-DICHLOROETHENE	0/6	---	0.0054-0.026	---	0	1	0.07	0.003	0.054	0.73	0.058	8.28
1,2-DICHLOROETHANE	0/6	---	0.0054-0.026	---	0	7	0.4	0.001	0.35	4	0.024	21.2
1,2-DICHLOROPROPANE	0/6	---	0.0054-0.026	---	0	9	15	0.001	0.35	5	0.03	32.7
2-BUTANONE	0/6	---	0.11-0.52	---	0	---	---	---	7300	20000	10	89.6
2-HEXANONE	0/6	---	0.054-0.26	---	0	---	---	---	---	---	---	12.6
4-METHYL-2-PENTANONE	0/6	---	0.054-0.26	---	0	---	---	---	790	---	---	443
ACETONE	5/6	0.002-1	0.52	05/03-03-90 #2 (90)	1	7800	100000	0.8	1600	4200	3.1	2.5
BENZENE	0/6	---	0.0054-0.026	---	0	22	0.8	0.002	0.67	9	0.34	0.25462
BROMODICHLOROMETHANE	0/6	---	0.0054-0.026	---	0	10	3000	0.03	1.0	11	0.63	0.53978
BROMOFORM	0/6	---	0.0054-0.026	---	0	81	53	0.04	62	290	0.75	15.9
BROMOMETHANE	0/6	---	0.011-0.052	---	0	110	10	0.01	3.9	11	0.052	0.23516
CARBON DISULFIDE	0/6	---	0.0054-0.026	---	0	7800	720	2	360	990	10	0.09412
CARBON TETRACHLORIDE	0/6	---	0.0054-0.026	---	0	5	0.3	0.003	0.24	3.6	0.066	2.98
CHLOROBENZENE	0/6	---	0.0054-0.026	---	0	1600	130	0.07	1.0	150	1.3	13.1
CHLOROETHANE	0/6	---	0.011-0.052	---	0	---	---	---	3.0	---	---	---
CHLOROFORM	1/6	0.95	0.0054-0.0059	05/03-08-90 #2 (90)	1	100	0.3	0.03	0.24	3.3	0.59	1.19
CHLOROMETHANE	0/6	---	0.011-0.052	---	0	---	---	---	1.2	---	---	10.4
CIS-1,2-DICHLOROETHENE	1/6	0.03	0.0054-0.026	05/03-04-90 #2 (90)	1	780	1200	0.02	43	119	0.4	0.78373[6]
CIS-1,3-DICHLOROPROPENE	0/6	---	0.0054-0.026	---	0	4	0.1	0.0002	---	---	---	0.39786
DIBROMOCHLOROMETHANE	0/6	---	0.0054-0.026	---	0	8	1300	0.02	1.1	---	---	2.05
ETHYLBENZENE	0/6	---	0.0054-0.026	---	0	7800	400	0.7	230	5000	13	5.16
METHYLENE CHLORIDE	5/6	0.018-0.3	0.0054	05/03-08-90 #2 (90)	5	85	13	0.001	8.9	120	0.023	4.05
STYRENE	0/6	---	0.0054-0.026	---	0	16000	1500	0.2	1.0	12000	3.5	4.69
TETRACHLOROETHENE	0/6	---	0.0054-0.026	---	0	12	11	0.003	5.7	50	0.058	9.92
TOLUENE	0/6	---	0.0054-0.026	---	0	16000	650	0.6	520	1800	12	5.45
TRANS-1,2-DICHLOROETHENE	0/6	---	0.0054-0.026	---	0	1600	3100	0.03	63	190	0.68	0.78373
TRANS-1,3-DICHLOROPROPENE	0/6	---	0.0054-0.026	---	0	4	0.1	0.0002	---	---	---	0.39786
TRICHLOROETHENE	0/6	---	0.0054-0.026	---	0	58	5	0.003	2.8	48	0.057	12.4
VINYL ACETATE	0/6	---	0.054-0.26	---	0	78000	1000	8	430	1200	2.3	12.7
VINYL CHLORIDE	1/6	0.0002	0.011-0.052	05/03-04-90 #2 (90)	0	0.3	0.03	0.0007	0.022	0.31	0.013	0.64614
XYLENES, TOTAL	0/6	---	0.0054-0.026	---	0	160000	410[6]	9[6]	210	5300	190	10
Semivolatile Organics (mg/kg)												
1,2,4-TRICHLOROBENZENE	0/7	---	0.72-7.8	---	0	780	3200	0.3	6.0	1800	5.3	11.1
1,2-DICHLOROBENZENE	0/7	---	0.72-7.8	---	0	7000	560	0.9	370	3000	17	2.96
1,2-DIPHENYLHYDRAZINE	0/7	---	0.72-7.8	---	0	---	---	---	0.61	---	---	---
1,3-DICHLOROBENZENE	0/7	---	0.72-7.8	---	0	---	---	---	13	114	0.42	37.7
1,4-DICHLOROBENZENE	0/7	---	0.72-7.8	---	0	27	---	0.1	3.0	42	2.2	0.54559
2,4,5-TRICHLOROPHENOL	0/7	---	0.72-7.8	---	0	7800	---	14	6100	18000	250	14.1
2,4,6-TRICHLOROPHENOL	0/7	---	0.72-7.8	---	0	58	200	0.008	44	390	1.5	9.94
2,4-DICHLOROPHENOL	0/7	---	0.72-7.8	---	0	230	---	0.05	1.0	550	1.1	87.5
2,4-DIMETHYLPHENOL	0/7	---	0.72-7.8	---	0	1600	---	0.4	1.0	3600	9	0.01
2,4-DINITROPHENOL	0/7	---	3.6-39	---	0	160	---	0.01	120	360	0.29	0.06086
2,4-DINITROTOLUENE	0/7	---	0.72-7.8	---	0	0.9	---	0.00004	120	---	---	1.28
2,6-DINITROTOLUENE	0/7	---	0.72-7.8	---	0	0.9	---	0.00003	61	---	---	0.03283
2-CHLORONAPHTHALENE	0/7	---	0.72-7.8	---	0	---	---	---	4900	---	---	0.01218
2-CHLOROPHENOL	0/7	---	0.72-7.8	---	0	390	53000	0.2	6.0	380	0.75	0.24266
2-METHYL-4,6-DINITROPHENOL	0/7	---	3.6-39	---	0	---	---	---	---	---	---	---
2-METHYLNAPHTHALENE	3/7	0.074-0.32	0.72-1.6	05/03-06-90 #2 (90), 05/03-08-90 #2 (90)	0	---	---	---	---	---	---	3.24
2-METHYLPHENOL	1/7	0.12	0.72-7.8	05/03-06-90 #2 (90)	0	3900	---	0.8	3100	7600	14	40.4

TABLE 6-3

HISTORICAL DATA SUMMARY - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 5 - OLD BURN PIT
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
2-NITROANILINE	0/7	---	3.5-39	---	0	---	---	---	3.5	---	---	74.1
2-NITROPHENOL	0/7	---	0.72-7.8	---	0	---	---	---	---	---	---	1.6
3,3'-DICHLOROBENZIDINE	0/7	---	1.4-16	---	0	1	---	0.0003	1.1	9.5	0.062	0.64636
3-NITROANILINE	0/7	---	3.5-39	---	0	---	---	---	---	---	---	3.16
4-BROMOPHENYL PHENYL ETHER	0/7	---	0.72-7.8	---	0	---	---	---	---	---	---	---
4-CHLORO-3-METHYLPHENOL	0/7	---	1.4-16	---	0	---	---	---	---	---	---	7.95
4-CHLOROANILINE	0/7	---	1.4-7.8	---	0	310	---	0.03	240	730	0.97	1.1
4-CHLOROPHENYL PHENYL ETHER	0/7	---	0.72-7.8	---	0	---	---	---	---	---	---	---
4-METHYLPHENOL	1/7	0.33	0.72-7.8	05/03-06-90 #2 (90)	0	---	---	---	310	---	---	163
4-NITROANILINE	0/7	---	3.5-39	---	0	---	---	---	---	---	---	21.9
4-NITROPHENOL	0/7	---	3.6-39	---	0	---	---	---	490	---	---	5.12
ACENAPHTHENE	2/7	0.053-0.63	0.72-1.6	05/03-08-90 #2 (90)	0	4700	---	29	3700	9500	130	682
ACENAPHTHYLENE	0/7	---	0.72-7.8	---	0	---	---	---	---	---	---	682
ANILINE	0/7	---	1.4-16	---	0	---	---	---	85	---	---	0.05678
ANTHRACENE	2/7	0.095-1.5	0.72-1.6	05/03-08-90 #2 (90)	0	23000	---	590	22000	47000	51	1480
BENZIDINE	0/7	---	3.6-39	---	0	---	---	---	0.0021	---	---	---
BENZO(A)ANTHRACENE	2/7	0.091-4.4	0.72-1.6	05/03-08-90 #2 (90)	2	0.9	---	0.08	0.62	5	5	5.21
BENZO(A)PYRENE	2/7	0.039-3.5	0.72-1.6	05/03-08-90 #2 (90)	1	0.09	---	0.4	0.062	0.5	0.5	1.52
BENZO(B)FLUORANTHENE	2/7	0.044-5	0.72-1.6	05/03-08-90 #2 (90)	1	0.9	---	0.2	0.62	5	5	59.8
BENZO(G,H,I)PERYLENE	1/7	1.6	0.72-1.6	05/03-08-90 #2 (90)	0	---	---	---	---	---	---	119
BENZO(K)FLUORANTHENE	2/7	0.038-2.6	0.72-1.6	05/03-08-90 #2 (90)	1	9	---	2	6.2	50	39	1480
BENZOIC ACID	0/7	---	3.6-39	---	0	310000	---	20	100000	730000	590	---
BENZYL ALCOHOL	0/7	---	1.4-16	---	0	---	---	---	18000	---	---	65.8
BIS(2-CHLOROETHOXY)METHANE	0/7	---	0.72-7.8	---	0	---	---	---	---	---	---	0.30209
BIS(2-CHLOROETHYL)ETHER	0/7	---	0.72-7.8	---	0	0.6	0.2	0.00002	0.21	1.6	0.0007	23.7
BIS(2-CHLOROISOPROPYL) ETHER	0/7	---	0.72-7.8	---	0	---	---	---	6.9	31	0.027	---
BIS(2-ETHYLHEXYL)PHTHALATE	3/7	1.9-2.3	0.72-1.6	05/03-05-90 #2 (90)	3	46	31000	180	35	300	300	0.92594
BUTYLBENZYL PHTHALATE	0/7	---	0.72-7.8	---	0	16000	930	810	12000	36000	930	0.23889
CHRYSENE	2/7	0.14-6.1	0.72-1.6	05/03-08-90 #2 (90)	1	88	---	8	62	500	26	4.73
DI-N-BUTYL PHTHALATE	2/7	0.064-0.34	0.72-7.8	05/03-06-90 #2 (90)	1	7800	2300	270	6100	18000	2300	0.14979
DI-N-OCTYL PHTHALATE	0/7	---	0.72-7.8	---	0	1600	10000	10000	1200	3700	2000	709
DIBENZO(A,H)ANTHRACENE	0/7	---	0.72-7.8	---	0	0.09	---	0.08	0.062	0.5	0.5	18.4
DIBENZOFURAN	2/7	0.053-0.52	0.72-1.6	05/03-08-90 #2 (90)	0	---	---	---	290	---	---	---
DIETHYL PHTHALATE	2/7	0.12-0.15	0.72-7.8	05/03-06-90 #2 (90)	0	63000	2000	23	49000	150000	450	24.8
DIMETHYL PHTHALATE	0/7	---	0.72-7.8	---	0	---	---	---	100000	---	---	734
FLUORANTHENE	3/7	0.046-7.8	0.72-1.6	05/03-08-90 #2 (90)	0	3100	---	210	2300	6300	880	122
FLUORENE	2/7	0.061-0.87	0.72-1.6	05/03-08-90 #2 (90)	0	3100	---	28	2600	6300	170	122
HEXACHLOROBENZENE	0/7	---	0.72-7.8	---	0	0.4	1	0.1	3.0	2.7	2.2	0.19678
HEXACHLOROBUTADIENE	0/7	---	0.72-7.8	---	0	8	8	0.1	6.0	36	16	0.03976
HEXACHLOROCYCLOPENTADIENE	0/7	---	0.72-7.8	---	0	550	10	20	420	1300	400	0.75537
HEXACHLOROETHANE	0/7	---	0.72-7.8	---	0	46	55	0.02	35	183	2.8	0.59634
INDENO(1,2,3-CD)PYRENE	1/7	1.6	0.72-1.6	05/03-08-90 #2 (90)	1	0.9	---	0.7	0.62	5	3	109
ISOPHORONE	0/7	---	0.72-7.8	---	0	670	4600	0.03	510	4500	5.3	139
N-NITROSO-DI-N-PROPYLAMINE	0/7	---	0.72-7.8	---	0	0.09	---	0.000002	0.069	0.61	0.0006	0.54368
N-NITROSODIMETHYLAMINE	0/7	---	0.72-7.8	---	0	---	---	---	0.0095	---	---	0.0000321
N-NITROSODIPHENYLAMINE	0/7	---	0.72-7.8	---	0	130	---	0.06	9.0	810	9.7	0.54514
NAPHTHALENE	3/7	0.096-0.94	0.72-1.6	05/03-08-90 #2 (90)	2	3100	---	4	56	3200	0.7	0.09939
NITROBENZENE	0/7	---	0.72-7.8	---	0	39	92	0.007	20	91	0.028	1.31
PENTACHLOROPHENOL	0/7	---	3.6-39	---	0	3	---	0.001	3.0	20	0.028	0.11927
PHENANTHRENE	3/7	0.098-7.4	0.72-1.6	05/03-08-90 #2 (90)	0	---	---	---	---	---	---	45.7
PHENOL	0/7	---	0.72-7.8	---	0	47000	---	5	37000	89000	110	120
PYRENE	3/7	0.057-12	0.72-1.6	05/03-08-90 #2 (90)	0	2300	---	210	2300	5500	570	78.5
Pesticides/PCBs/Herbicides (mg/kg)												
2,4,5-T	0/7	---	0.067-0.084	---	0	---	---	---	610	---	---	0.59634
2,4,5-TP (SILVEX)	0/7	---	0.057-0.071	---	0	---	---	---	490	---	---	0.1088

TABLE 6-3

HISTORICAL DATA SUMMARY - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 5 - OLD BURN PIT
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
2,4-D	0/7	---	0.4-0.5	---	0	---	---	---	690	---	---	0.02725
4,4'-DDD	0/7	---	0.0069-0.086	---	0	3	---	0.8	2.4	28	28	0.75815
4,4'-DDE	4/7	0.0026-0.017	0.0029-0.031	05/03-05-90 #2 (90)	0	2	---	3	1.7	20	20	0.59587
4,4'-DDT	3/7	0.00039-0.022	0.0089-0.094	05/03-05-90 #2 (90)	1	2	---	2	1.7	20	20	0.0175
ALDRIN	0/7	---	0.0029-0.031	---	0	0.04	3	0.02	0.029	0.25	0.25	0.00332
ALPHA-BHC	0/7	---	0.0022-0.024	---	0	0.1	0.8	0.00003	0.090	0.99	0.0072	0.09939
ALPHA-CHLORDANE	4/7	0.00061-0.0035	0.0038-0.039	05/03-05-90 #2 (90)	0	0.5[10]	20[10]	0.5[10]	---	---	---	0.224[10]
AROCLOR-1016	0/7	---	0.047-0.51	---	0	1[11]	---	---	3.9	---	---	0.000332[11]
AROCLOR-1221	0/7	---	0.047-0.51	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1232	0/7	---	0.047-0.51	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1242	0/7	---	0.047-0.51	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1248	0/7	---	0.047-0.51	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1254	0/7	---	0.094-1	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
AROCLOR-1260	0/7	---	0.094-1	---	0	1[11]	---	---	0.22	---	---	0.000332[11]
BETA-BHC	0/7	---	0.0044-0.047	---	0	0.4	---	0.0001	0.32	3.5	0.026	0.00398
DELTA-BHC	0/7	---	0.0065-0.071	---	0	---	---	---	55	---	---	9.94
DIAZINON	0/7	---	0.11-0.12	---	0	---	---	---	---	---	---	---
DIELDRIN	1/7	0.014	0.0014-0.016	05/03-02-90 #2 (90)	1	0.04	1	0.0002	0.030	0.27	0.046	0.00238
ENDOSULFAN I	2/7	0.0036-0.0042	0.01-0.11	05/03-05-90 #2 (90)	0	470[12]	---	0.9[12]	370	1100	20	0.11927[12]
ENDOSULFAN II	0/7	---	0.0029-0.031	---	0	470[12]	---	0.9[12]	---	---	---	0.11927[12]
ENDOSULFAN SULFATE	0/7	---	0.048-0.52	---	0	---	---	---	---	---	---	0.03578
ENDRIN	0/7	---	0.0044-0.047	---	0	23	---	0.05	18	54	0.99	0.0101
ENDRIN ALDEHYDE	0/7	---	0.017-0.18	---	0	---	---	---	---	---	---	0.0105
ETHION	0/7	---	0.028-0.03	---	0	---	---	---	31	---	---	---
ETHYL PARATHION	0/7	---	0.032-0.035	---	0	---	---	---	370	---	---	---
ETHYL TRITHION	0/7	---	0.035-0.038	---	0	---	---	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/7	---	0.0029-0.031	---	0	0.5	---	0.0005	0.44	4.8	0.0094	0.005
GAMMA-CHLORDANE	0/5	---	0.0038-0.039	---	0	0.5[10]	20[10]	0.5[10]	1.6	---	---	0.224[10]
HEPTACHLOR	4/7	0.00027-0.00065	0.0022-0.024	05/03-05-90 #2 (90)	0	0.1	0.1	1	0.11	0.56	0.56	0.00598
HEPTACHLOR EPOXIDE	0/7	---	0.06-0.65	---	0	0.07	5	0.03	0.053	0.46	0.46	0.15188
MALATHION	0/7	---	0.06-0.064	---	0	---	---	---	1200	---	---	---
METHOXYCHLOR	1/7	0.00091	0.13-1.4	05/03-04-90 #2 (90)	0	390	---	8	310	900	160	0.01988
METHYL PARATHION	0/7	---	0.065-0.07	---	0	---	---	---	15	---	---	0.000292
TOXAPHENE	0/7	---	0.17-1.88	---	0	0.6	89	2	0.44	3.9	3.9	0.11927
Inorganics (mg/kg)												
ALUMINUM	7/7	8080-23600	---	05/03-04-90 #2 (90)	0	---	---	---	76000	---	---	---
ANTIMONY	3/7	6.11-44.7	1.5	05/03-08-90 #2 (90)	3	31	---	0.3	31	138	5.4	0.1423
ARSENIC	7/7	5.67-26.8	---	05/03-08-90 #2 (90)	7	0.4	750	1	0.39	3.9	3.9	5.7
BARIUM	7/7	29.7-5040	---	05/03-08-90 #2 (90)	7	5500	690000	82	5400	24000	1600	1.04
BERYLLIUM	7/7	1.3-7.99	---	05/03-08-90 #2 (90)	7	0.1	1300	3	150	1.9	1.9	1.06
CADMIUM	5/7	0.5-68.5	0.4	05/03-05-90 #2 (90)	5	78	1800	0.4	37	12	7.5	0.00222
CALCIUM	7/7	324-23900	---	05/03-08-90 #2 (90)	0	---	---	---	---	---	---	---
CHROMIUM (TOTAL)	7/7	12-504	---	05/03-08-90 #2 (90)	7	390	270	2	210	470	38	0.4
COBALT	7/7	4.5-32.9	---	05/03-08-90 #2 (90)	7	---	---	---	4700	---	---	0.14033
COPPER	7/7	9-1940	---	05/03-08-90 #2 (90)	7	---	---	---	2900	13000	580	0.3132
IRON	7/7	18500-205000	---	05/03-08-90 #2 (90)	4	---	---	---	23000	---	---	---
LEAD	7/7	8.4-2010	---	05/03-08-90 #2 (90)	7	400[14]	---	---	400	350	81	0.05373
MAGNESIUM	7/7	625-3790	---	05/03-08-90 #2 (90)	0	---	---	---	---	---	---	---
MANGANESE	7/7	295-1190	---	05/03-08-90 #2 (90)	0	---	---	---	1800	---	---	---
MERCURY	3/7	0.117-0.617	0.1	05/03-08-90 #2 (90)	3	23	10	0.1	---	55	2.1	0.1
NICKEL	7/7	11-208	---	05/03-08-90 #2 (90)	7	1600	13000	7	1600	6900	130	13.6
SELENIUM	3/7	0.31-1.66	0.3	05/03-08-90 #2 (90)	3	390	---	0.3	390	1700	5.2	0.02765
SILVER	4/7	1.3-24.8	1.3	05/03-08-90 #2 (90)	2	390	---	2	390	1700	31	4.04
SODIUM	7/7	31.4-758	---	05/03-08-90 #2 (90)	0	---	---	---	---	---	---	---

TABLE 6-3

HISTORICAL DATA SUMMARY - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 5 - OLD BURN PIT
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
THALLIUM	2/7	0.2	0.2	05/03-02-90 #2 (90), 05/03-03-90 #2 (90)	2	---	---	0.04	---	31	2.9	0.05692
ZINC	7/7	43.5-3090	---	05/03-08-90 #2 (90)	7	23000	---	620	23000	104000	10000	6.62
Miscellaneous Parameters (mg/kg)												
TOTAL PHOSPHORUS	7/7	89.5-801	---	05/03-08-90 #2 (90)	7	---	---	---	1.6	---	---	---

--- Not applicable/Not available.

BGS Below ground surface
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
OSWER Office of Solid Waste and Emergency Response
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SSL Soil Screening Level
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, May 1996.
2 Because of karst geologic conditions present at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
3 U.S. EPA, Region 9, May 1998.
4 IDEM, October 1997.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 trans-1,2-Dichloroethene.
7 1,3-Dichloropropene.
8 o-Xylene.
9 m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Hexavalent chromium.
14 OSWER soil screening level for residential land use (U.S. EPA, July 1994).
15 Thallium carbonate.

TABLE 6-4

HISTORICAL DATA SUMMARY - GROUND WATER, UNCONSOLIDATED AQUIFERS
SWMU 5 - OLD BURN PIT
NSWC CRANE, INDIANA
PAGE 1 OF 5

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	5/37	2-28	1-5	05-17 (83b) (02/10/83)	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/24	---	1-5	---	0	---	0.055	0.9	---	13
1,1,2-TRICHLOROETHANE	0/24	---	1-5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/24	---	1-5	---	0	---	810	990	---	47
1,1-DICHLOROETHENE	2/37	1-3	1-5	05-04 (82f) (11/04/82)	2	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/24	---	1-5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	2/24	0.2-0.4	1-5	05-19 (92) (07/14/92)	2	5	0.16	5	---	380
1,3-DICHLOROPROPENE	0/6	---	1	---	0	---	0.081	1.3	---	7.9
2-BUTANONE	0/17	---	100	---	0	---	1900	2500	---	7100
2-CHLOROETHYL VINYL ETHER	0/7	---	1-2	---	0	---	---	---	---	---
2-HEXANONE	0/17	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/17	---	50	---	0	---	160	---	---	3680
ACETONE	17/17	1.9-66	---	05-13 (92) (07/14/92)	0	---	610	770	---	78000
ACROLEIN	0/1	---	100	---	0	---	0.042	0.056	---	0.205
ACRYLONITRILE	0/1	---	100	---	0	---	0.039	---	---	0.89
BENZENE	2/24	4-23	1-5	05-16 (83a) (01/13/83)	2	5	0.41	5	---	114
BROMODICHLOROMETHANE	0/24	---	1-5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/24	---	1-5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/24	---	2-10	---	0	---	8.7	11	---	---
CARBON DISULFIDE	0/17	---	5	---	0	---	1000	1300	---	84.1
CARBON TETRACHLORIDE	0/24	---	1-5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/24	---	1-5	---	0	100	110	100	20[7]	10
CHLOROETHANE	0/24	---	2-10	---	0	---	4.6	---	---	230000
CHLOROFORM	9/31	3-70	1-5	05-12 (82f) (11/04/82)	9	80[6]	0.16	100	---	79
CHLOROMETHANE	0/24	---	2-10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	4/17	7.4-160	5	05-13 (92) (07/14/92)	2	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/18	---	1-5	---	0	---	0.081(8)	---	---	7.9
DIBROMOCHLOROMETHANE	0/23	---	1	---	0	80[6]	0.13	---	---	6400
DICHLORODIFLUOROMETHANE	0/1	---	10	---	0	---	390	---	---	---
ETHYLBENZENE	0/24	---	1-5	---	0	700	1300	700	---	17.2
FLUORODICHLOROMETHANE	0/6	---	2	---	0	---	---	---	---	---
METHYLENE CHLORIDE	22/31	1-8	1	05-17 (83b) (02/10/83)	20	5	4.3	5	---	430
STYRENE	0/17	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	1/31	1	1-5	05-09 (82f) (11/04/82)	0	5	1.1	5	---	8.9
TOLUENE	1/24	1	1-5	05-01 (92) (07/14/92)	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	11/44	2-3800	1-5	05-04 (82f) (11/04/82)	5	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/18	---	1-5	---	0	---	0.081(8)	---	---	7.9
TRICHLOROETHENE	20/44	1-3700	1-5	05-04 (82f) (11/04/82)	19	5	1.6	5	---	75
TRICHLOROFLUOROMETHANE	4/14	1-3	1	05-17 (83b) (02/10/83)	0	---	1300		---	---
VINYL ACETATE	0/17	---	50	---	0	---	410	550	---	248.03
VINYL CHLORIDE	1/31	2	1-10	05-12 (82f) (11/04/82)	1	2	0.02	2	---	9.2
XYLENES, TOTAL	0/17	---	5	---	0	10000	1400(9)	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/16	---	10	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/22	---	1-10	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/16	---	10	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/22	---	1-10	---	0	600	5.5	22	---	87
1,4-DICHLOROBENZENE	0/22	---	1-10	---	0	75	0.50	75	---	43
2,4,5-TRICHLOROPHENOL	0/16	---	10	---	0	---	3600	3600	1[7]	---
2,4,6-TRICHLOROPHENOL	0/16	---	10	---	0	---	6.1	77	1[7]	2
2,4-DICHLOROPHENOL	0/16	---	10	---	0	---	110	110	0.3[7]	18
2,4-DIMETHYLPHENOL	0/16	---	10	---	0	---	730	730	400[7]	100.17

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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water[5]
2,4-DINITROPHENOL	0/16	---	50	---	0	---	73	73	---	4.07
2,4-DINITROTOLUENE	0/16	---	10	---	0	---	73	---	---	230
2,6-DINITROTOLUENE	0/16	---	10	---	0	---	37	---	---	42
2-CHLORONAPHTHALENE	0/16	---	10	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/16	---	10	---	0	---	30	38	0.1[7]	8.8
2-METHYL-4,6-DINITROPHENOL	0/16	---	50	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/16	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/16	---	10	---	0	---	1800	1800	---	---
2-NITROANILINE	0/16	---	50	---	0	---	2.1	---	---	---
2-NITROPHENOL	0/16	---	10	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/16	---	20	---	0	---	0.15	1.9	---	99.75
3-NITROANILINE	0/16	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/16	---	10	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/16	---	20	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/16	---	20	---	0	---	150	150	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/16	---	10	---	0	---	---	---	---	---
4-METHYLPHENOL	1/16	2	10	05-01 (92 (07/14/92)	0	---	180	---	---	---
4-NITROANILINE	0/16	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/16	---	50	---	0	---	290	---	---	35
ACENAPHTHENE	0/16	---	10	---	0	---	370	460	20[7]	9.9
ACENAPHTHYLENE	0/16	---	10	---	0	---	---	---	---	4840
ANILINE	0/16	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/16	---	10	---	0	---	1800	43	---	0.029
BENZIDINE	0/16	---	50	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/16	---	10	---	0	---	0.092	1.2	---	0.839
BENZO(A)PYRENE	0/16	---	10	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/16	---	10	---	0	---	0.092	1.2	---	9.07
BENZO(G,H,I)PERYLENE	0/16	---	10	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/16	---	10	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/16	---	50	---	0	---	150000	150000	---	---
BENZYL ALCOHOL	0/16	---	20	---	0	---	11000	---	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/16	---	10	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/16	---	10	---	0	---	0.0098	0.15	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/16	---	10	---	0	---	0.96	4.2	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	1/16	8.2	10	05-07 (92) (07/14/92)	1	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/16	---	10	---	0	---	7300	2700	---	49
CHRYSENE	0/16	---	10	---	0	---	9.2	1.6	---	0.033
DI-N-BUTYL PHTHALATE	0/16	---	10	---	0	---	3600	3600	---	3
DI-N-OCTYL PHTHALATE	0/16	---	10	---	0	---	730	20	---	30
DIBENZO(A,H)ANTHRACENE	0/16	---	10	---	0	---	0.0092	0.12	---	0.0016
DIBENZOFURAN	0/16	---	10	---	0	---	24	---	---	20
DIBROMOCHLOROMETHANE	0/23	---	1	---	0	80	0.13	---	---	6400
DIETHYL PHTHALATE	0/16	---	10	---	0	---	29000	29000	---	3
DIMETHYL PHTHALATE	0/16	---	10	---	0	---	360000	---	---	73
FLUORANTHENE	0/16	---	10	---	0	---	1500	210	---	8.1
FLUORENE	0/16	---	10	---	0	---	240	310	---	3.9
HEXACHLOROBENZENE	0/16	---	10	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/16	---	10	---	0	---	0.86	7.3	---	0.134
HEXACHLOROCYCLOPENTADIENE	0/16	---	10	---	0	50	260	50	1[7]	77.04
HEXACHLOROETHANE	0/16	---	10	---	0	---	4.8	36	---	30.5
INDENO(1,2,3-CD)PYRENE	0/16	---	10	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/16	---	10	---	0	---	71	900	---	900
N-NITROSO-DI-N-PROPYLAMINE	0/16	---	10	---	0	---	0.0096	0.12	---	---
N-NITROSODIMETHYLAMINE	0/16	---	10	---	0	---	0.0013	---	---	---

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						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water[5]
N-NITROSODIPHENYLAMINE	0/16	---	10	---	0	---	14	170	---	13
NAPHTHALENE	0/16	---	10	---	0	---	6.2	8.3	---	44
NITROBENZENE	0/16	---	10	---	0	---	3.4	4.3	30[7]	740
PENTACHLOROPHENOL	0/16	---	50	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/16	---	10	---	0	---	---	---	---	2.1
PHENOL	0/16	---	10	---	0	---	22000	22000	300[7]	100
PYRENE	0/16	---	10	---	0	---	180	140	---	0.3
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-TP (SILVEX)	1/31	500	0.5-500	05-05 (82b) (04/13/82)	1	50	290	---	---	326.64
2,4-D	0/31	---	3.8	---	0	70	360	---	---	---
4,4'-DDD	1/15	0.13	0.1-0.11	05-07 (92) (07/14/92)	1	---	0.28	3.6	---	0.0011
4,4'-DDE	3/15	0.01-0.03	0.04	05-07 (92) (07/14/92)	3	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/15	---	0.11-0.12	---	0	---	0.2	2.5	0.001	0.001
ALDRIN	0/15	---	0.04	---	0	---	0.004	0.05	---	0.0185
ALPHA-BHC	0/15	---	0.03	---	0	---	0.011	0.14	---	12.38
ALPHA-CHLORDANE	13/15	0.03-0.09	0.05	05-09 (92) (07/14/92)	13	2[10]	0.19(10)	0.0043(10)	0.0043[10]	0.00029[10]
AROCLOR-1016	0/15	---	0.62-0.66	---	0	0.5[11]	0.96	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1221	0/15	---	0.62-6.4	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1232	0/15	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1242	0/15	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1248	0/15	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1254	4/15	0.36-0.84	1.2-1.3	05-09 (92) (07/14/92)	4	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1260	0/15	---	1.2-1.3	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
BETA-BHC	2/15	0.04-0.05	0.06	05-19 (92) (07/14/92)	2	---	0.037	0.47	---	0.495
DELTA-BHC	0/15	---	0.09	---	0	---	---	---	---	666.67
DIELDRIN	0/15	---	0.02	---	0	---	0.0042	0.053	0.056	0.000026
DISULFOTON	0/15	---	0.67-0.71	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/15	---	0.13-0.14	---	0	---	220	220	0.056	0.003
ENDOSULFAN II	5/15	0.01-0.02	0.04	05-07 (92) (07/14/92), 05-16 (92) (07/14/92)	5	---	220(12)	220(12)	0.056	0.003
ENDOSULFAN SULFATE	3/15	0.12-0.18	0.06-0.67	05-07 (92) (07/14/92)	0	---	---	---	---	2.22
ENDRIN	1/45	0.04	0.04-0.06	05-07 (92) (07/14/92)	1	2	11	2	0.036	0.002
ENDRIN ALDEHYDE	1/15	0.16	0.22-0.23	05-07 (92) (07/14/92)	1	---	---	---	---	0.15
ETHYL PARATHION	0/15	---	0.57-0.61	---	0	---	---	---	---	---
FAMPHUR	0/15	---	0.57-1.2	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/45	---	0.04-0.08	---	0	0.2	0.052	0.2	---	0.01
GAMMA-CHLORDANE	2/15	0.05-0.1	0.05	05-01 (92) (07/14/92)	2	2[10]	0.19(10)	---	0.0043[10]	0.00029[10]
HEPTACHLOR	7/15	0.01-0.07	0.03	05-09 (92) (07/14/92)	7	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/15	---	0.79-0.85	---	0	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/15	---	5.7-6.1	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/45	---	1.6-1.8	---	0	40	180	40	0.03	0.005
METHYL PARATHION	0/15	---	1.1-1.2	---	0	---	9.1	---	---	---
PHORATE	0/15	---	0.38-0.41	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/45	---	1.6-2.4	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	0/16	---	30	---	0	50 to 200[7,13]	36000	---	87	---
ANTIMONY	8/16	4.2-10.3	3	05-19 (92 (07/14/92)	2	6	15	6	---	31
ARSENIC	4/85	1-4	1-10	05-08 (92) (07/14/92)	4	50	0.045	50	150	53
BARIUM	48/85	22-860	50-100	05-11 (86a) (02/07/86)	0	2000	2600	2000	---	5000
BERYLLIUM	0/16	---	1-5	---	0	4	73	4	---	7.6
CADMIUM	0/85	---	0.2-10	---	0	5	18	5	2.2	0.66
CALCIUM	16/16	41600-109000	---	05-13 (92 (07/14/92)	0	---	---	---	---	---
CHROMIUM (TOTAL)	3/85	10-40	5-20	05-03 (86a) (02/07/86)	2	100	180(14)	100	11[14]	4[illegible]

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						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water[5]
COBALT	1/16	21	20	05-15 (92) (07/14/92)	1	---	2200	---	---	5
COPPER	0/16	---	5	---	0	1300[15]	1400	1300	9	5
CYANIDE	0/16	---	5	---	0	200	730(16)	---	5.2[16]	5.2[16]
IRON	61/108	20-22000	10-40	05-08 (86a) (02/06/86)	38	300[7,13]	11000	---	1000	---
LEAD	5/85	5-15	1-30	05-03 (81) (12/07/81)	5	15[15]	4	15	2.5	1.3
MAGNESIUM	16/16	3530-27700	---	05-07 (92) (07/14/92)	0	---	---	---	---	---
MANGANESE	96/121	7-7800	5-990	05-08 (86a) (02/06/86)	86	50[7,13]	880	---	---	---
MERCURY	1/85	0.2	0-0.3	05-06 (81) (12/07/81)	1	2	11	2	0.77	0.0013
NICKEL	5/16	8-12	5	05-16 (92) (07/14/92)	0	100	730	100	52	29
POTASSIUM	16/16	607-3620	---	05-08 (92) (07/14/92)	0	---	---	---	---	---
SELENIUM	2/85	1	1-5	05-10 (86a) (02/06/86), 05-12 (86a) (02/07/86)	0	50	180	50	5	5
SILVER	3/85	9-50	1-10	05-02 (81) (12/07/81), 05-08 (82b) (04/13/82)	3	100[7,13]	180	180	---	1
SODIUM	101/101	1900-208000	---	05-01 (82) (07/20/82)	0	---	---	---	---	---
THALLIUM	0/16	---	2	---	0	2	2.9(17)	2	---	0.56
TIN	0/16	---	50	---	0	---	22000	---	---	73
VANADIUM	0/16	---	10	---	0	---	260	---	---	19
ZINC	2/16	24-27	5-10	05-06 (92) (07/14/92)	0	5000[7,13]	11000	11000	120	58.9
Radionuclides (pCi/L)										
GROSS ALPHA	9/31	1.4-11	1.3-4.51	05-05 (82c) (07/20/82)	0	15	---	---	---	---
GROSS BETA	25/31	1.08-7.88	1.63-2.53	05-08 (81) (12/07/81)	0	---	---	---	---	---
RADIUM-226	2/2	0.68	---	05-05 (82c) (07/20/82)	0	---	---	---	---	---
Miscellaneous Parameters (ug/L, unless otherwise noted)										
CHLORIDE	68/85	1000-110000	10-1000	05-04 (83b) (02/26/83), 05-04 (84a) (02/04/84)	0	250000[7,13]	---	---	230000	---
FLUORIDE	31/51	100-410	5-100	05-05 (82b) (04/13/82)	0	4000	2200	---	---	---
NITRATE, AS NITROGEN	11/11	25-606	---	05-10 (92) (07/14/92)	0	10000	10000	---	---	---
NITRATE/NITRITE	24/32	30-2000	50	05-02 (82e) (09/28/82)	0	10000	1000(18)	---		---
NITRITE, AS NITROGEN	1/11	7	5	05-08 (92) (07/14/92)	0	1000	1000	---	---	---
ORGANIC BROMINE	4/59	2-9	2-10	05-04 (84a) (02/04/84)	0	---	---	---	---	---
ORGANIC CHLORINE	25/59	10-2200	10	05-04 (84b) (06/14/84)	0	---	---	---	---	---
ORGANIC IODINE	15/59	2-150	2-10	05-08 (84a) (02/04/84)	0	---	---	---	---	---
pH (standard units)	149/149	0.4-7.9	---	05-13 (84b) (06/14/84)	0	---	---	---	6.5-9	---
PHENOLS	19/85	10-100	4-50	05-03 (82c) (07/20/82)	0	---	---	---	---	---
SPECIFIC CONDUCTIVITY (umho/cm)	141/142	50-4490	0	05-11 (84b) (06/12/84)	0	---	---	---	---	---
SULFATE	78/84	5000-150000	10-5000	05-07 (86a) (02/06/86)	0	500000	---	---	---	---
SULFIDE	9/16	22-203	20	05-04 (92) (07/14/92)	9	---	---	---	2	---
TOTAL COLIFORM (phm)	5/10	1-240	1	05-02 (81) (12/07/81), 05-02 (82a) (03/05/82)	0	---	---	---	---	---
TOTAL ORGANIC CARBON	105/143	800-73000	500-2000	05-08 (82b) (04/13/82)	0	---	---	---	---	---
TOTAL ORGANIC HALOGENS	53/84	5.6-1620	5-10	05-04 (82b) (04/13/82)	0	---	---	---	---	---

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit

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						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water[5]

U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable by not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

Figures 6-3 through 6-6 depict those locations where exceedances of human health and ecological risk-based criteria have been noted during previous investigations. Separate figures are provided for soil (surface soil and subsurface soil combined) and ground water. For each sample matrix, separate figures are presented to illustrate human health and ecological exceedances.

Because shallow ground water at the site discharges to Culpepper Branch Creek and surface water/sediment samples have not been collected from the site, historical ground water data were compared to ecological screening criteria for surface water. The comparison is considered to be conservative, because it does not include the dilution of contaminants in the creek. Thus, this comparison may not be reflective of actual surface water quality in the creeks and marsh/wet areas of the site.

6.4.1 Organic Constituents

Halogenated hydrocarbons were found in the ground water and soil at the Old Burn Pit. Trichloroethene, chloroform, and cis-1,2-dichloroethene were detected in both the ground water and soil. These chemicals were predominantly found in the subsurface soil and most likely have migrated into the ground water. The only other volatile organic compound detected in the soil was 1,2-dichloropropane. Other volatiles detected in the ground water were 1,1-dichloroethene, benzene, tran-1,2-dichloroethene, 1,2-dichloropropane, and vinyl chloride. These constituents were predominantly found in the wells located in the paleostream channel (i.e., a preferential flow pathway).

Benzene and Aroclor-1254 were detected in the environmental samples collected from SWMU 5, Old Burn Pit. Benzene was found only in well 5-16 (Table 6-4), which is located outside the paleostream channel and cross gradient from the burn pit and burial area. Both chemicals were detected in the ground water samples collected during the 1992 sampling event, but have never been detected in the soils at the site. These chemicals may be present at low levels (i.e., generally less than 5 µg/L) in the ground water as a result of historical Basewide maintenance practices. Historically, it was common practice to treat areas alongside roadways with a mixture of herbicides and waste fuel oils. This practice was performed for insect control and dust suppression purposes. Benzene and Aroclor-1254 have also been detected at low levels in the ground water at SWMU 4, 9, and 10, which implies that these chemicals may not be site-related constituents. However, these chemicals were conservatively identified as detected chemicals of interest for the site.

Acetone, methylene chloride, and phthalates were also detected in the soil and/or ground water samples collected at the site. Some reported concentrations of these chemicals exceeded risk-based criteria, as

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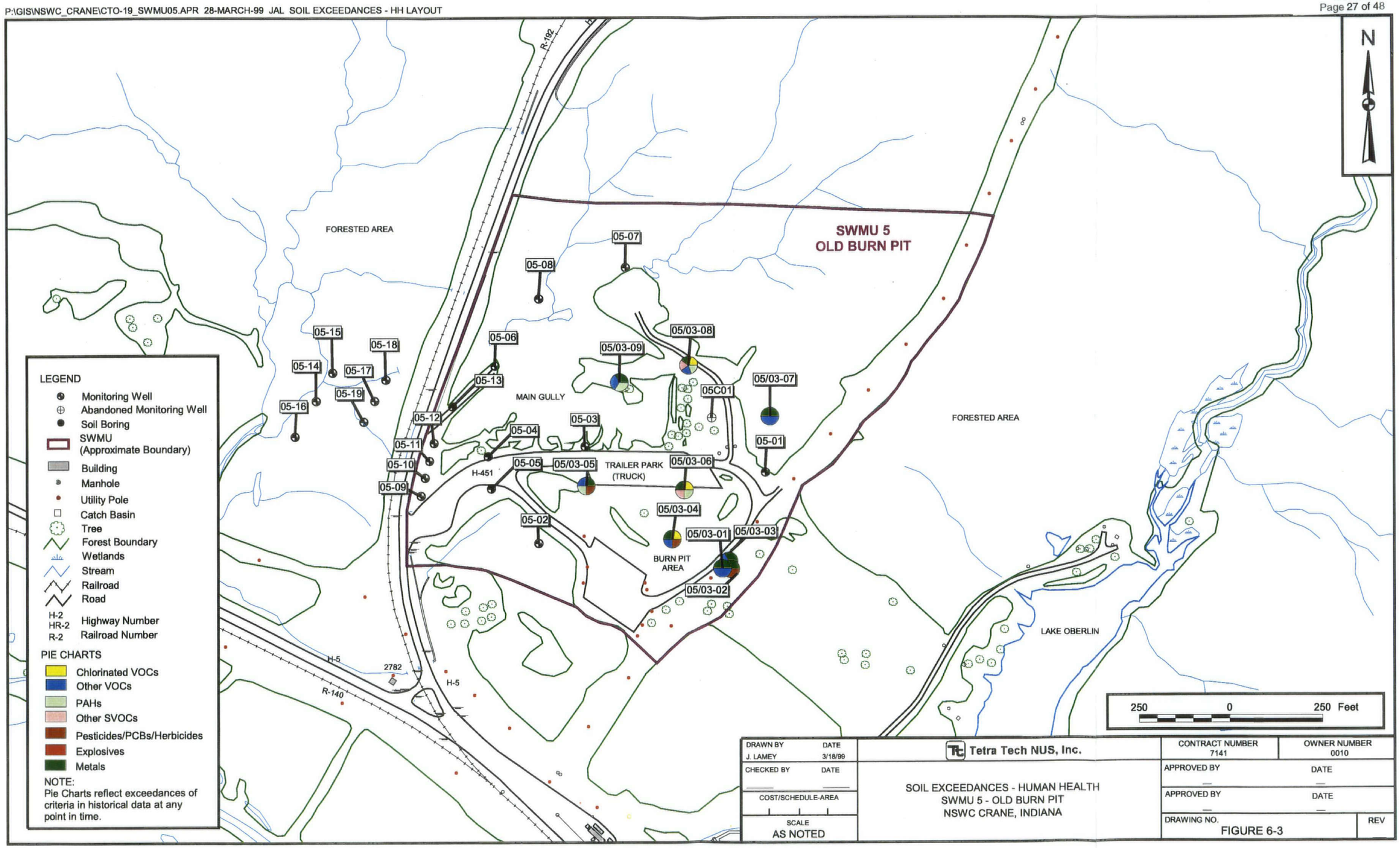

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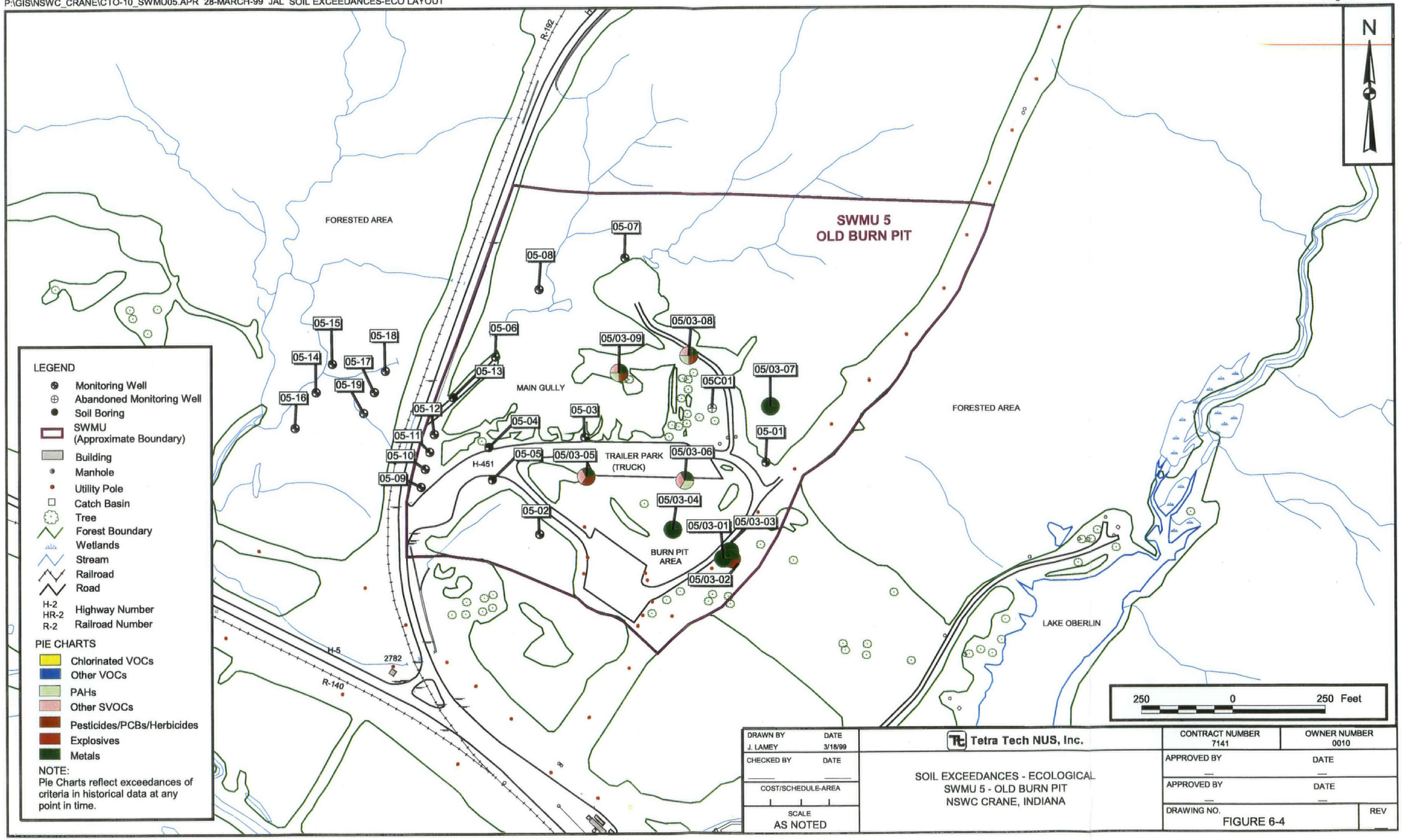

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CHECKED BY	DATE	SOIL EXCEEDANCES - ECOLOGICAL SWMU 5 - OLD BURN PIT NSWC CRANE, INDIANA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 6-4 / REV

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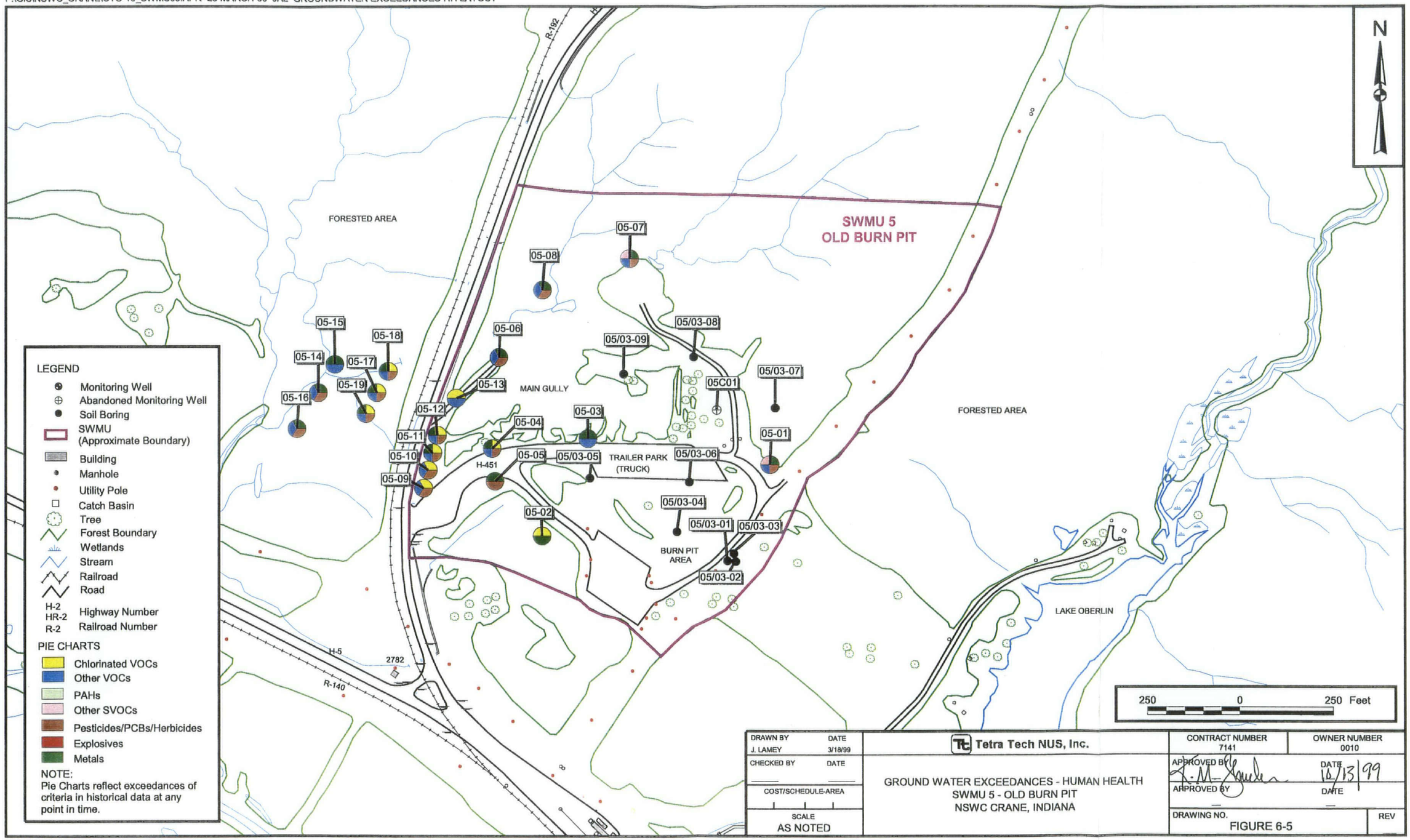

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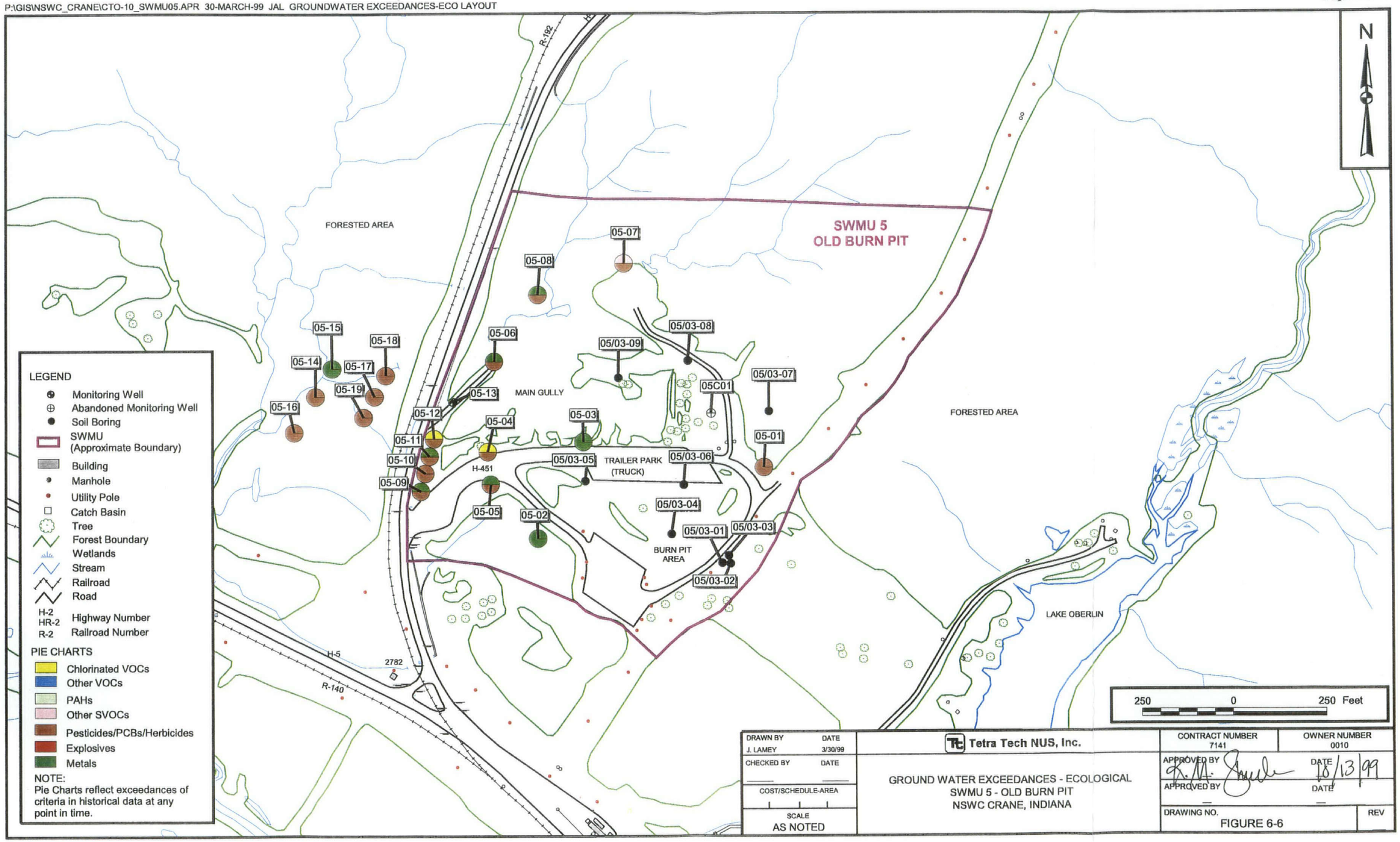

illustrated on Figures 6-3 through 6-6. These chemicals were detected in the laboratory and field QC blanks associated with the site samples. Therefore, they are not considered to be site-related constituents and were eliminated as parameters of interest for the Old Burn Pit. These chemicals were also reported at similar concentrations in environmental samples collected at SWMUs 4, 9, and 10, supporting the conclusion that the presence of these chemicals is attributable to contamination introduced through sampling (decontamination or ambient conditions) or analysis.

As seen in Table 6-4, several pesticides and a herbicide were found at levels greater than the lowest screening criteria for aqueous matrices (i.e., ground water or surface water criteria). These constituents were found predominantly in wells located outside the paleostream channel. Endrin was the only pesticide that was found in both the soil and ground water. The infrequent detection of pesticides, as well as their presence in wells outside the paleostream channel may indicate that they are not a result of past burning activities conducted at the site. Their presence may be attributable to activities such as insect control. Also, many of these pesticides were identified as parameters of interest for ground water because reported concentrations exceeded surface water screening criteria for ecological receptors. As mentioned previously, this is a conservative comparison and serves to overestimate potential impacts to surface water as a result of ground water discharge. These pesticides may not be present in the surface water at the site, but are identified as chemicals of interest for SWMU 5 for conservative purposes.

PAHs were found in the surface and subsurface soil samples collected at the site (Figures 6-2 and 6-3). However, these chemicals were not detected in ground water (Figures 6-4 and 6-5). PAHs are typical byproducts from incomplete combustion. It is reasonable to find these constituents at the burn pit and in the ash in the burial area. Consequently, these chemicals are likely to be site-related constituents.

Reportedly, explosives were not burned at the SWMU 5, Old Burn Pit. Given that explosives are not considered to be parameters of concern for the site, these chemicals were not analyzed during previous site investigations. However, samples collected at the site were analyzed for a full suite of semivolatile organic compounds, which includes a few explosives (dinitrotoluenes) and some explosive-related chemicals (nitrogen-containing constituents). None of these chemicals were detected in the soil and ground water samples.

6.4.2 Inorganic Constituents

A variety of inorganics was found in the soil and ground water at the Old Burn Pit. Those metals that exceeded the lowest screening criteria for soil and ground water are as follows:

- Soil: Antimony, arsenic, barium, beryllium, cadmium, chromium (total), cobalt, copper, iron, lead, mercury, phosphorus, nickel, selenium, silver, thallium, and zinc
- Ground Water: Antimony, arsenic, chromium (total), cobalt, iron, lead, mercury, and silver

For both surface and subsurface soil, the highest concentrations of inorganics were detected in borings 05/03-08 and 05/03-09. These borings were located directly in the gully north of the burn pit area. The monitoring wells that most consistently showed the highest concentrations of inorganics were wells 05-03, 05-06, and 05-08. Wells 05-06 and 05-08 are downgradient (i.e., north-northwest) of the gully, and 05-03 is downgradient of the burn pit. Based on the historical data, a correlation between inorganics in soil and ground water may exist.

6.4.3 Summary of Detected Chemicals of Interest

The following constituents are detected chemicals of interest for soil and ground water at the Old Burn Pit (i.e., chemicals reported at concentrations in excess of risk-based screening criteria):

- Soil: 1,1,2,2-Tetrachloroethane, chloroform, cis-1,2-dichloroethene, trichloroethene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)flouranthene, chrysene, indeno(1,2,3-cd)pyrene, naphthalene, aldrin, dieldrin, endrin, and various inorganics

- Ground Water: 1,1-Dichloroethene, 1,2-dichloropropane, benzene, chloroform, cis-1,2-dichloroethene, trans-1,2-dichloroethene, trichloroethene, vinyl chloride, 2,4,5-TP, 4,4'-DDD, 4,4'-DDE, alpha-chlordane, Aroclor-1254, beta-BHC, ensdosulfan II, endrin, endrin aldehyde, gamma-chlordane, heptachlor, and various inorganics

Because of the uncertainty associated with the historical analytical data, all constituents reported at concentrations in excess of risk-based criteria were included in the list of detected chemicals of interest for the site. This list was used to develop appropriate chemical categories to be included in the analytical program for the proposed field investigation, which is presented in the following section.

6.5 PROPOSED INVESTIGATION

The proposed field investigation for SWMU 5, Old Burn Pit was developed based on a site-specific CSM. The general methodology used to develop the proposed investigation (and CSM) was presented in Section 4.0. This section of the Work Plan provides the rationale for the proposed site-specific investigation.

6.5.1 Conceptual Site Model

The CSM for the Old Burn Pit, which defines the contaminant source, transport mechanisms, exposure routes, and potential receptors for the site is presented as Figure 6-7. Based on a review of the existing data for the site, a release of hazardous constituents to the surrounding soil has occurred as a result of historical site operations (i.e., the burning of garbage, trash, and debris and placement of ash/residue in the gully north of the burn pit area). The historical data also indicate that residual contaminants in the soil have migrated to ground water via infiltration/percolation. Additional release mechanisms, which are also expected to contribute to the contaminant transport, include discharge of ground water to surface water/sediment (Culpepper Branch Creek), deposition via surface water runoff, and generation of fugitive dust and volatile emissions from soil.

Current and likely future land use at the Old Burn Pit is expected to be limited. As mentioned previously, the site is currently inactive; no waste disposal activities occur at the site under current land use. All hazardous waste generated by NSWC Crane operations is disposed accordingly. All other refuse is disposed in the Facility's sanitary landfill.

Based on the general scenarios and receptor classes identified in Section 4.0, the following potential receptors may be exposed to contaminated media at the site:

- Trespassers (ages 6 to 17 years) – Likely receptor under current and future land use. Although access to the Base is controlled, once inside the Base, access to the site is not limited by any physical constraints (i.e., the site is not patrolled or enclosed by a fence). In addition, hunting activities are permitted at the Base. Given that the site is near a forested area, hunters may trespass onto the site. This receptor may be exposed to potentially contaminated surface soil, air and surface water and sediment in Culpepper Branch Creek.

- Maintenance Workers – Likely receptor under future land use. This receptor may be exposed to potentially contaminated surface soil and air. Exposure to ground water at the site and surface water and sediment in Culpepper Branch Creek is not expected to occur.

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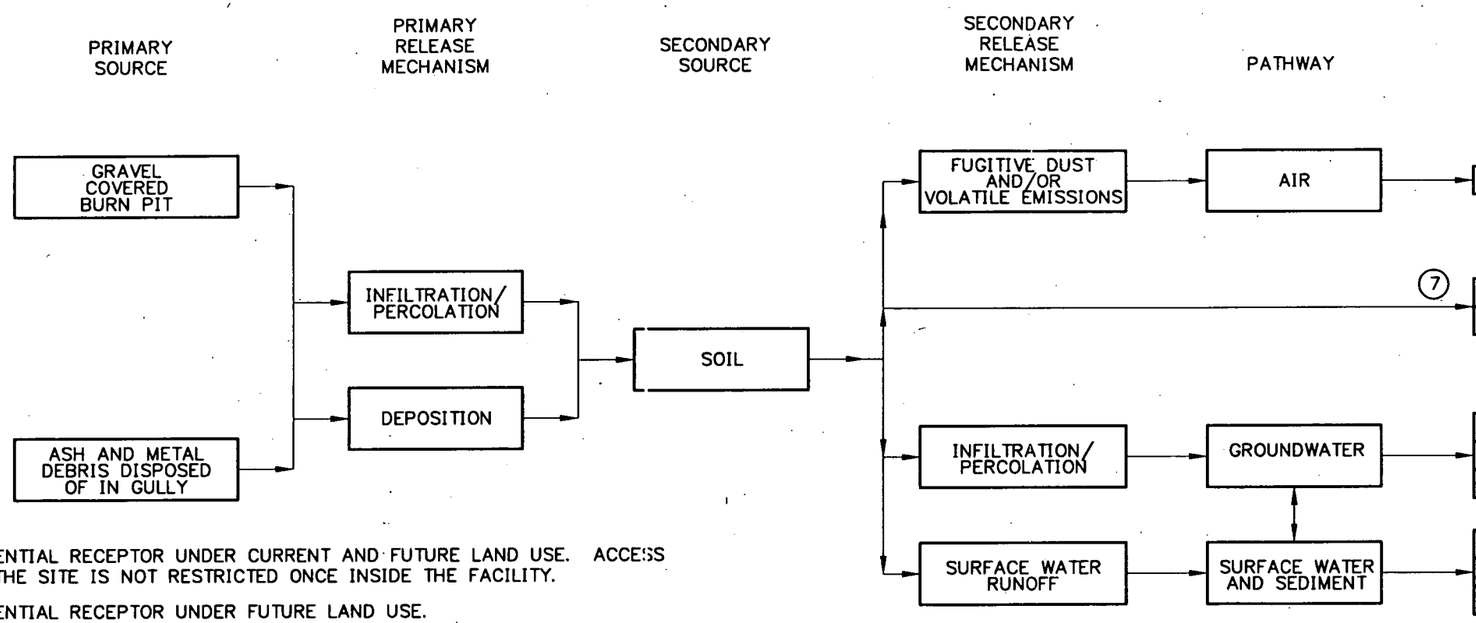

EXPOSURE ROUTE	HUMAN RECEPTORS: ADOLESCENT TRESPASSER (1)	MAINTENANCE WORKER (2)	CONSTRUCTION WORKER (3)	OCCUPATIONAL WORKER (4)	RECREATIONAL USER (ADULT) (5)	RESIDENT (ADULT/CHILD) (6)	ECOLOGICAL RECEPTORS: TERRESTRIAL	AQUATIC
INHALATION	●	●	●		●	●	○	
(7) INGESTION	●	●	●		●	●	●	
(7) DERMAL CONTACT	●	●	●		●	●	○	
INGESTION			○			●		
INHALATION			○			●		
DERMAL CONTACT			●			●		
INGESTION	●				●	●	●	●
INHALATION	○				○	○	○	
DERMAL CONTACT	●				●	●	○	●

KEY

(1) POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. ACCESS TO THE SITE IS NOT RESTRICTED ONCE INSIDE THE FACILITY.

(2) POTENTIAL RECEPTOR UNDER FUTURE LAND USE.

(3) POTENTIAL RECEPTOR UNDER FUTURE LAND USE. A SHORT-TERM PROJECT (i.e., UTILITY INSTALLATION) MAY OCCUR.

(4) UNLIKELY RECEPTOR SITE IS NOT LIKELY TO BE DEVELOPED.

(5) POTENTIAL RECEPTOR UNDER FUTURE LAND USE. BASE COULD CLOSE AND BE TURNED INTO A STATE PARK.

(6) POTENTIAL RECEPTOR UNDER FUTURE LAND USE. EVALUATED FOR DECISION-MAKING PURPOSES.

(7) FOODCHAIN MODELING WILL BE CONDUCTED FOR ECOLOGICAL RECEPTORS.

● EXPOSURE PATHWAY TO BE EVALUATED IN THE RISK ASSESSMENT.

○ RELATIVELY INSIGNIFICANT POTENTIAL EXPOSURE PATHWAY COMPARED TO OTHER PATHWAYS EVALUATED IN THE RISK ASSESSMENT. RISKS NOT EVALUATED QUANTITATIVELY.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 3/3/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE NONE

CONCEPTUAL SITE MODEL
SWMU 5-OLD BURN PIT
NSWC CRANE, INDIANA

CONTRACT NO. 7141
APPROVED BY DATE 10/13/99
APPROVED BY DATE
DRAWING NO. FIGURE 6-7
REV. 0

FORM CADD NO. SDV_BH12.DGN - REV 0 - 1/20/98

- Construction Workers – Potential receptor under future land use. No construction activities are currently planned at the site. In addition, the shallow depth to ground water (as shallow as 4 feet bgs) and the topography of a majority of the site (i.e., the gully) would likely preclude development of the area. However, a small, short-term construction project, such as a utility installation, could result in exposure to potentially contaminated media. This receptor may be exposed to surface and subsurface soil, air and ground water.

- Recreational Users – Potential receptor under future land use. If the Facility was to close, the most likely scenario is that the property would be converted into a state park. This receptor may be exposed to potentially contaminated surface soil, air and surface water and sediment in Culpepper Branch Creek. However, it is highly unlikely that NSWC Crane would close because principal Base operations, the demilitarization of munitions, are critical to the support of the U.S. Naval fleet.

- Residents - Potential receptor under future land use. As mentioned previously, development of the site would be unlikely because of the shallow depth to ground water and the nature of the site. However, other areas of the Facility could be developed for residential purposes, if the Facility were to close. Future residents may be exposed to potentially contaminated surface soil, air, ground water, and surface water and sediment in Culpepper Branch Creek. Although this scenario is highly unlikely, a future residential scenario is typically evaluated in the risk assessment for decision-making purposes. For example, the need for deed restrictions at a site may be eliminated prior to site closure, if minimal risks are estimated for residential receptors.

- Ecological Receptors - Under current and future land use, various ecological receptors, terrestrial and aquatic, are also likely to come in contact with site media. Terrestrial receptors may contact potentially contaminated surface soil and ingest contaminated prey items and/or surface water. Aquatic receptors may be exposed to potentially contaminated surface water, prey, and sediment.

Details regarding the assumed receptor characteristics (intake rate, frequency and duration of exposure, body weight, etc.) are defined in Sections 10.0 and 11.0 of this Work Plan, which present the methodologies for the human health and ecological risk assessments.

6.5.2 Proposed Sampling and Analysis

The primary objective of the proposed field investigation is to collect field and laboratory data needed to evaluate the potential risks for human and ecological receptors identified in the CSM. Figure 6-8 identifies the proposed sample locations. Table 6-5 summarizes the proposed sampling and analysis for

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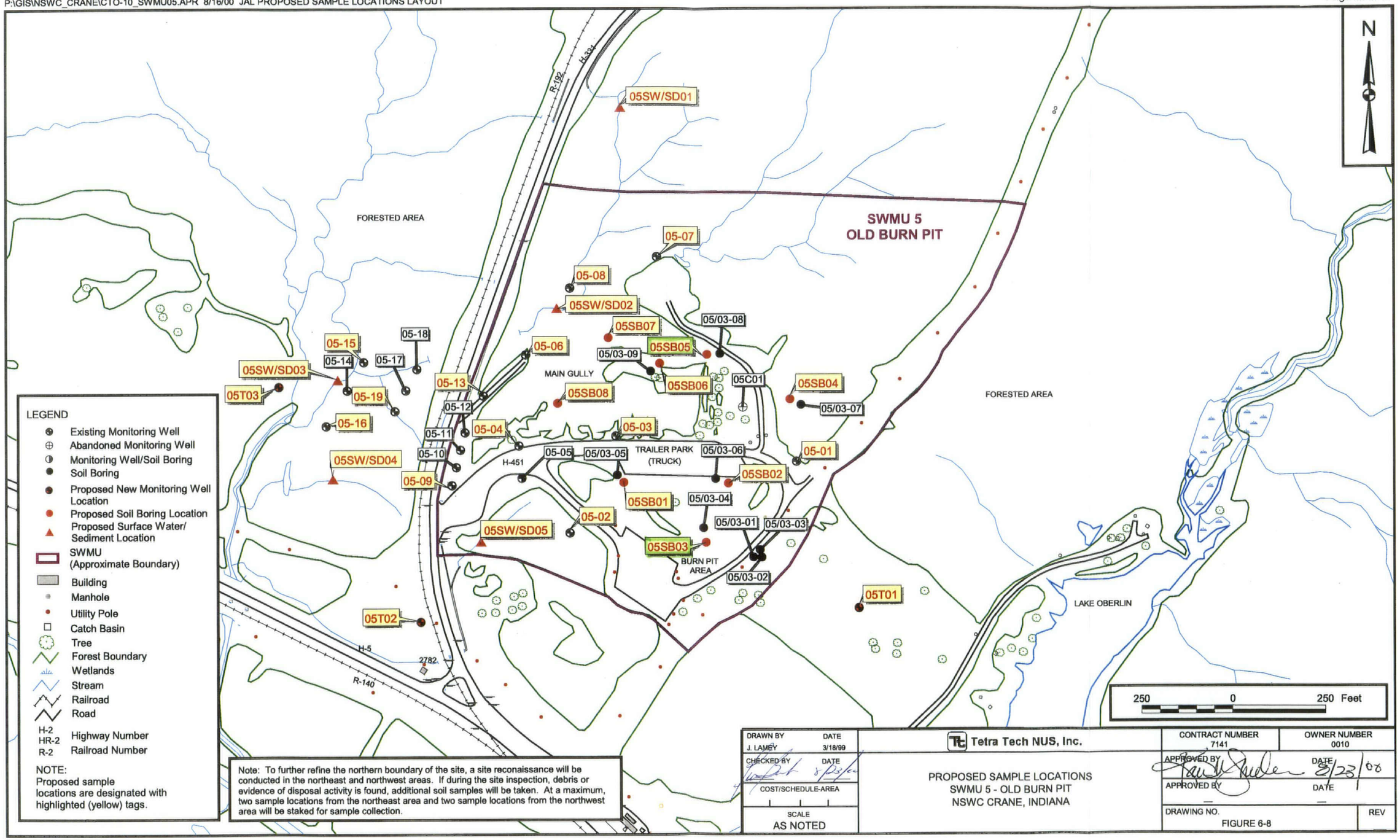


TABLE 6-5

SUMMARY OF OBJECTIVES/PROPOSED SAMPLING
SWMU 5 - OLD BURN PIT
NSWC CRANE, INDIANA

OVERALL OBJECTIVES FOR SAMPLING PROGRAM

TYPE OF PROGRAM / SAMPLING OBJECTIVE	PARAMETER TYPE	TARGET CONSTITUENTS[1]	OBJECTIVE FOR ANALYSIS	LIMIT OF DETECTION	EVALUATIONS TO BE PERFORMED
Type: RCRA Risk Assessment to fulfill requirements of RCRA Part B permit. Objectives: Determine human health and ecological risks for potential receptors exposed to site media under current and future land use. Determine if there has been a release of hazardous constituents to off-SWMU surface water and sediment	Field (Soil, Ground Water and Surface Water)	Dissolved Oxygen Oxidation Reduction Potential pH Specific Conductivity Temperature Turbidity PID Reading[2]	Evaluate general water quality. Determine if well water is equivalent to formation water (i.e., stability). To determine the correct subsurface soil sample interval (PID reading only).	As per selected field instrumentation. Instrumentation will be calibrated according to manufacturer's manuals.	Qualitatively used to evaluate general water quality.
	Laboratory (Soil, Ground Water, Surface Water, and Sediment)	Appendix IX VOCs Appendix IX SVOCs Appendix IX Pesticides/PCBs Appendix IX Herbicides Dioxins/Furans Appendix IX Inorganics (total and dissolved[3]) Cyanide (total and dissolved[3]) Miscellaneous Inorganics[4] (total and dissolved[3])	To obtain a representative presentation of the nature and quantity of constituents that were released to media by past operational activities.	Reporting limit low enough to meet Federal/State ARARs/TBCs and evaluate adverse human health and environmental impacts.	Comparison of constituents found in site media to risk-based screening criteria to determine if these media were affected by past site operations. Comparison of inorganic site soil data to established Basewide background levels for similar soil types. Estimate human health risks, as outlined in Section 10.0, Figure 10-1. Estimate ecological risks, as outlined in Section 11.0, Figure 11-1.
		Hardness[5] TSS[5]	Evaluate surface water conditions.	As per chosen laboratory methods.	To be used to assess potential risks for ecological receptors.
		CEC[6] pH[6] TOC[6][7]	Evaluate soil and/or sediment conditions.	As per chosen laboratory methods.	For soil, evaluate the potential for contaminant migration from the site and the potential for risks outside the site boundaries. For sediment, to be used to assess potential risks for ecological receptors.

SPECIFIC OBJECTIVES FOR SAMPLING LOCATIONS

MEDIUM	SAMPLE COLLECTION TECHNIQUE	SAMPLING POINT[8]		
		SAMPLE LOCATION	COMMENT	OBJECTIVE OF LOCATION
Surface/Subsurface Soil[10]	Grab surface soil sample; specific collection technique identified in FSP, Section 2.4.2.1. Grab subsurface soil sample; specific collection technique identified in FSP, Section 2.4.2.3.	05SB01 through 05SB03	Three locations at the burn pit area. Samples collected at ground surface (0 to 2 feet bgs) at a discrete depth between 2 to 10 feet bgs (interval based on PID readings). If ground water is encountered prior to 10 feet bgs, a sample will be collected from a depth above the water depth. Two samples from 3 borings for a total of 6 samples.	Evaluate contaminant concentrations at burn pit at varying depths. Soil depths reflect the exposure pathways for the identified potential receptors.
		05SB04 through 05SB08	Five locations within the gully north of the burn pit. Samples collected at ground surface (0 to 2 feet bgs) and at a discrete depth between 2 to 10 feet bgs (interval based on PID readings). If ground water is encountered prior to 10 feet bgs, a sample will be collected from a depth above the water table. Two samples from 5 borings (10 samples).	Evaluate contaminant concentrations in gully at varying depths. Soil depths reflect the exposure pathways for the identified potential receptors.
Ground Water	Grab sample; specific collection technique identified in FSP, Section 2.4.1.	05-01 and 05T01	Sample existing monitoring well 05-01 at eastern site boundary. Install and sample new monitoring well, 05T01 at southeastern site boundary.	Evaluate ground water quality at a locations immediately upgradient of the gully and burn pit.
		05-02 through 05-04, 05-09, 05-13, 05-15, 05-16, 05-19	Sample 8 existing monitoring wells outside and within site boundaries.	Evaluate ground water quality at locations affected by site activities downgradient of the burn pit.
		05-06 through 05-08	Sample 3 existing monitoring wells within site boundaries at north/northwestern portions of site.	Evaluate ground water quality at locations affected by site activities downgradient of the gully.
		05T02 and 05T03	Install and sample new monitoring wells at southern and western site boundaries.	Evaluate ground water quality at a location immediately downgradient of the site. Evaluate impact of paleostream channel ground water migration.
Surface Water/Sediment[9]	Grab sample; specific collection technique identified in FSP, Section 2.4.3 (surface water) and 2.4.4 (sediment).	05SW/SD01	Location in unnamed tributary outside northern site boundary.	Evaluate surface water/sediment quality at a location immediately upstream of the site.
		05SW/SD02	Location within site boundaries in an unnamed tributary at the gully northwest of the burn pit.	Evaluate surface water/sediment quality at a location affected by site activities.
		05SW/SD03 through 05SW/SD05	Locations outside of western and southern site boundaries in unnamed tributaries.	Evaluate surface water/sediment quality at locations immediately downstream of the site.

ARARs Applicable, Relevant, and Appropriate Requirements
CEC Cation Exchange Capacity
FSP Field Sampling Plan
QAPP Quality Assurance Project Plan
PCBs Polychlorinated biphenyls
PID Photoionization detector
SVOCs Semivolatile Organic Compounds
TBCs To Be Considered Values
TOC Total Organic Carbon
TSS Total Suspended Solids
VOCs Volatile Organic Compounds

1 The list of specific chemicals included as target constituents is identified in the QAPP, Section 1.0, Table 1-1. Constituents to be analyzed for all samples, all matrices collected, unless otherwise noted.
2 Soil samples only will be monitored with an PID. The other identified field parameters will be collected for ground water and surface water.
3 Total and dissolved inorganic analyses will be performed for surface water samples.
4 Miscellaneous inorganics include calcium, iron, magnesium, manganese, potassium, and sodium.
5 Analyses to be performed on surface water samples only.
6 Analyses to be performed on 30 percent of the soil samples collected.
7 TOC analyses will be conducted on all sediment samples.
8 Proposed sampling locations are identified on Figure 6-8.
9 Due to the intermittent flow, surface water may not be available at all sample locations. If no surface water is available at a location(s), the proposed sediment sample(s) only will be collected.
10 To further refine the northern boundary of the site, a site reconnaissance will be conducted in the northeast and northwest areas. If during the site inspection, debris or evidence of disposal activity is found, additional soil samples will be taken. At a maximum, two sample locations from the northeast and two sample locations fromt he northwest will be staked for sample collection.

SWMU 5, Old Burn Pit, including overall objectives and objectives for the selection of a particular sampling point. The remainder of this section provides the rationale for the proposed sampling and analysis program.

As depicted on Table 6-5, environmental samples collected from the site will be analyzed for a comprehensive field and laboratory analytical program. Field parameters will be collected for ground water and surface water samples. Typical water quality indicator parameters, such as turbidity, will be collected in the field. Soil samples will be screened for VOCs using monitoring equipment (PID).

Soil, sediment, surface water, and ground water samples will be collected and analyzed for the full list of Appendix IX constituents (VOCs, SVOCs, pesticides, PCBs, inorganics), as well as other miscellaneous inorganics. Surface water samples also will be analyzed for total and dissolved inorganics, hardness, and TSS and sediment samples will be analyzed for TOC to assist in assessing the potential risks for ecological receptors. Additionally, soil characteristic parameters (CEC, pH, and TOC), will be collected to determine the likelihood of the potential fate and transport of contaminants at the site (and the potential for risks outside the site boundaries). Ground water samples will not be analyzed for dissolved inorganics since low flow sampling procedures will be used eliminate turbidity concerns.

As noted previously, Figure 6-8 illustrates the proposed sampling locations for the field investigation at the Old Burn Pit. The rationale for the collection of these samples is, as follows:

- Surface/Subsurface Soils (Borings) (16): Three soil borings will be placed in the burn pit. Five soil borings will be placed in the gully north of the burn pit where residual ash and metal debris were buried. Collocated surface and subsurface soil samples will be obtained at each of these locations for a total of 16 soil samples. A sample will be obtained from the surface (0 to 2 feet bgs) and at a subsurface depth (not greater than 10 feet bgs) to be determined in the field using screening techniques (i.e., from a depth correlated with the highest PID reading). Approximate locations of the soil borings are presented on Figure 6-8.

  To further refine the northern boundary of the site, a site reconnaissance will be conducted in the northeast and northwest areas. If during the site inspection, debris or evidence of disposal activity is found, additional soil samples will be taken. At a maximum, two sample locations from the northeast and two sample locations from the northwest will be staked for sample collection.

  Ground Water (15): Twelve of the existing monitoring wells (05-01 through 05-04, 05-06 through 05-09, 05-13, 05-15, 05-16, and 05-19) at the site will be sampled. Three new monitoring wells will

be installed and sampled during this field effort. Well 05T01 will be located at the southeastern site boundary. Well 05T01 in conjunction with well 05-01 will be used to evaluate ground water quality upgradient of the burn pit and burial area. Well 05T03 will be installed on the western boundary of the site to evaluate ground water quality immediately downgradient of the site. Well 05T02 will be installed south of the site to evaluate the impact of the paleostream channel on ground water migration.

- Surface Water and Sediment (5): Collocated surface and sediment samples will be collected from five locations. One location, 05SW/SD01, is outside the northern boundary of the site in the unnamed tributary and will be sampled to evaluate upstream conditions. Three locations will be sampled outside near the western (05SW/SD03 and 05SW/SD04) and southern (05SW/SD05) site boundaries in unnamed tributaries. These locations will address downstream conditions. One location (05SW/SD02) will be used to monitor stream conditions in the gully at the site. This sample will be located in an unnamed tributary at the gully northwest of the burn pit.

The FSP, presented in Appendix A, provides details on the field sampling procedures (installation of soil borings and monitoring wells and collection of samples) to be used at the site. The associated HASP is contained in Appendix B. The QAPP, located in Appendix C, provides details on the analytical methodologies to be used for the proposed field investigation.

The data collected during the proposed field investigation will be used to assess potential risks for human and ecological receptors exposed to site media under current and/or future land use. A description of how the data obtained during the proposed field investigation will be managed prior to the risk assessment is presented in Section 9.0. General methodologies and techniques used to calculate potential risks for the site are provided in Sections 10.0 (human health) and 11.0 (ecological).

7.0 SWMU 9 – PESTICIDE CONTROL/R-150 TANK AREA

The proposed field investigation for SWMU 7, Pesticide Control/R-150 Tank Area, needed to fulfill the overall objectives of this CTO (i.e., the completion of human health and ecological risk assessments), is provided in this section.

Section 7.1 presents a brief background of activities, which have occurred at the site. The physical setting (geology, hydrology, topography, etc.) is contained in Section 7.2. A brief synopsis of the previous site investigations and hazard identification based on the historical site data are presented in Sections 7.3 and 7.4, respectively. Section 7.5 summarizes the proposed field investigation for the site.

7.1 BACKGROUND

SWMU 9 is an inactive site composed of three distinct areas: Building 55, Building 2189, and the R-150 Tank area. Pesticide control activities occurred at Buildings 55 and 2189, which are no longer present at the site. Waste solvents were stored at the R-150 Tank area; the tank has been removed from the site. The three areas are located near each other in a triangular configuration. Building 2189 is 1150 feet north of Building 55. The R-150 Tank area is approximately 800 feet southwest of Building 2189 and 700 feet northwest of Building 55.

Pesticides control activities, which were conducted at the site from 1950 to 1974, consisted of the storage and management of various types and quantities of pesticides and herbicides. The original Pesticide Control Building was Building 55. Around 1970, pesticide control operations were moved from Building 55 to Building 2189. Pesticide spray tanks and containers were reportedly rinsed in the vicinity of Building 2189 on the west side of the building. It is not known whether rinsing activities occurred outside Building 55.

Pesticides and herbicides stored at the Building 55 included, but were not limited to, 2,4-D, 2,4,5-T, silvex (a mixture of 2,4-D and 2,4-T), fenac, monuron, ureabor, carbaryl, chlordane, DDT, diazinon, dieldrin, lindane, malathion, and pyrethrum. In addition to the chemicals stored and used at Building 55, the pesticide krovar (a mixture of duron and bromac) was added to the chemical inventory when pesticide control operations were moved from Building 55 to Building 2189.

Pesticides control operations ceased at the site around 1974. Buildings 55 and 2189 have since been demolished. The concrete pad for Building 55 is not apparent at the former building location; however, the concrete pad for Building 2189 is still present.

The R-150 Tank, which was located in a gravel parking lot adjacent to Highway 349, was installed at the site in the early 1970s and was used for the storage of spent waste solvents. The tank was 11 feet wide by 35 feet long. The base of the tank was reportedly 15 feet deep. The tank was excavated and removed on September 27 - 28, 1983. During the tank removal, soil surrounding the tank excavation was removed and stockpiled at the site. The excavated soil was disposed in an offsite secure landfill in December 1983.

7.2 PHSYICAL SETTING

The Pesticide Control/R-150 Tank Area is located in the central portion of the NSWC Crane, approximately 5 miles northeast of the Burns City Gate No. 2. The site (including space between the three distinct areas) occupies approximately 11 acres. Site operations were centered around the three areas (Building 55, Building 2189, and the R-150 Tank area) previously identified. The site is bounded on the east by Highway 45. The site map for SWMU 9, the Pesticide Control/R-150 Tank Area, is presented as Figure 7-1.

7.2.1 Topography/Hydrology

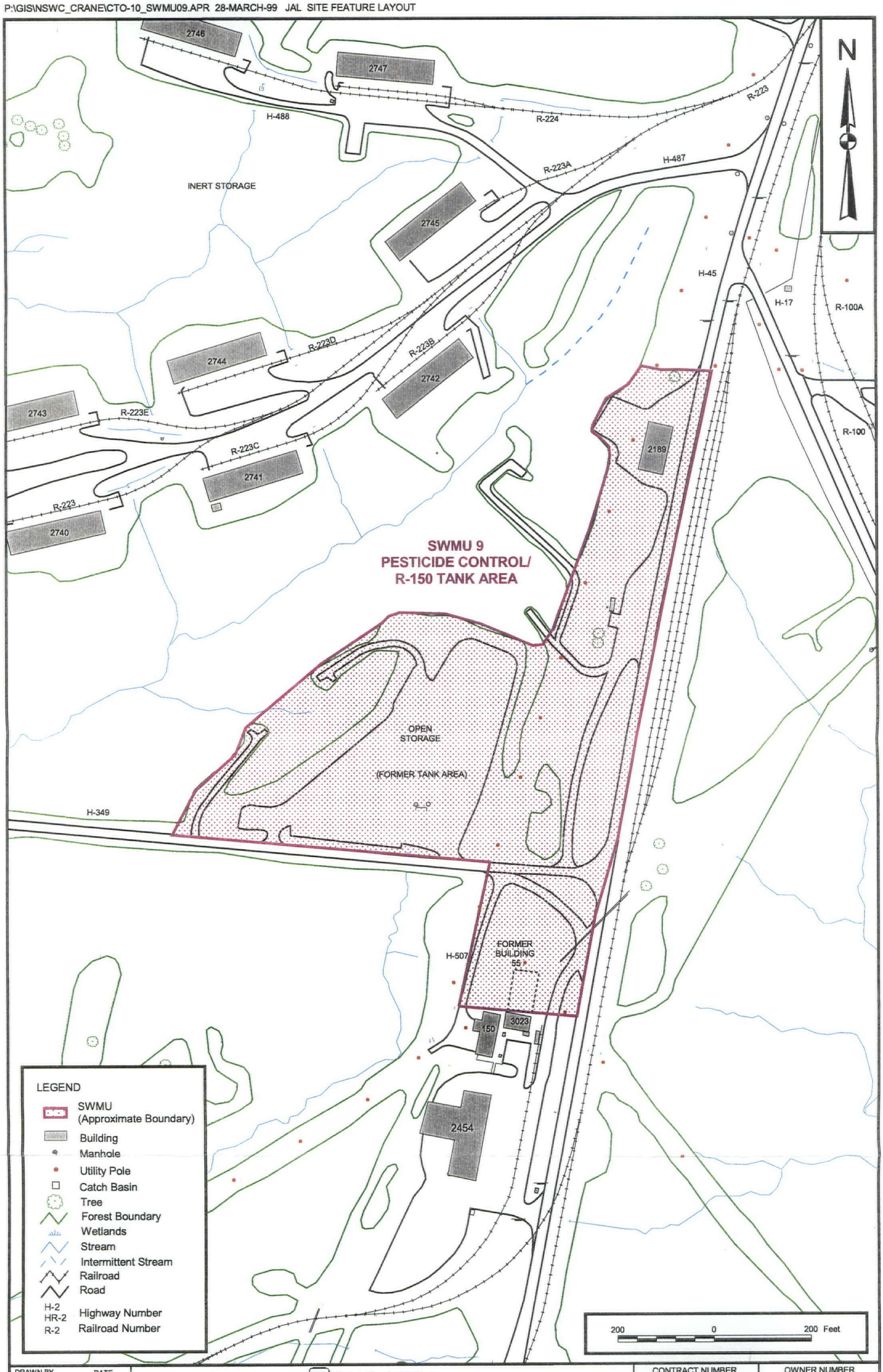
The topography at the site consists of undulating terrain dissected by many small drainage ways. The site lies along a northwesterly slope. At the foot of the slope is an intermittent stream. Runoff from the site is directed toward the intermittent stream, which flows from the northeast to the southwest. The intermittent stream ultimately discharges into Boggs Creek.

7.2.2 Geology

The site geologic profile consists of up to 10 feet of soil overburden that is underlain by Pennsylvanian-age sedimentary rocks of the Raccoon Creek Group Mansfield Formation. Sedimentary rocks immediately underlying this site consist of interbedded sandstone, clay, shale occasional limestone, and coal. Sandstone and shale are the predominant rock types.

The soils at the site consist of 2 to 10 feet of clay and clayey sand. Soils from 0 to 7 feet bgs are predominantly inorganic sandy silts and clays. Soils from 7 feet bgs are composed of fine- to medium-grained sand and gravel.

P:\GIS\NSWC_CRANE\CTO-10_SWMU09.APR 28-MARCH-99 JAL SITE FEATURE LAYOUT



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
J. LAMEY	3/4/99		7141	0010
CHECKED BY	DATE	SITE MAP SWMU 9 - PESTICIDE CONTROL/R-150 TANK AREA NSWC CRANE, INDIANA	APPROVED BY	DATE 10/14/99
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 7-1	REV

7.2.3 Hydrogeology

Available evidence indicates that ground water moves through the soil or in the rock fractures at the site. The ground water gradient is west/northwest. The static water level ranges from 7.5 feet bgs at the R-150 Tank Area to within a few feet of the ground surface downgradient of monitoring well 09-03 (location illustrated on Figure 7-2). The water table is believed to drop below the intermittent stream located west of the site. Therefore, ground water at the site may not discharge to the intermittent stream.

7.3 PREVIOUS INVESTIGATIONS

A brief description of the historical data collections activities conducted at SWMU 9, Pesticide Control/ R-150 Tank Area, is contained in this section. Soil and ground water samples have been collected at locations illustrated in Figure 7-2. A tabular summary of the previous investigations completed for the site is presented in Table 7-1.

Various investigations were completed at the site from 1981 to 1987 as part of several multi-site investigations. The first of which was the IAS (NEESA, 1983), which was initiated in April 1981 in response to the NACIP Program. NEESA completed the IAS in May 1983 with assistance from the Ordnance Environmental Support Agency and the U.S. ACE WES. The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations.

The IAS consisted of the installation of a total of 14 monitoring wells throughout the site. The first round of wells installed in 1981 consisted of a total of nine wells. Five monitoring wells (09-01, 09-03 through 09-05, and 09-08) were installed at various locations (upgradient, downgradient, and cross-gradient) to address the R-150 Tank. Four monitoring wells (09-02, 09-06, 09-07, 09-09) were installed at locations (west) downgradient of Building 2189 to address pesticide operations at the building. During the installation of these wells, soil samples were collected and tested for various soil characteristics, as identified in Table 7-1. Ground water samples collected from the wells were analyzed for a comprehensive list of chemical constituents and RCRA water quality parameters.

In July 1983 four core borings (WT-1 through WT-4) were drilled on each side of the R-150 Tank. Water and soil samples were collected from the bore holes. The analytical results for these samples indicated

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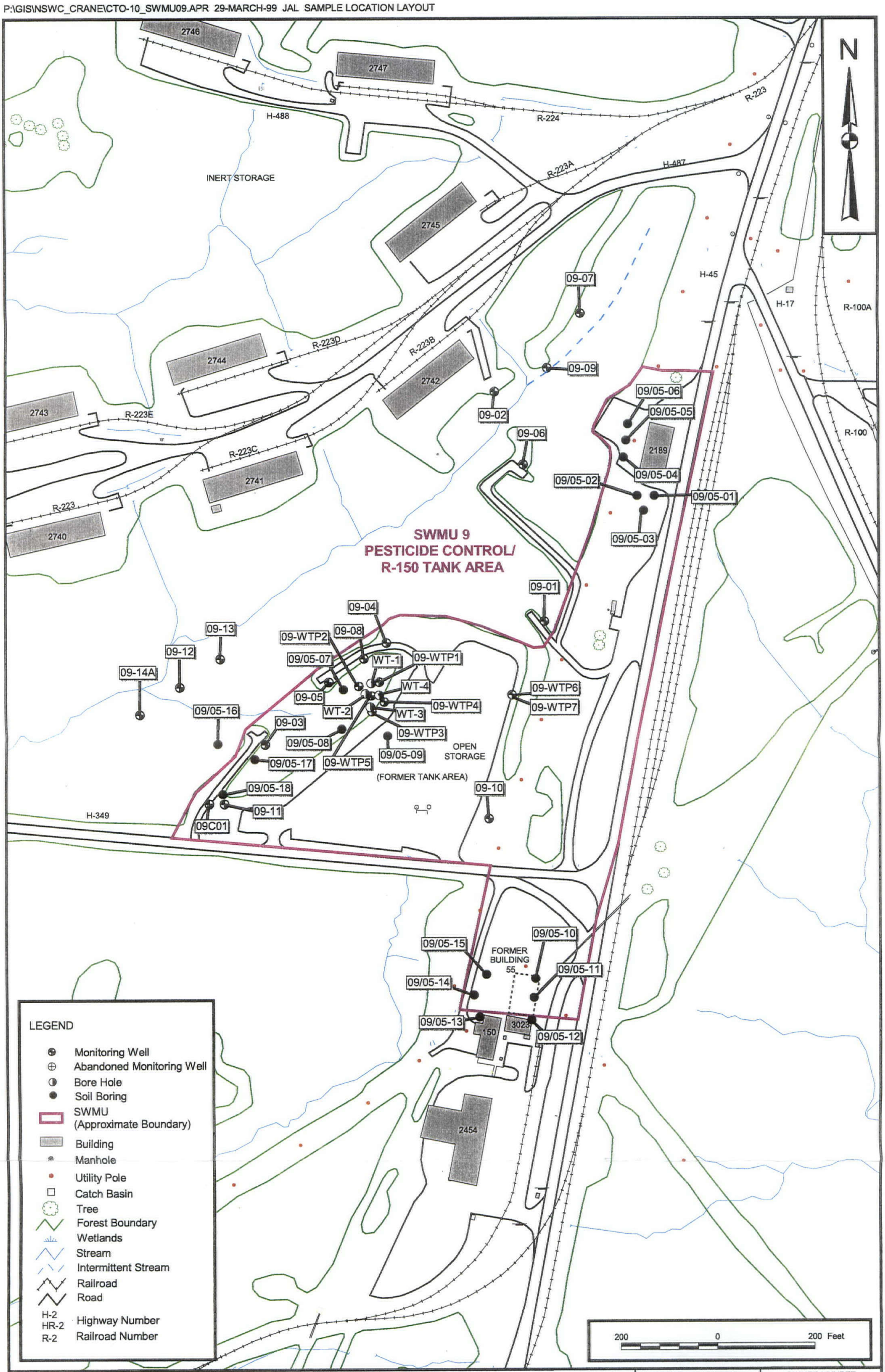
P:\GIS\NSWC_CRANE\CTO-10_SWMU09.APR 29-MARCH-99 JAL SAMPLE LOCATION LAYOUT



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
J. LAMEY	3/5/99		7141	0010
CHECKED BY	DATE	HISTORICAL SAMPLE LOCATIONS SWMU 9 - PESTICIDE CONTROL/R-150 TANK AREA NSWC CRANE, INDIANA	APPROVED BY K.M. Smacher	DATE 10/14/99
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 7-2	REV

TABLE 7-1

SUMMARY OF HISTORICAL SITE INVESTIGATIONS
SWMU 9 - PESTICIDE CONTOL/R-150 TANK AREA
NSWC CRANE, INDIANA

INVESTIGATION (REPORT/REFERENCE)	EXTENT OF INVESTIGATION			RESULTS OF INVESTIGATION	
	SUMMARY	DATE OF SAMPLING	ANALYTICAL PROGRAM (PARAMETER/ANALYTICAL METHOD)	DETECTED PARAMETERS OF INTEREST	CONCLUSIONS
General Basewide Investigations[1] (1981-1987)	Installation of 9 monitoring wells in 1981 (4 wells west of Building 2189, 3 wells downgradient of the R-150 tank, and 1 well upgradient of each area). Physical soil testing to define hydrogeological characteristics. In 1983, drilled 4 borings, one on each side of the R-150 tank. Grab soil and water samples collected from bore holes and analyzed for select parameters. Installed 5 monitoring wells in 1983 at locations downgradient of the R-150 tank to define the extent of contamination. Quarterly/semiannual ground water monitoring instituted to identify the presence or absence of contamination.	December 1982 - September 1991[2] February 1983 - June 1986[3]	Miscellaneous Physical Soil Testing (cation exchange capacity, grain size, Atterberg limits, density, water content, and permeability tests) -- Various Methods RCRA Group I - III Parameters[4] - Various Methods Select VOCs (1,1,1-TCA and TCE), pesticides, and inorganics for four grab soil and ground water samples (July 1983). Methods not identified.	VOCs (1,1,1-TCE, 1,1,2,2-PCA, benzene, chloroform, cis-1,3-dichloropropene, PCE, TCE, trans-1,2-DCE, 1,1-DCA, 1,1-DCE, and vinyl chloride), inorganics (mainly As, Ag, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, and Zn), Nitrate/ Nitrite, Sulfide and Sulfate	Site geological profile consists of up to 10 feet of soil overburden which is underlain by Pennsylvanian age sedimentary rocks, consisting of sandstone, clay, shale, and occasional limestone and coal. The soil consists of 2 to 10 feet of clay and clayey sand. Ground water flow direction is west-northwest. Depth to water table ranges from 7.5 feet near R-150 tank to a few feet bgs. The data indicated that there is an isolated VOC plume around the former location of the R-150 Tank. In addition, the highest detects of inorganics are located in this area. Ground water samples were collected from bore holes, not monitoring wells, thus the elevated high inorganic concentrations are considered to be attributable to turbid sample conditions. VOCs were not detected in downgradient wells. Pesticides, PCBs, and SVOCs were not found to be constituents of concern for the site. Detects of acetone, methylene chloride, and phthalates are thought to be laboratory contaminants.
Proposed Ground Water Assessment Plan for R-150 Tank Storage Closure, Pest Control Area (May and Murphy, 1989)	Installation of 6 wells around the R-150 tank (1 well upgradient of the tank, 4 wells circularly around perimeter of the tank, and 1 well directly in area of the excavated tank. Wells were sampled when installed and included in the monitoring program.	September 1986 - September 1991[2]	RCRA Group I - III Parameters[4] - Various Methods	VOCs (1,1,1-TCA and TCE) and inorganics mainly Fe and Mn)	The results of the monitoring program confirmed the presence of VOCs in gorund water near the R-150 Tank. However, the presence of elevated inorganic concentrations in this area was not confirmed.
RFI Phase II Soils Release Characterization for SWMU 09/05 Pest Control Area/R-150 Tank Site, Naval Surface Warfare Center Crane, Indiana (U.S. ACE WES, 1998c)	Collection of 3 surface soil samples from the western side of the site. Installation of 15 soil borings (3 in the vicinity of Building 2189, 6 in the vicinity of Building 55, 3 near the R-150 tank area, and 3 at a background location). Subsurface and surface soil sampling performed to determine if a chemical release had occurred at the site (i.e., identify residual contaminant concentrations in soil).	August 1992	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Organochlorine Pesticides/PCBs -- SW-846 Method 8080 Organophosphorus Pesticides -- SW-846 Method 8140 Herbicides -- SW-846 Method 8150 Inorganics -- SW-846 Methods 6010/7060/7471/7740 and ASTM D4190-82 TPH -- EPA 418.1	Surface soil - PAHs, pesticides (disulfoton and phorate), inorganics (mainly As, Ba, Pb, and Se), and TPH. Subsurface soil - PAHs, alpha-BHC, dinoseb, inorganics (mainly As, Ba, Pb, Hg, Ni, Se, and Zn) and TPH.	PAHs and TPH were detected at elevated levels in borings 09/05-05 and 09/05-06, which are located in proximity to Highway 45 at the former location of Building 2189. Several pesticides and a herbicide were detected in various areas of the sites. Pesticides were found in the surface soil from boring 09/05-18, collected from a location near Highway 349 by the R-150 Tank area; an elevated TPH concentration was also noted in this sample. Pesticides were detected in the subsurface soil from boring 09/05-05, near Building 2189. Dinoseb was detected in boring 09/05-03, the background location. PAHs detected near Building 2189 are not likely related to site activities. Blank samples for the soil program had a substantial amount of various contaminants, including methylene chloride, phthalates, Cd, Cr, select SVOCs, and pesticides. Because of the detections in the blank samples, reported concentrations of these constituents in the site samples are suspect and may, in fact, be laboratory contamination.
RFI Phase III Ground Water Work Plan for Naval Weapons Support Center, Crane, Indiana, Pest Control Area/R-150 Tank (U.S. ACE WES, 1995)[6]	Collection of a round of ground water samples from 20 existing monitoring wells to determine the rate and extent of migration of contaminated ground water.	July 1992	VOCs -- SW-846 Method 3240 SVOCs -- SW-846 Method 8270 Organochlorine Pesticides/PCBs -- SW-846 Method 8080 Organophosphorus Pesticides -- SW-846 Method 8140 Herbicides -- SW-846 Method 8150 Inorganics -- SW-846 Methods 6010/7060/7471/7740 Water Quality Parameters - Various EPA Methods	VOCs (1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCA 1,2-dichloropropane, benzene, cis-1,2-DCE, TCE, and vinyl chloride), pesticides, Aroclor-1254, inorganics (mainly As, Sb, Co, Fe, Mn, Ni, and Zn), sulfate and sulfide	The results of this monitoring program confirmed that the VOC ground water contamination is localized in the area of the R-150 Tank and is not moving down gradient. Pesticides are detected throughout the ground water monitoring well network. Reported inorganics correspond with the inorganics found during earlier site investigations. The highest levels of inorganics were detected in wells 09-02, 09-12, and 09-13, which are all located near the creek to the west of the site. Detections of acetone, methylene chloride, and phthlates are thought to be due to laboratory contamination.

Ag Silver
As Arsenic
ASTM American Standard Testing Methods
Ba Barium
bgs Below ground surface
Cd Cadmium
Co Cobalt
Cu Copper
Cr Chromium
DCA Dichloroethane
DCE Dichloroethene
Fe Iron
Hg Mercury
Mn Manganese
NA Not applicable
Ni Nickel
PCE Tetrachloroethene
PAHs Polynuclear Aromatic Hydrocarbons
Pb Lead
PCA Tetrachloroethane
PCBs Polychlorinated Biphenyls
RCRA Resource Conservation and Recovery Act
RFI RCRA Facility Investigation
Sb Antimony
Se Selenium
SVOCs Semivolatile Organic Compounds
SWMU Solid Waste Management Unit
TCA Trichloroethane
TCE Trichloroethene
TPH Total Petroleum Hydrocarbons
VOCs Volatile Organic Compounds
Zn Zinc

1 Includes, but is not limited to, Hydrogeologic Investigations at Waste Disposal Sites (U.S. ACE WES, 1982), Initial Assessment Study of the Naval Weapons Support Center, Crane, Indiana (NEESA, 1983) and Definition of Contaminated Ground-Water Plumes at Selected Waste Disposal Sites (U.S. ACE WES, 1984).
2 Quarterly monitoring.
3 Semiannual monitoring.
4 Includes select VOCs, inorganics, pesticides, herbicides, radionuclides, phenol, chloride, fluoride, nitrate, nitrite, sulfate, and total bacteria.
5 Includes phosphorus and tin.
6 Only sampling of existing wells was conducted. Additional work proposed in the work plan and a Ground Water Release Characterization Report was not generated for the sampling effort because of funding issues.

that the tank had leaked and that hazardous constituents (VOCs) had been released to the surrounding environment. The tank was subsequently excavated and removed from the site in September 1983.

To better delineate the ground water plume at the R-150 Tank area, five monitoring wells (09-10 through 09-13, plus 09-14A) were installed around and downgradient of the tank in 1983. Upon well installation, samples were collected and analyzed for a comprehensive list of constituents. The wells were then added to the quarterly and semi-annual sampling programs initiated at the Pesticide Control/ R-150 Tank Area as part of the IAS.

Based on the initial conclusions of the IAS, it was determined that SWMU 9 did not present an immediate human health and environmental threat. However, the site was recommended for further study to evaluate potential long-term impacts.

In 1986 seven monitoring wells were installed around the R-150 Tank as part of the Ground water Assessment Plan (May and Murphy, 1989) for tank closure. Four wells were located circularly around the tank (09-WTP1 through 09-WTP4) and one well (09-WTP5) was placed directly in the location where the tank was situated prior to excavation. Two wells, 09-WTP6 and 09-WTP-7) were placed at locations upgradient of the tank. Ground water samples were collected and analyzed for various constituents.

In response to the recommendation presented in the IAS, a RFI Phase II Soil Release Characterization was performed at the Pesticide Control/R-150 Tank Area in 1992 (U.S. ACE WES, 1998c). The objective of the study was to determine soil conditions at the site and to identify and characterize hazardous constituents released to the surrounding environment. Fifteen soil borings (labeled 09/05-01 through 09/05-15 on Figure 7-2) were installed at the site. Both surface and subsurface samples were collected at each boring and analyzed for a comprehensive analytical program, as indicated in Table 7-1.

In 1992 a draft Work Plan for a RFI Ground Water Release Characterization was prepared by U.S. ACE WES (1995). The objective of the sampling effort was to determine the extent of hazardous constituents present in the ground water, as well as the rate of migration. The proposed ground water study included the collection of samples from the existing 20 monitoring wells at the site, plus the installation of additional wells.

Because of funding constraints, only a portion of the work proposed in the plan was conducted in 1992. Additional proposed monitoring wells were not installed and not all ground water samples collected were analyzed for all proposed chemical constituents or for the same list of constituents. A ground water Release Characterization Report was not generated for the sampling effort because of funding issues.

7.4 HAZARD IDENTIFICATION

The hazard identification characterizes those constituents that may be attributable to historical operations at the site. Based on knowledge of site practices and an interpretation of the historical data (i.e., comparison of detected constituents to risk-based screening criteria), a list of detected chemicals of interest was developed for Pesticide Control/R-150 Tank Area. Detected chemicals of interest are defined as those chemicals, excluding blank contaminants, present at concentrations greater than risk-based screening criteria. Discussions of those constituents detected at concentrations in excess of current human health and ecological screening criteria are provided in Sections 7.4.1 (organics) and 7.4.2 (inorganics). A summary of the detected parameters of interest is contained in Section 7.4.3.

Historical site data were compared to human health and ecological criteria to identify chemicals of interest. Summaries of the comparison of historical site data to human health and ecological risk-based criteria are presented in Tables 7-2 (surface soil), 7-3 (subsurface soil), and 7-4 (ground water, Lower Pennsylvanian aquifer). A brief description of the screening criteria used was provided in Section 4.2 of this Work Plan.

Figures 7-3 through 7-6 depict those locations where exceedances of human health and ecological risk-based criteria have been noted during previous investigations. Separate figures are provided for soil (surface soil and subsurface soil combined) and ground water. For each sample matrix, separate figures are presented to illustrate human health and ecological exceedances.

Because shallow ground water at the site discharges to various unnamed tributaries and since surface water/sediment samples have not been collected from the site, historical ground water data were compared to ecological screening criteria for surface water. The comparison is considered to be conservative, because it does not include the dilution of contaminants in the creek. Thus, those chemicals identified as detected chemicals of interest based solely on the comparison of ground water data to surface water criteria may not actually be present in the surface water at concentrations of potential concern.

7.4.1 Organic Constituents

Various chlorinated solvents were detected in the ground water at the site, near the R-150 Tank. Although the source of chlorinated solvents, the tank, has been removed from the site, chlorinated solvents have migrated to the ground water and are present at concentrations of potential concern (i.e., in excess of

TABLE 7-2

HISTORICAL DATA SUMMARY - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 9 - PESTICIDE CONTROL AREA
NSWC CRANE, INDIANA
PAGE 1 OF 3

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. E PA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
Volatile Organics (mg/kg)												
1,1,1-TRICHLOROETHANE	4/13	0.0005-0.0027	0.005-0.006	09/05-6-92-1 (92) (08/14/92)	0	---	1200	0.1	770	2400	1.9	29.8
1,1,2,2-TETRACHLOROETHANE	0/13	---	0.005-0.006	---	0	3	0.6	0.0002	0.38	5.4	0.007	0.12722
1,1,2-TRICHLOROETHANE	0/13	---	0.005-0.006	---	0	11	1	0.0009	0.84	10	0.03	28.6
1,1-DICHLOROETHANE	0/13	---	0.005-0.006	---	0	7800	1300	1	590	1400	5.6	20.1
1,1-DICHLOROETHENE	0/13	---	0.005-0.006	---	0	1	0.07	0.003	0.054	0.73	0.058	8.28
1,2-DICHLOROETHANE	0/13	---	0.005-0.006	---	0	7	0.4	0.001	0.35	4	0.024	21.2
1,2-DICHLOROPROPANE	0/13	---	0.005-0.006	---	0	9	15	0.001	0.35	5	0.03	32.7
2-BUTANONE	0/13	---	0.011-0.12	---	0	---	---	---	7300	20000	10	89.6
2-HEXANONE	0/13	---	0.05-0.06	---	0	---	---	---	---	---	---	12.6
4-METHYL-2-PENTANONE	0/13	---	0.05-0.06	---	0	---	---	---	790	---	---	443
ACETONE	10/13	0.0037-0.041	0.11-0.12	09/05-16-92-1 (92) (08/15/92)	0	7800	100000	0.8	1600	4200	3.1	2.5
BENZENE	1/13	0.001	0.005-0.006	09/05-13-92-1 (92) (08/18/92)	0	22	0.8	0.002	0.67	9	0.34	0.25462
BROMODICHLOROMETHANE	7/13	0.0035-0.0058	0.005-0.006	09/05-1-92-1 (92) (08/13/92)	0	10	3000	0.03	1.0	11	0.63	0.53978
BROMOFORM	0/13	---	0.005-0.006	---	0	81	53	0.04	62	290	0.75	15.9
BROMOMETHANE	0/13	---	0.01-0.012	---	0	110	10	0.01	3.9	11	0.052	0.23516
CARBON DISULFIDE	0/13	---	0.005-0.006	---	0	7800	720	2	360	990	10	0.09412
CARBON TETRACHLORIDE	0/13	---	0.005-0.006	---	0	5	0.3	0.003	0.24	3.6	0.066	2.98
CHLOROBENZENE	1/13	0.0008	0.005-0.006	09/05-13-92-1 (92) (08/18/92)	0	1600	130	0.07	1.0	150	1.3	13.1
CHLOROETHANE	0/13	---	0.01-0.012	---	0	---	---	---	3.0	---	---	---
CHLOROFORM	9/13	0.00027-0.026	0.005-0.0055	09/05-1-92-1 (92) (08/13/92)	0	100	0.3	0.03	0.24	3.3	0.59	1.19
CHLOROMETHANE	0/13	---	0.01-0.012	---	0	---	---	---	1.2	---	---	10.4
CIS-1,2-DICHLOROETHENE	0/13	---	0.005-0.006	---	0	780	1200	0.02	43	119	0.4	0.78373[6]
CIS-1,3-DICHLOROPROPENE	0/13	---	0.005-0.006	---	0	4	0.1	0.0002	---	---	---	0.39786
DIBROMOCHLOROMETHANE	6/13	0.00053-0.0019	0.005-0.006	09/05-1-92-1 (92) (08/13/92)	0	8	1300	0.02	1.1	---	---	2.05
ETHYLBENZENE	2/13	0.00079-0.0018	0.005-0.006	09/05-10-92-1 (92) (08/15/92)	0	7800	400	0.7	230	5000	13	5.16
METHYLENE CHLORIDE	13/13	0.008-0.039	---	09/05-10-92-1 (92) (08/15/92)	13	85	13	0.001	8.9	120	0.023	4.05
STYRENE	1/13	0.00064	0.005-0.006	09/05-13-92-1 (92) (08/18/92)	0	16000	1500	0.2	1.0	12000	3.5	4.69
TETRACHLOROETHENE	0/13	---	0.005-0.006	---	0	12	11	0.003	5.7	50	0.058	9.92
TOLUENE	3/13	0.00051-0.002	0.005-0.006	09/05-10-92-1 (92) (08/15/92)	0	16000	650	0.6	520	1800	12	5.45
TRANS-1,2-DICHLOROETHENE	0/13	---	0.005-0.006	---	0	1600	3100	0.03	63	190	0.68	0.78373
TRANS-1,3-DICHLOROPROPENE	0/13	---	0.005-0.006	---	0	4	0.1	0.0002	---	---	---	0.39786
TRICHLOROETHENE	0/13	---	0.005-0.006	---	0	58	5	0.003	2.8	48	0.057	12.4
VINYL ACETATE	0/13	---	0.05-0.06	---	0	78000	1000	8	430	1200	2.3	12.7
VINYL CHLORIDE	0/13	---	0.01-0.012	---	0	0.3	0.03	0.0007	0.022	0.31	0.013	0.64614
XYLENES, TOTAL	4/13	0.0012-0.012	0.005-0.006	09/05-10-92-1 (92) (08/15/92)	0	160000	410[8]	9[8]	210	5300	190	10
Semivolatile Organics (mg/kg)												
1,2,4-TRICHLOROBENZENE	0/13	---	0.68-14	---	0	780	3200	0.3	6.0	1800	5.3	11.1
1,2-DICHLOROBENZENE	0/13	---	0.68-14	---	0	7000	560	0.9	370	3000	17	2.96
1,2-DIPHENYLHYDRAZINE	0/13	---	0.68-14	---	0	---	---	---	0.61	---	---	---
1,3-DICHLOROBENZENE	0/13	---	0.68-14	---	0	---	---	---	13	114	0.42	37.7
1,4-DICHLOROBENZENE	0/13	---	0.68-14	---	0	27	---	0.1	3.0	42	2.2	0.54559
2,4,5-TRICHLOROPHENOL	0/13	---	0.68-14	---	0	7800	---	14	6100	18000	250	14.1
2,4,6-TRICHLOROPHENOL	0/13	---	0.68-14	---	0	58	200	0.008	44	390	1.5	9.94
2,4-DICHLOROPHENOL	0/13	---	0.68-14	---	0	230	---	0.05	1.0	550	1.1	87.5
2,4-DIMETHYLPHENOL	0/13	---	0.68-14	---	0	1600	---	0.4	1.0	3600	9	0.01
2,4-DINITROPHENOL	0/13	---	3.4-70	---	0	160	---	0.01	120	360	0.29	0.06086
2,4-DINITROTOLUENE	0/13	---	0.68-14	---	0	0.9	---	0.00004	120	---	---	1.28
2,6-DINITROTOLUENE	0/13	---	0.68-14	---	0	0.9	---	0.00003	61	---	---	0.03283
2-CHLORONAPHTHALENE	0/13	---	0.68-14	---	0	---	---	---	4900	---	---	0.01218
2-CHLOROPHENOL	0/13	---	0.68-14	---	0	390	53000	0.2	6.0	380	0.75	0.24266
2-METHYL-4,6-DINITROPHENOL	0/13	---	3.4-70	---	0	---	---	---	---	---	---	---
2-METHYLNAPHTHALENE	1/13	0.05	0.68-14	09/05-8-92-1 (92) (08/14/92)	0	---	---	---	---	---	---	3.24
2-METHYLPHENOL	1/13	0.21	0.68-14	09/05-8-92-1 (92) (08/14/92)	0	3900	---	0.8	3100	7600	14	40.4
2-NITROANILINE	0/13	---	3.4-70	---	0	---	---	---	3.5	---	---	74.1
2-NITROPHENOL	0/13	---	0.68-14	---	0	---	---	---	---	---	---	1.6
3,3'-DICHLOROBENZIDINE	0/13	---	1.4-28	---	0	1	---	0.0003	1.1	9.5	0.062	0.64636
3-NITROANILINE	0/13	---	3.4-70	---	0	---	---	---	---	---	---	3.16
4-BROMOPHENYL PHENYL ETHER	0/13	---	0.68-14	---	0	---	---	---	---	---	---	---
4-CHLORO-3-METHYLPHENOL	0/13	---	1.4-28	---	0	---	---	---	---	---	---	7.95
4-CHLOROANILINE	0/13	---	1.4-28	---	0	310	---	0.03	240	730	0.97	1.1
4-CHLOROPHENYL PHENYL ETHER	0/13	---	0.68-14	---	0	---	---	---	---	---	---	---

TABLE 7-2

HISTORICAL DATA SUMMARY - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 9 - PESTICIDE CONTROL AREA
NSWC CRANE, INDIANA
PAGE 2 OF 3

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. E PA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
4-METHYLPHENOL	0/13	—	0.68-14	—	0	—	—	—	310	—	—	163
4-NITROANILINE	0/13	—	3.4-70	—	0	—	—	—	—	—	—	21.9
4-NITROPHENOL	0/13	—	3.4-70	—	0	—	—	—	490	—	—	5.12
ACENAPHTHENE	1/13	4.9	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	0	4700	—	29	3700	9500	130	682
ACENAPHTHYLENE	0/13	—	0.68-14	—	0	—	—	—	—	—	—	682
ANILINE	0/13	—	1.4-28	—	0	—	—	—	85	—	—	0.05678
ANTHRACENE	2/13	0.021-11	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	23000	—	590	22000	47000	51	1480
BENZIDINE	0/13	—	3.4-70	—	0	—	—	—	0.0021	—	—	—
BENZO(A)ANTHRACENE	1/13	29	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	0.9	—	0.08	0.62	5	5	5.21
BENZO(A)PYRENE	1/13	27	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	0.09	—	0.4	0.062	0.5	0.5	1.52
BENZO(B)FLUORANTHENE	1/13	29	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	0.9	—	0.2	0.62	5	5	59.8
BENZO(G,H,I)PERYLENE	1/13	9.7	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	0	—	—	—	—	—	—	119
BENZO(K)FLUORANTHENE	1/13	19	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	9	—	2	6.2	50	39	1480
BENZOIC ACID	0/13	—	3.4-70	—	0	310000	—	20	100000	730000	590	—
BENZYL ALCOHOL	0/13	—	1.4-28	—	0	—	—	—	18000	—	—	65.8
BIS(2-CHLOROETHOXY)METHANE	0/13	—	0.68-14	—	0	—	—	—	—	—	—	0.30209
BIS(2-CHLOROETHYL)ETHER	0/13	—	0.68-14	—	0	0.6	0.2	0.00002	0.21	1.6	0.0007	23.7
BIS(2-CHLOROISOPROPYL) ETHER	0/13	—	0.68-14	—	0	—	—	—	6.9	31	0.027	—
BIS(2-ETHYLHEXYL)PHTHALATE	4/13	0.051-0.18	0.68-14	09/05-1-92-1 (92) (08/13/92)	0	46	31000	180	35	300	300	0.92594
BUTYLBENZYL PHTHALATE	0/13	—	0.68-14	—	0	16000	930	810	12000	36000	930	0.23889
CHRYSENE	1/13	34	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	88	—	8	62	500	26	4.73
DIBENZO(A,H)ANTHRACENE	0/13	—	0.68-14	—	0	0.09	—	0.08	6100	18000	2300	18.4
DIBENZOFURAN	1/13	2	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	0	—	—	—	1200	3700	2000	—
DIETHYL PHTHALATE	1/13	0.048	0.68-14	09/05-9-92-1 (92) (08/15/92)	0	63000	2000	23	0.062	0.5	0.5	24.8
DIMETHYL PHTHALATE	0/13	—	0.68-14	—	0	—	—	—	290	—	—	734
DI-N-BUTYL PHTHALATE	8/13	0.079-0.35	0.77-14	09/05-18-92-1 (92) (08/15/92)	4	7800	2300	270	49000	150000	450	0.14979
DI-N-OCTYL PHTHALATE	2/13	0.098-0.14	0.68-14	09/05-9-92-1 (92) (08/15/92)	0	1600	10000	10000	100000	—	—	709
FLUORANTHENE	1/13	55	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	0	3100	—	210	2300	6300	880	122
FLUORENE	2/13	0.04-6	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	0	3100	—	28	2600	6300	170	122
HEXACHLOROBENZENE	0/13	—	0.68-14	—	0	0.4	1	0.1	3.0	2.7	2.2	0.19678
HEXACHLOROBUTADIENE	0/13	—	0.68-14	—	0	8	8	0.1	6.0	36	16	0.03976
HEXACHLOROCYCLOPENTADIENE	0/13	—	0.68-14	—	0	550	10	20	420	1300	400	0.75537
HEXACHLOROETHANE	0/13	—	0.68-14	—	0	46	55	0.02	35	183	2.8	0.59634
INDENO(1,2,3-CD)PYRENE	1/13	11	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	0.9	—	0.7	0.62	5	3	109
ISOPHORONE	0/13	—	0.68-14	—	0	670	4600	0.03	510	4500	5.3	139
NAPHTHALENE	1/13	0.21	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	3100	—	4	0.069	0.61	0.0006	0.09939
NITROBENZENE	0/13	—	0.68-14	—	0	39	92	0.007	0.0095	—	—	1.31
N-NITROSODIMETHYLAMINE	0/13	—	0.68-14	—	0	—	—	—	9.0	810	9.7	0.0000321
N-NITROSO-DI-N-PROPYLAMINE	0/13	—	0.68-14	—	0	0.09	—	0.000002	56	3200	0.7	0.54368
N-NITROSODIPHENYLAMINE	0/13	—	0.68-14	—	0	130	—	0.06	20	91	0.028	0.54514
PENTACHLOROPHENOL	0/13	—	3.4-70	—	0	3	—	0.001	3.0	20	0.028	0.11927
PHENANTHRENE	2/13	0.12-49	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	—	—	—	—	—	—	45.7
PHENOL	1/13	0.15	0.68-14	09/05-8-92-1 (92) (08/14/92)	0	47000	—	5	37000	89000	110	120
PYRENE	2/13	0.072-88	0.68-0.8	09/05-6-92-1 (92) (08/14/92)	1	2300	—	210	2300	5500	570	78.5
Pesticides/PCBs/Herbicides (mg/kg)												
2,4,5-T	1/13	0.038	0.067-0.08	09/05-16-92-1 (92) (08/15/92)	0	—	—	—	610	—	—	0.59634
2,4,5-TP (SILVEX)	0/13	—	0.057-0.068	—	0	—	—	—	490	—	—	0.1088
2,4-D	0/13	—	0.4-0.48	—	0	—	—	—	690	—	—	0.02725
4,4'-DDD	4/13	0.00091-0.027	0.0075-0.0088	09/05-9-92-1 (92) (08/15/92)	0	3	—	0.8	2.4	28	28	0.75815
4,4'-DDE	6/13	0.00048-0.0049	0.0027-0.0032	09/05-8-92-1 (92) (08/14/92)	0	2	—	3	1.7	20	20	0.59587
4,4'-DDT	8/13	0.00097-0.069	0.0082-0.0096	09/05-9-92-1 (92) (08/15/92)	1	2	—	2	1.7	20	20	0.0175
ALDRIN	3/13	0.00057-0.0037	0.0027-0.0032	09/05-13-92-1 (92) (08/18/92)	1	0.04	3	0.02	0.029	0.25	0.25	0.00332
ALPHA-BHC	0/13	—	0.002-0.0024	—	0	0.1	0.8	0.00003	0.090	0.99	0.0072	0.09939
ALPHA-CHLORDANE	8/13	0.00051-0.0027	0.0034-0.004	09/05-7-92-1 (92) (08/14/92)	0	0.5[10]	20[10]	0.5[10]	—	—	—	0.224[10]
AROCLOR-1016	0/13	—	0.044-0.053	—	0	1[11]	—	—	3.9	—	—	0.000332[11]
AROCLOR-1221	0/13	—	0.044-0.053	—	0	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1232	0/13	—	0.044-0.053	—	0	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1242	0/13	—	0.044-0.053	—	0	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1248	0/13	—	0.044-0.053	—	0	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1254	2/13	0.017-0.19	0-0.1	09/05-8-92-1 (92) (08/14/92)	2	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1260	0/13	—	0.089-0.11	—	0	1[11]	—	—	0.22	—	—	[illegible][11]

TABLE 7-2

HISTORICAL DATA SUMMARY - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 9 - PESTICIDE CONTROL AREA
NSWC CRANE, INDIANA
PAGE 3 OF 3

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. E PA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
BETA-BHC	7/13	0.00087-0.005	0.0041-0.0048	09/05-7-92-1 (92) (08/14/92)	7	0.4	---	0.0001	0.32	3.5	0.026	0.00398
DELTA-BHC	0/13	---	0.0061-0.0072	---	0	---	---	---	---	---	---	9.94
DIELDRIN	9/13	0.00047-0.041	0.0014-0.0016	09/05-9-92-1 (92) (08/15/92)	9	0.04	1	0.0002	0.030	0.27	0.046	0.00238
DINOSEB	0/13	---	0.023-0.028	---	0	---	---	---	61	---	---	0.0218
DISULFOTON	1/13	0.044	0.024-0.028	09/05-18-92-1 (92) (08/15/92)	1	---	---	---	2.4	---	---	0.01988
ENDOSULFAN I	1/13	0.011	0.0095-0.099	09/05-8-92-1 (92) (08/14/92)	0	470[12]	---	0.9[12]	370	1100	20	0.11927
ENDOSULFAN II	2/13	0.00074-0.0014	0.0027-0.0032	09/05-6-92-1 (92) (08/14/92)	0	470[12]	---	0.9[12]	---	---	---	0.11927
ENDOSULFAN SULFATE	1/13	0.0098	0.045-0.053	09/05-3-92-1 (92) (08/12/92)	0	---	---	---	---	---	---	0.03578
ENDRIN	2/13	0.00055-0.0006	0.0041-0.0049	09/05-2-92-1 (92) (08/13/92)	0	23	---	0.05	18	54	0.99	0.0101
ENDRIN ALDEHYDE	4/13	0.002-0.098	0.016-0.019	09/05-9-92-1 (92) (08/15/92)	1	---	---	---	---	---	---	0.0105
ETHYL PARATHION	1/13	0.048	0.014-0.024	09/05-18-92-1 (92) (08/15/92)	0	---	---	---	370	---	---	---
FAMPHUR	1/13	0.016	0.041-0.048	09/05-18-92-1 (92) (08/15/92)	0	---	---	---	---	---	---	0.0497
GAMMA-BHC (LINDANE)	0/13	---	0.0027-0.0032	---	0	0.5	---	0.0005	0.44	4.8	0.0094	0.005
GAMMA-CHLORDANE	7/13	0.00072-0.0061	0.0034-0.004	09/05-8-92-1 (92) (08/14/92)	0	0.5[10]	20[10]	0.5[10]	1.6	---	---	0.224[10]
HEPTACHLOR	4/13	0.00041-0.0032	0.002-0.0024	09/05-13-92-1 (92) (08/18/92)	0	0.1	0.1	1	0.11	0.56	0.56	0.00598
HEPTACHLOR EPOXIDE	1/13	0.024	0.057-0.067	09/05-8-92-1 (92) (08/14/92)	0	0.07	5	0.03	0.053	0.46	0.46	0.15188
KEPONE	0/13	---	0.41-0.49	---	0	---	---	---	0.027	---	---	0.03272
METHOXYCHLOR	0/13	---	0.12-0.14	---	0	390	---	8	310	900	160	0.01988
METHYL PARATHION	1/13	0.073	0.04-0.048	09/05-18-92-1 (92) (08/15/92)	1	---	---	---	15	---	---	0.000292
PHORATE	2/13	0.039-0.051	0.014-0.016	09/05-18-92-1 (92) (08/15/92)	2	---	---	---	12	---	---	0.000496
TOXAPHENE	0/13	---	0.16-0.19	---	0	0.6	89	2	0.44	3.9	3.9	0.11927
Inorganics (mg/kg)												
ARSENIC	13/13	0.41-9.03	---	09/05-1-92-1 (92) (08/13/92)	13	0.4	750	1	0.39	3.9	3.9	5.7
BARIUM	13/13	30.6-276	---	09/05-16-92-1 (92) (08/15/92)	13	5500	690000	82	5400	24000	1600	1.04
CADMIUM	10/13	0.047-0.633	0.02	09/05-8-92-1 (92) (08/14/92)	10	78	1800	0.4	37	12	7.5	0.00222
CHROMIUM (TOTAL)	13/13	11.5-22.9	---	09/05-8-92-1 (92) (08/14/92)	13	390	270	2	210	470	38	0.4
LEAD	13/13	7.3-161	---	09/05-10-92-1 (92) (08/15/92)	13	400[14]	---	---	400	350	81	0.05373
MERCURY	0/13	---	0.1	---	0	23	10	0.1	---	55	2.1	0.01
SELENIUM	8/13	0.22-0.38	0.2	09/05-13-92-1 (92) (08/18/92)	8	390	---	0.3	390	1700	5.2	0.02765
SILVER	0/13	---	0.1-1	---	0	390	---	2	390	1700	31	4.04
Miscellaneous Parameters (mg/kg)												
TOTAL PETROLEUM HYDROCARBONS	8/13	4-6500	25	09/05-8-92-1 (92) (08/14/92)	3	---	---	---	---	---	---	---

--- Not applicable/Not available.

BGS Below ground surface
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
OSWER Office of Solid Waste and Emergency Response
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SSL Soil Screening Level
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, May 1996.
2 Because of karst geologic conditions present at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
3 U.S. EPA, Region 9, May 1998.
4 IDEM, October 1997.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 trans-1,2-Dichloroethene.
7 1,3-Dichloropropene.
8 o-Xylene.
9 m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Hexavalent chromium.
14 OSWER soil screening level for residential land use (U.S. EPA, July 1994).
15 State notification level for UST program (IDEM, March 1999).

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TABLE 7-3

HISTORICAL DATA SUMMARY - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 9 - PESTICIDE CONTROL AREA
NSWC CRANE, INDIANA
PAGE 1 OF 4

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Suface Soil	Subsurface Soil	
Volatile Organics (mg/kg)												
1,1,1-TRICHLOROETHANE	4/49	0.0011-0.0078	0.005-0.01	09/05-5-92-1 (92) (08/13/92)	0	—	1200	0.1	770	2400	1.9	29.8
1,1,2,2-TETRACHLOROETHANE	0/41	—	0.0055-0.006	—	0	3	0.6	0.0002	0.38	5.4	0.007	0.12722
1,1,2-TRICHLOROETHANE	0/41	—	0.0055-0.006	—	0	11	1	0.0009	0.84	10	0.03	28.6
1,1-DICHLOROETHANE	0/41	—	0.0055-0.006	—	0	7800	1300	1	590	1400	5.6	20.1
1,1-DICHLOROETHENE	0/41	—	0.0055-0.006	—	0	1	0.07	0.003	0.054	0.73	0.058	8.28
1,2-DICHLOROETHANE	0/41	—	0.0055-0.006	—	0	7	0.4	0.001	0.35	4	0.024	21.2
1,2-DICHLOROPROPANE	0/41	—	0.0055-0.006	—	0	9	15	0.001	0.35	5	0.03	32.7
2-BUTANONE	5/41	0.002-0.033	0.011-0.12	09/05-1-92-2 (92) (08/13/92)	0	—	—	—	7300	20000	10	89.6
2-HEXANONE	0/41	—	0.055-0.06	—	0	—	—	—	—	—	—	12.6
4-METHYL-2-PENTANONE	0/41	—	0.055-0.06	—	0	—	—	—	790	—	—	443
ACETONE	36/41	0.0041-0.16	0.11-0.12	09/05-14-92-1 (92) (08/18/92)	0	7800	100000	0.8	1600	4200	3.1	2.5
BENZENE	1/41	0.0011	0.0055-0.006	09/05-13-92-2 (92) (08/18/92)	0	22	0.8	0.002	0.67	9	0.34	0.25462
BROMODICHLOROMETHANE	30/41	0.00052-0.007	0.0055-0.006	09/05-3-92-2 (92) (08/12/92)	0	10	3000	0.03	1.0	11	0.63	0.53978
BROMOFORM	0/41	—	0.0055-0.006	—	0	81	53	0.04	62	290	0.75	15.9
BROMOMETHANE	0/41	—	0.011-0.012	—	0	110	10	0.01	3.9	11	0.052	0.23516
CARBON DISULFIDE	1/41	0.0034	0.0055-0.006	09/05-14-92-2 (92) (08/18/92)	0	7800	720	2	360	990	10	0.09412
CARBON TETRACHLORIDE	0/41	—	0.0055-0.006	—	0	5	0.3	0.003	0.24	3.6	0.066	2.98
CHLOROBENZENE	3/41	0.00047-0.001	0.0055-0.006	09/05-6-92-3 (92) (08/14/92)	0	1600	130	0.07	1.0	150	1.3	13.1
CHLOROETHANE	0/41	—	0.011-0.012	—	0	—	—	—	3.0	—	—	—
CHLOROFORM	34/41	0.003-0.039	0.0055-0.006	09/05-9-92-2 (92) (08/15/92)	3	100	0.3	0.03	0.24	3.3	0.59	1.19
CHLOROMETHANE	0/41	—	0.011-0.012	—	0	—	—	—	1.2	—	—	10.4
CIS-1,2-DICHLOROETHENE	0/41	—	0.0055-0.006	—	0	780	1200	0.02	43	119	0.4	0.78373[6]
CIS-1,3-DICHLOROPROPENE	0/41	—	0.0055-0.006	—	0	4	0.1	0.0002	—	—	—	0.39786
DIBROMOCHLOROMETHANE	24/41	0.0005-0.0025	0.0055-0.006	09/05-14-92-2 (92) (08/18/92), 09/05-9-92-2 (92) (08/15/92)	0	8	1300	0.02	1.1	—	—	2.05
ETHYLBENZENE	3/41	0.00049-0.00077	0.0055-0.006	09/05-13-92-2 (92) (08/18/92)	0	7800	400	0.7	230	5000	13	5.16
METHYLENE CHLORIDE	42/45	0.0048-0.17	0.12	WT-4A (83) (7/20/83)	42	85	13	0.001	8.9	120	0.023	4.05
STYRENE	1/41	0.00056	0.0055-0.055	09/05-6-92-3 (92) (08/14/92)	0	16000	1500	0.2	1.0	12000	3.5	4.69
TETRACHLOROETHENE	0/41	—	0.0055-0.006	—	0	12	11	0.003	5.7	50	0.058	9.92
TOLUENE	9/41	0.00054-0.0022	0.0055-0.006	09/05-8-92-2 (92) (08/14/92)	0	16000	650	0.6	520	1800	12	5.45
TRANS-1,2-DICHLOROETHENE	0/41	—	0.0055-0.006	—	0	1600	3100	0.03	63	190	0.68	0.78373
TRANS-1,3-DICHLOROPROPENE	0/41	—	0.0055-0.006	—	0	4	0.1	0.0002	—	—	—	0.39786
TRICHLOROETHENE	0/49	—	0.005-0.01	—	0	58	5	0.003	2.8	48	0.057	12.4
VINYL ACETATE	0/41	—	0.055-0.06	—	0	78000	1000	8	430	1200	2.3	12.7
VINYL CHLORIDE	0/41	—	0.011-0.012	—	0	0.3	0.03	0.0007	0.022	0.31	0.013	0.64614
XYLENES, TOTAL	14/41	0.00062-0.0042	0.0055-0.006	09/05-6-92-2 (92) (08/14/92)	0	160000	410[8]	9[8]	210	5300	190	10
Semivolatile Organics (mg/kg)												
1,2,4-TRICHLOROBENZENE	0/41	—	0.73-7.6	—	0	780	3200	0.3	6.0	1800	5.3	11.1
1,2-DICHLOROBENZENE	0/41	—	0.73-7.6	—	0	7000	560	0.9	370	3000	17	2.96
1,2-DIPHENYLHYDRAZINE	0/41	—	0.73-7.6	—	0	—	—	—	0.61	—	—	—
1,3-DICHLOROBENZENE	0/41	—	0.73-7.6	—	0	—	—	—	13	114	0.42	37.7
1,4-DICHLOROBENZENE	0/41	—	0.73-7.6	—	0	27	—	0.1	3.0	42	2.2	0.54559
2,4,5-TRICHLOROPHENOL	0/41	—	0.73-7.6	—	0	7800	—	14	6100	18000	250	14.1
2,4,6-TRICHLOROPHENOL	0/41	—	0.082-7.6	—	0	58	200	0.008	44	390	1.5	9.94
2,4-DICHLOROPHENOL	0/41	—	0.73-7.6	—	0	230	—	0.05	1.0	550	1.1	87.5
2,4-DIMETHYLPHENOL	0/41	—	0.73-7.6	—	0	1600	—	0.4	1.0	3600	9	0.01
2,4-DINITROPHENOL	0/41	—	3.6-38	—	0	160	—	0.01	120	360	0.29	0.06086
2,4-DINITROTOLUENE	0/41	—	0.73-7.6	—	0	0.9	—	0.00004	120	—	—	1.28
2,6-DINITROTOLUENE	0/41	—	0.73-7.6	—	0	0.9	—	0.00003	61	—	—	0.03283
2-CHLORONAPHTHALENE	0/41	—	0.73-7.6	—	0	—	—	—	4900	—	—	0.01218
2-CHLOROPHENOL	0/41	—	0.73-7.6	—	0	390	53000	0.2	6.0	380	0.75	0.24266
2-METHYL-4,6-DINITROPHENOL	0/41	—	3.6-38	—	0	—	—	—	—	—	—	—
2-METHYLNAPHTHALENE	0/41	—	0.73-7.6	—	0	—	—	—	—	—	—	3.24
2-METHYLPHENOL	0/41	—	0.73-7.6	—	0	3900	—	0.8	3100	7600	14	40.4
2-NITROANILINE	0/41	—	3.6-38	—	0	—	—	—	3.5	—	—	74.1
2-NITROPHENOL	0/41	—	0.73-7.6	—	0	—	—	—	—	—	—	1.6

TABLE 7-3

HISTORICAL DATA SUMMARY - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 9 - PESTICIDE CONTROL AREA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Suface Soil	Subsurface Soil	
3,3'-DICHLOROBENZIDINE	0/41	---	1.2-15	—	0	1	—	0.0003	1.1	9.5	0.062	0.64636
3-NITROANILINE	0/41	—	3.6-38	---	0	---	---	---	---	—	—	3.16
4-BROMOPHENYL PHENYL ETHER	0/41	—	0.73-7.6	—	0	---	---	---	—	—	---	---
4-CHLORO-3-METHYLPHENOL	0/41	---	0.81-15	---	0	---	---	---	---	---	---	7.95
4-CHLOROANILINE	0/41	—	1.5-15	—	0	310	---	0.03	240	730	0.97	1.1
4-CHLOROPHENYL PHENYL ETHER	0/41	---	0.73-7.6	—	0	---	---	---	---	—	—	—
4-METHYLPHENOL	0/41	---	0.73-7.6	---	0	---	—	—	310	---	—	163
4-NITROANILINE	0/41	—	3.6-38	---	0	—	---	---	—	—	—	21.9
4-NITROPHENOL	0/41	---	3.6-38	—	0	---	---	---	490	—	—	5.12
ACENAPHTHENE	0/41	—	0.73-7.6	—	0	4700	—	29	3700	9500	130	682
ACENAPHTHYLENE	0/41	---	0.73-7.6	---	0	---	---	—	---	—	—	682
ANILINE	0/41	—	1.5-15	—	0	---	—	---	85	—	—	0.05678
ANTHRACENE	1/41	0.2	0.73-0.83	09/05-5-92-1 (92) (08/13/92)	0	23000	---	590	22000	47000	51	1480
BENZIDINE	0/41	---	3.6-38	---	0	---	—	---	0.0021	—	—	—
BENZO(A)ANTHRACENE	1/41	0.56	0.73-0.83	09/05-5-92-1 (92) (08/13/92)	1	0.9	—	0.08	0.62	5	5	5.21
BENZO(A)PYRENE	0/41	—	0.73-7.6	—	0	0.09	---	0.4	0.062	0.5	0.5	1.52
BENZO(B)FLUORANTHENE	1/41	0.32	0.73-1.6	09/05-5-92-1 (92) (08/13/92)	1	0.9	---	0.2	0.62	5	5	59.8
BENZO(G,H,I)PERYLENE	0/41	—	0.73-7.6	—	0	—	---	---	---	—	—	119
BENZO(K)FLUORANTHENE	1/41	0.43	0.73-0.83	09/05-5-92-1 (92) (08/13/92)	0	9	—	2	6.2	50	39	1480
BENZOIC ACID	1/41	0.02	3.6-38	09/05-4-92-3 (92) (08/13/92)	0	310000	—	20	100000	730000	590	—
BENZYL ALCOHOL	0/41	—	1.2-15	---	0	—	---	—	18000	---	---	65.8
BIS(2-CHLOROETHOXY)METHANE	0/41	—	0.73-7.6	—	0	---	—	---	—	—	---	0.30209
BIS(2-CHLOROETHYL)ETHER	0/41	---	0.73-7.6	---	0	0.6	0.2	0.00002	0.21	1.6	0.0007	23.7
BIS(2-CHLOROISOPROPYL) ETHER	0/41	—	0.73-7.6	—	0	—	---	—	6.9	31	0.027	—
BIS(2-ETHYLHEXYL)PHTHALATE	15/41	0.028-0.76	0.73-7.6	09/05-11-92-1 (92) (08/17/92)	0	46	31000	180	35	300	300	0.92594
BUTYLBENZYL PHTHALATE	0/41	—	0.73-7.6	—	0	16000	930	810	12000	36000	930	0.23889
CHRYSENE	1/41	0.62	0.73-0.83	09/05-5-92-1 (92) (08/13/92)	0	88	---	8	62	500	26	4.73
DIBENZO(A,H)ANTHRACENE	0/41	—	0.73-7.6	—	0	0.09	—	0.08	6100	18000	2300	18.4
DIBENZOFURAN	0/41	---	0.73-7.6	---	0	---	---	—	1200	3700	2000	---
DIETHYL PHTHALATE	0/41	—	0.73-7.6	—	0	63000	2000	23	0.062	0.5	0.5	24.8
DIMETHYL PHTHALATE	0/41	---	0.73-7.6	—	0	---	---	—	290	—	—	734
DI-N-BUTYL PHTHALATE	27/41	0.022-6.9	0.75-0.82	09/05-4-92-3 (92) (08/13/92)	17	7800	2300	270	49000	150000	450	0.14979
DI-N-OCTYL PHTHALATE	12/41	0.069-0.27	0.086-7.6	09/05-6-92-2 (92) (08/14/92)	0	1600	10000	10000	100000	—	—	709
FLUORANTHENE	1/41	1.3	0.73-0.83	09/05-5-92-1 (92) (08/13/92)	0	3100	---	210	2300	6300	880	122
FLUORENE	0/41	—	0.73-7.6	---	0	3100	---	28	2600	6300	170	122
HEXACHLOROBENZENE	0/41	---	0.73-7.6	---	0	0.4	1	0.1	3.0	2.7	2.2	0.19678
HEXACHLOROBUTADIENE	0/41	—	0.73-7.6	---	0	8	8	0.1	6.0	36	16	0.03976
HEXACHLOROCYCLOPENTADIENE	0/41	---	0.73-7.6	---	0	550	10	20	420	1300	400	0.75537
HEXACHLOROETHANE	0/41	—	0.73-7.6	—	0	46	55	0.02	35	183	2.8	0.59634
INDENO(1,2,3-CD)PYRENE	0/41	---	0.73-7.6	—	0	0.9	—	0.7	0.62	5	3	109
ISOPHORONE	0/41	—	0.73-7.6	—	0	670	4600	0.03	510	4500	5.3	139
NAPHTHALENE	0/41	—	0.73-7.6	—	0	3100	—	4	0.069	0.61	0.0006	0.09939
NITROBENZENE	0/41	—	0.73-7.6	—	0	39	92	0.007	0.0095	—	—	1.31
N-NITROSODIMETHYLAMINE	0/41	---	0.73-7.6	—	0	---	—	—	9.0	810	9.7	0.0000321
N-NITROSO-DI-N-PROPYLAMINE	0/41	—	0.73-7.6	—	0	0.09	—	0.000002	56	3200	0.7	0.54368
N-NITROSODIPHENYLAMINE	0/41	---	0.73-7.6	---	0	130	---	0.06	20	91	0.028	0.54514
PENTACHLOROPHENOL	0/41	—	3.6-38	---	0	3	—	0.001	3.0	20	0.028	0.11927
PHENANTHRENE	1/41	0.94	0.73-0.87	09/05-5-92-1 (92) (08/13/92)	0	---	---	---	---	—	—	45.7
PHENOL	0/41	—	0.73-7.6	---	0	47000	—	5	37000	89000	110	120
PYRENE	1/41	1.3	0.73-0.83	09/05-5-92-1 (92) (08/13/92)	0	2300	---	210	2300	5500	570	78.5
Pesticides/PCBs/Herbicides (mg/kg)												
2,4,5-T	0/41	---	0.072-0.083	---	0	---	---	—	610	—	—	0.59634
2,4,5-TP (SILVEX)	0/41	—	0.061-0.07	—	0	—	—	—	490	—	—	0.1088
2,4-D	2/41	0.0018-0.006	0.43-0.5	09/05-3-92-3 (92) (08/12/92)	0	—	---	—	690	—	—	0.02725
4,4'-DDD	9/41	0.00087-0.0082	0.0033-0.0092	09/05-4-92-2 (92) (08/13/92)	0	3	---	0.8	2.4	28	28	0.75815
4,4'-DDE	14/41	0.00031-0.02	0.0027-0.0033	09/05-10-92-4 (92) (08/15/92)	0	2	---	3	1.7	20	20	0.59587
4,4'-DDT	8/41	0.0012-0.032	0.008-0.01	09/05-4-92-2 (92) (08/13/92)	1	2	—	2	1.7	20	20	0.0175

TABLE 7-3

HISTORICAL DATA SUMMARY - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 9 - PESTICIDE CONTROL AREA
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Suface Soil	Subsurface Soil	
ALDRIN	17/41	0.00031-0.0037	0.0027-0.0033	09/05-14-92-1 (92) (08/18/92)	1	0.04	3	0.02	0.029	0.25	0.25	0.00332
ALPHA-BHC	1/41	0.00062	0.002-0.0025	09/05-5-92-1 (92) (08/13/92)	1	0.1	0.8	0.00003	0.090	0.99	0.0072	0.09939
ALPHA-CHLORDANE	31/41	0.00049-0.0047	0.0033-0.0042	09/05-14-92-3 (92) (08/18/92)	0	0.5[10]	20[10]	0.5[10]	—	—	—	0.224[10]
AROCLOR-1016	0/41	—	0.043-0.054	—	0	1[11]	—	—	3.9	—	—	0.000332[11]
AROCLOR-1221	0/41	—	0.043-0.054	—	0	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1232	0/41	—	0.043-0.054	—	0	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1242	1/45	0.048	0.02-0.2	WT-1A (83) (7/20/83)	1	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1248	0/44	—	0.02-0.054	—	0	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1254	7/45	0.014-0.037	0.02-0.11	09/05-14-92-3 (92) (08/18/92)	7	1[11]	—	—	0.22	—	—	0.000332[11]
AROCLOR-1260	0/45	—	0.02-0.11	—	0	1[11]	—	—	0.22	—	—	0.000332[11]
BETA-BHC	21/41	0.00057-0.012	0.0044-0.005	09/05-7-92-3 (92) (08/14/92)	21	0.4	—	0.0001	0.32	3.5	0.026	0.00398
DELTA-BHC	0/41	—	0.006-0.0075	—	0	—	—	—	—	—	—	9.94
DIELDRIN	26/41	0.00015-0.013	0.0015-0.0017	09/05-10-92-4 (92) (08/15/92)	0	0.04	1	0.0002	0.030	0.27	0.046	0.00238
DINOSEB	1/41	0.059	0.025-0.029	09/05-3-92-3 (92) (08/12/92)	1	—	—	—	61	—	—	0.0218
DISULFOTON	0/41	—	0.026-0.028	—	0	—	—	—	2.4	—	—	0.01988
ENDOSULFAN I	1/41	0.0012	0.0093-0.012	09/05-6-92-3 (92) (08/14/92)	0	470[12]	—	0.9[12]	370	1100	20	0.11927
ENDOSULFAN II	6/41	0.00056-0.026	0.0027-0.0033	09/05-10-92-4 (92) (08/15/92)	0	470[12]	—	0.9[12]	—	—	—	0.11927
ENDOSULFAN SULFATE	4/41	0.0065-0.028	0.044-0.055	09/05-13-92-4 (92) (08/18/92)	0	—	—	—	—	—	—	0.03578
ENDRIN	2/41	0.00049-0.00074	0.004-0.005	09/05-1-92-2 (92) (08/13/92)	0	23	—	0.05	18	54	0.99	0.0101
ENDRIN ALDEHYDE	5/41	0.0024-0.011	0.015-0.019	09/05-5-92-1 (92) (08/13/92)	1	—	—	—	—	—	—	0.0105
ETHYL PARATHION	0/41	—	0.022-0.024	—	0	—	—	—	370	—	—	—
FAMPHUR	0/41	—	0.044-0.05	—	0	—	—	—	—	—	—	0.0497
GAMMA-BHC (LINDANE)	0/41	—	0.0027-0.0033	—	0	0.5	—	0.0005	0.44	4.8	0.0094	0.005
GAMMA-CHLORDANE	10/41	0.0004-0.0034	0.0033-0.0042	09/05-5-92-1 (92) (08/13/92)	0	0.5[10]	20[10]	0.5[10]	1.6	—	—	0.224[10]
HEPTACHLOR	25/41	0.0002-0.052	0.0014-0.0025	09/05-14-92-1 (92) (08/18/92)	1	0.1	0.1	1	0.11	0.56	0.56	0.00598
HEPTACHLOR EPOXIDE	0/41	—	0.055-0.069	—	0	0.07	5	0.03	0.053	0.46	0.46	0.15188
KEPONE	0/41	—	0.4-0.5	—	0	—	—	—	0.027	—	—	0.03272
METHOXYCHLOR	5/41	0.018-0.059	0.014-0.15	09/05-10-92-4 (92) (08/15/92)	4	390	—	8	310	900	160	0.01988
METHYL PARATHION	0/41	—	0.045-0.049	—	0	—	—	—	15	—	—	0.000292
PHORATE	0/41	—	0.015-0.016	—	0	—	—	—	12	—	—	0.000496
TOXAPHENE	0/41	—	0.16-0.2	—	0	0.6	89	2	0.44	3.9	3.9	0.11927
Inorganics (mg/kg)												
ARSENIC	45/45	1.22-13.1	—	09/05-10-92-2 (92) (08/15/92)	45	0.4	750	1	0.39	3.9	3.9	5.7
BARIUM	45/45	28.3-154	—	09/05-13-92-4 (92) (08/18/92)	45	5500	690000	82	5400	24000	1600	1.04
CADMIUM	19/49	0.022-0.346	0.02-0.8	09/05-14-92-3 (92) (08/18/92)	19	78	1800	0.4	37	12	7.5	0.00222
CHROMIUM (TOTAL)	41/41	9.5-28.6	—	09/05-5-92-2 (92) (08/13/92)	41	390	270	2	210	470	38	0.4
LEAD	32/41	4.4-41	4	09/05-5-92-1 (92) (08/13/92)	32	400[14]	—	—	400	350	81	0.05373
MERCURY	2/49	0.1-0.2	0.01-0.1	WT-4A (83) (7/20/83)	2	23	10	0.1	—	55	2.1	0.01
NICKEL	4/4	18-27	—	WT-3B (83) (7/20/83)	4	1600	13000	7	1600	6900	130	13.6
SELENIUM	11/41	0.24-0.48	0.2	09/05-5-92-1 (92) (08/13/92)	11	390	—	0.3	390	1700	5.2	0.02765
SILVER	0/45	—	0.08-1	—	0	390	—	2	390	1700	31	4.04
ZINC	8/8	0.87-96	—	WT-3A (83) (7/20/83)	7	23000	—	620	23000	104000	10000	6.62
Miscellaneous Parameters (mg/kg)												
TOTAL PETROLEUM HYDROCARBONS	6/41	1-3000	25	09/05-5-92-1 (92) (08/13/92)	0	—	—	—	—	—	—	—

--- Not applicable/Not available.

BGS Below ground surface
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
OSWER Office of Solid Waste and Emergency Response
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SSL Soil Screening Level
SWMU Solid Waste Management Unit

TABLE 7-3

HISTORICAL DATA SUMMARY - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 9 - PESTICIDE CONTROL AREA
NSWC CRANE, INDIANA
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						Ingestion	Inhalation	Migration to Ground Water[2]		Suface Soil	Subsurface Soil	

U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, May 1996.
2 Because of karst geologic conditions present at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
3 U.S. EPA, Region 9, May 1998.
4 IDEM, October 1997.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 trans-1,2-Dichloroethene.
7 1,3-Dichloropropene.
8 o-Xylene.
9 m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Hexavalent chromium.
14 OSWER soil screening level for residential land use (U.S. EPA, July 1994).
15 State notification level for UST program (IDEM, March 1999).

TABLE 7-4

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 9 - PESTICIDE CONTROL AREA
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	91/198	0.6-1200	0.5-10	09-WT1 (83c) (08/31/83)	**16**	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	8/27	1-2	1-10	09-01 (83d) (08/03/83), 09-08 (81) (12/14/81), 09-08 (83c) (07/31/83)	**8**	---	0.055	0.9	---	13
1,1,2-TRICHLOROETHANE	0/20	---	1-10	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	4/21	7.9-67	1-5	09-03 (88a) (01/26/88)	**2**	---	810	990	---	47
1,1-DICHLOROETHENE	2/19	30-47	1-5	09-03 (88a) (01/26/88)	**2**	7	0.046	7	---	78
1,2-DICHLOROETHANE	2/21	2-2.3	1-10	09-03 (92) (07/14/92)	**2**	5	0.12	5	---	190
1,2-DICHLOROPROPANE	1/20	0.3	1-10	09-04 (92) (07/14/92)	**1**	5	0.16	5	---	380
2-BUTANONE	0/12	---	100-170	---	0	---	1900	2500	---	7100
2-CHLOROETHYL VINYL ETHER	0/4	---	1	---	0	---	---	---	---	---
2-HEXANONE	0/12	---	50-84	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/12	---	50-84	---	0	---	160	---	---	3680
ACETONE	12/12	1.3-51	---	09-02 (92) (07/14/92)	0	---	610	770	---	78000
ACROLEIN	0/4	---	100	---	0	---	0.042	0.056	---	0.205
ACRYLONITRILE	0/4	---	100	---	0	---	0.039	---	---	0.89
BENZENE	8/27	0.8-2	1-10	09-07 (81) (12/14/81), 09-07 (83c) (07/30/83)	**8**	5	0.41	5	---	114
BROMODICHLOROMETHANE	0/20	---	1-10	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/20	---	1-10	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/20	---	10-20	---	0	---	8.7	11	---	---
CARBON DISULFIDE	0/12	---	5-8.4	---	0	---	1000	1300	---	84.1
CARBON TETRACHLORIDE	0/20	---	1-10	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/20	---	1-10	---	0	100	110	100	20[7]	10
CHLOROETHANE	0/20	---	10-20	---	0	---	4.6	---	---	230000
CHLOROFORM	5/25	1-17	1-10	09-04 (83d) (08/03/83)	**5**	80[6]	0.16	100	---	79
CHLOROMETHANE	0/20	---	10-20	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	5/13	24-220	5	09-03 (92) (07/14/92)	**1**	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	1/20	1	1-10	09-07 (85a) (01/16/85)	**1**	---	0.081(8)	---	---	7.9
DIBROMOCHLOROMETHANE	0/16	---	1-1000	---	0	80[6]	0.13	---	---	6400
DICHLORODIFLUOROMETHANE	0/4	---	10	---	0	---	390	---	---	---
ETHYLBENZENE	0/20	---	1-10	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	33/37	0.3-11	1	09-03 (88a) (01/26/88)	**2**	5	4.3	5	---	430
STYRENE	0/12	---	5-8.4	---	0	100	1600	100	---	56
TETRACHLOROETHENE	5/24	1-5	1-10	09-08 (83c) (07/31/83)	**2**	5	1.1	5	---	8.9
TOLUENE	2/22	3	1-10	09-07 (81) (12/14/81), 09-07 (83c) (07/30/83)	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	16/31	1-870	1-8.4	09-03 (81) (12/14/81), 09-03 (83c) (07/20/83)	**5**	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/20	---	1-10	---	0	---	0.081(8)	---	---	7.9
TRICHLOROETHENE	159/199	1-990	0.5-10	09-WT3P (89c) (07/16/89)	**153**	5	1.6	5	---	75
TRICHLOROFLUOROMETHANE	18/21	1-2	1	09-03 (83d) (08/03/83)	0	---	1300		---	---
VINYL ACETATE	0/12	---	50-84	---	0	---	410	550	---	248.03
VINYL CHLORIDE	2/20	0.3-1.4	10-20	09-05 (92) (07/14/92)	**2**	2	0.02	2	---	9.2
XYLENES, TOTAL	0/16	---	5-10	---	0	10000	1400(9)	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/12	---	10	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/12	---	10	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/12	---	10	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/12	---	10	---	0	600	5.5	22	---	87

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HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
1,4-DICHLOROBENZENE	0/12	---	10	---	0	75	0.50	75	---	43
2,4,5-TRICHLOROPHENOL	0/12	---	10	---	0	---	3600	3600	1[7]	---
2,4,6-TRICHLOROPHENOL	0/12	---	10	---	0	---	6.1	77	2[7]	2
2,4-DICHLOROPHENOL	0/12	---	10	---	0	---	110	110	0.3[7]	18
2,4-DIMETHYLPHENOL	0/12	---	10	---	0	---	730	730	400[7]	100.17
2,4-DINITROPHENOL	0/12	---	50	---	0	---	73	73	---	4.07
2,4-DINITROTOLUENE	0/12	---	10	---	0	---	73	---	---	230
2,6-DINITROTOLUENE	0/12	---	10	---	0	---	37	---	---	42
2-CHLORONAPHTHALENE	0/12	---	10	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/12	---	10	---	0	---	30	38	0.1[7]	8.8
2-METHYL-4,6-DINITROPHENOL	0/12	---	50	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/12	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/12	---	10	---	0	---	1800	1800	---	---
2-NITROANILINE	0/12	---	50	---	0	---	2.1	---	---	---
2-NITROPHENOL	0/12	---	10	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/12	---	20	---	0	---	0.15	1.9	---	99.75
3-NITROANILINE	0/12	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/12	---	10	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/12	---	20	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/12	---	20	---	0	---	150	150	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/12	---	10	---	0	---	---	---	---	---
4-METHYLPHENOL	0/12	---	10	---	0	---	180	---	---	---
4-NITROANILINE	0/12	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/12	---	50	---	0	---	290	---	---	35
ACENAPHTHENE	0/12	---	10	---	0	---	370	460	---	9.9
ACENAPHTHYLENE	0/12	---	10	---	0	---	---	---	---	4840
ANILINE	0/12	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/12	---	10	---	0	---	1800	43	---	0.029
BENZIDINE	0/12	---	50	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/12	---	10	---	0	---	0.092	1.2	---	0.839
BENZO(A)PYRENE	0/12	---	10	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/12	---	10	---	0	---	0.092	1.2	---	9.07
BENZO(G,H,I)PERYLENE	0/12	---	10	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/12	---	10	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/12	---	50	---	0	---	150000	150000	---	---
BENZYL ALCOHOL	0/12	---	20	---	0	---	11000	---	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/12	---	10	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/12	---	10	---	0	---	0.0098	0.15	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/12	---	10	---	0	---	0.96	4.2	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	2/14	8.4-27	10	09-10 (92) (07/14/92)	2	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/12	---	10	---	0	---	7300	2700	---	49
CHRYSENE	0/12	---	10	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/12	---	10	---	0	---	0.0092	0.12	---	0.0016
DIBENZOFURAN	0/12	---	10	---	0	---	24	---	---	20
DIBROMOCHLOROMETHANE	0/4	---	1-1000	---	0	80	0.13	---	---	6400
DIETHYL PHTHALATE	0/12	---	10	---	0	---	29000	29000	---	3
DIMETHYL PHTHALATE	0/12	---	10	---	0	---	360000	---	---	73
DI-N-BUTYL PHTHALATE	0/14	---	10	---	0	---	3600	3600	---	3
DI-N-OCTYL PHTHALATE	0/12	---	10	---	0	---	730	20	---	30
FLUORANTHENE	0/12	---	10	---	0	---	1500	210	---	8.1

TABLE 7-4

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
FLUORENE	0/12	---	10	---	0	---	240	310	---	3.9
HEXACHLOROBENZENE	0/12	---	10	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/12	---	10	---	0	---	0.86	7.3	---	0.134
HEXACHLOROCYCLOPENTADIENE	0/12	---	10	---	0	50	260	50	1[7]	77.04
HEXACHLOROETHANE	0/12	---	10	---	0	---	4.8	36	---	30.5
INDENO(1,2,3-CD)PYRENE	0/12	---	10	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/12	---	10	---	0	---	71	900	---	900
NAPHTHALENE	0/12	---	10	---	0	---	0.0096	0.12	---	44
NITROBENZENE	0/12	---	10	---	0	---	0.0013	---	30[7]	740
N-NITROSODIMETHYLAMINE	0/12	---	10	---	0	---	14	170	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/12	---	10	---	0	---	6.2	8.3	---	---
N-NITROSODIPHENYLAMINE	0/12	---	10	---	0	---	3.4	4.3	---	13
PENTACHLOROPHENOL	0/12	---	50	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/12	---	10	---	0	---	---	---	---	2.1
PHENOL	0/12	---	10	---	0	---	22000	22000	300[7]	100
PYRENE	0/12	---	10	---	0	---	180	140	---	0.3
TETRAHYDROFURAN	1/1	6	---	09-04 (86a) (02/05/86)	0	---	8.8	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-TP (SILVEX)	0/43	---	0.5-10	---	0	50	290	---	---	326.64
2,4-D	0/43	---	3.8-100	---	0	70	360	---	---	---
4,4'-DDD	1/12	0.03	0.1-0.12	09-04 (92) (07/14/92)	1	---	0.28	3.6	---	0.0011
4,4'-DDE	5/12	0.01-0.73	0.04	09-03 (92) (07/14/92)	5	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/12	---	0.11-0.12	---	0	---	0.2	2.5	0.001	0.001
ALDRIN	0/12	---	0.04	---	0	---	0.004	0.05	---	0.0185
ALPHA-BHC	0/12	---	0.03	---	0	---	0.011	0.14	---	12.38
ALPHA-CHLORDANE	10/12	0.01-0.06	0.05	09-03 (92) (07/14/92)	10	2[10]	0.19(10)	0.0043(10)	0.0043[10]	0.00029[10]
AROCLOR, TOTAL	0/163	---	0.2-10	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1016	0/12	---	0.62-6.3	---	0	0.5[11]	0.96	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1221	0/12	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1232	0/12	---	0.62-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1242	0/43	---	0.2-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1248	0/43	---	0.2-0.66	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1254	2/43	0.26-0.44	0.2-1.3	09-05 (92) (07/14/92)	2	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1260	0/43	---	0.2-1.3	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
BETA-BHC	3/12	0.02-0.05	0.06	09-12 (92) (07/14/92)	3	---	0.037	0.47	---	0.495
DELTA-BHC	0/12	---	0.09	---	0	---	---	---	---	666.67
DIELDRIN	0/12	---	0.02-0.19	---	0	---	0.0042	0.053	0.0019	0.000026
DISULFOTON	0/12	---	0.67-0.71	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/12	---	0.13-0.14	---	0	---	220	220	0.056	0.003
ENDOSULFAN II	2/12	0.01	0-0.04	09-06 (92) (07/14/92), 09-08 (92) (07/14/92)	2	---	220(12)	220(12)	0.056	0.003
ENDOSULFAN SULFATE	0/12	---	0.63-0.67	---	0	---	---	---	---	2.22
ENDRIN	0/55	---	0.04-0.2	---	0	2	11	2	0.036	0.002
ENDRIN ALDEHYDE	0/12	---	0.22-0.23	---	0	---	---	---	---	0.15
ETHYL PARATHION	0/12	---	0.06-0.61	---	0	---	---	---	---	---
FAMPHUR	0/12	---	0.57-1.2	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/56	---	0.04-4	---	0	0.2	0.052	0.2	---	0.01
GAMMA-CHLORDANE	0/12	---	0.05	---	0	2[10]	0.19(10)	---	0.0043[10]	0.00029[10]
HEPTACHLOR	10/12	0.01-0.73	0.03	09-02 (92) (07/14/92)	10	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/12	---	0.79-0.84	---	0	0.2	0.0074	0.2	0.0038	0.00048

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HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
KEPONE	0/12	---	5.7-6.1	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/55	---	1.6-100	---	0	40	180	40	0.03	0.005
METHYL PARATHION	0/12	---	1.1-1.2	---	0	---	9.1	---	---	---
PHORATE	0/12	---	0.38-0.4	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/56	---	1.6-5	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	0/12	---	30	---	0	50 to 200[13]	36000	---	87	---
ANTIMONY	9/12	4.6-9.1	3	09-13 (92) (07/14/92)	4	6	15	6	---	31
ARSENIC	5/91	2-9.4	2-50	09-02 (92) (07/14/92)	5	50	0.045	50	150	53
BARIUM	42/91	19-210	20-260	09-WT3P (91c) (07/08/91)	0	2000	2600	2000	---	5000
BERYLLIUM	0/12	---	1	---	0	4	73	4	---	7.6
CADMIUM	4/90	0.3-65	0.2-20	09-WT3 (83c) (08/31/83)	2	5	18	5	2.2	0.66
CALCIUM	42/42	19000-188000	---	09-09 (92) (07/14/92)	0	---	---	---	---	---
CHROMIUM (TOTAL)	3/92	20-4000	5-50	09-WT3 (83c) (08/31/83)	3	100	180(14)	100	11[14]	42
COBALT	5/12	22-67	20	09-12 (92) (07/14/92)	5	---	2200	---	---	5
COPPER	3/15	8-5500	5	09-WT3 (83c) (08/31/83)	3	1300[15]	1400	1300	9	5
CYANIDE	0/12	---	5	---	0	200	730(16)	---	5.2[16]	5.2[16]
IRON	114/165	10-28000	5-50	09-02 (86a) (02/05/86)		300[13]	11000	---	1000	---
LEAD	4/92	10-9000	1-50	09-WT3 (83c) (08/31/83)	4	15[15]	4	15	2.5	1.3
MAGNESIUM	42/42	9000-41000	---	09-WT4P (91a) (01/09/91)	0	---	---	---	---	---
MANGANESE	174/182	9-63000	5-10	09-07 (81) (12/14/81)	165	50[13]	880	---	---	---
MERCURY	3/92	0.2-0.7	0.2-100	09-WT2 (83c) (08/31/83)	3	2	11	2	0.012	0.0013
NICKEL	10/15	8-116	5	09-12 (92) (07/14/92)	5	100	730	100	52	29
POTASSIUM	42/42	600-8470	---	09-02 (92) (07/14/92)	0	---	---	---	---	---
SELENIUM	3/89	13-25	2-50	09-07 (81) (12/14/81), 09-07 (82a) (03/05/82)	3	50	180	50	5	5
SILVER	2/89	15-20	3-50	09-02 (82c) (07/27/82)	2	100[13]	180	180	---	1
SODIUM	150/150	3000-1000000	---	09-WT1P (88a) (01/26/88)	0	---	---	---	---	---
THALLIUM	0/12	---	2	---	0	2	2.9(17)	2	---	0.56
TIN	0/12	---	50	---	0	---	22000	---	---	73
VANADIUM	1/12	11	10	09-12 (92) (07/14/92)	0	---	260	---	---	19
ZINC	7/16	12-20000	10	09-WT3 (83c) (08/31/83)	5	5000[13]	11000	11000	120	58.9
Radionuclides (pCi/L)										
GROSS ALPHA	5/41	0.5-4.38	0-7.76	09-08 (82d) (09/14/82)	0	15	---	---	---	---
GROSS BETA	21/41	0.3-6.73	1.51-2.62	09-08 (81) (12/14/81)	0	---	---	---	---	---
RADIUM, TOTAL	5/5	0.4-0.7	---	09-WT5P (88a) (01/26/88)	0	---	---	---	---	---
RADIUM-226	6/8	0.21-1.04	0.11-0.27	09-02 (82c) (07/27/82)	0	---	---	---	---	---
Miscellaneous Parameters (ug/L)										
CHLORIDE	125/138	1000-79000	0-1	09-10 (88a) (01/25/88)	0	250000[13]	---	---	---	---
FLUORIDE	37/41	100-400	0.1	09-07 (81) (12/14/81)	0	4000	2200	---	---	---
NITRATE, AS NITROGEN	10/14	20-2500	0.02	09-WT3P (88a) (01/26/88)	0	10000	10000	---	---	---
NITRATE/NITRITE	31/36	50-1000	0.05	09-08 (82b) (04/06/82), 09-08 (82d) (09/14/82)	1	10000	1000(18)	---	---	---
NITRITE, AS NITROGEN	1/9	19	0.005	09-04 (92) (07/14/92)	0	1000	1000	---	---	---
ORGANIC BROMINE	1/46	7	0.002-0.02	09-04 (84a) (02/06/84)	0	---	---	---	---	---
ORGANIC CHLORINE	19/46	10-490	0.001-0.01	09-03 (86b) (06/17/86)	0	---	---	---	---	---
ORGANIC IODINE	36/46	4-280	0.002-0.01	09-02 (84b) (06/08/84)	0	---	---	---	---	---
pH (standard units)	275/275	0.17-16	---	09-03 (88a) (01/26/88)	1	---	---	---	6.5-9	---
PHENOLS	24/138	4-50	0.004-0.05	09-09 (88a) (01/28/88)	0	---	---	---	---	---
SPECIFIC CONDUCTIVITY (umho/cm)	259/259	285-9600	---	09-WT1P (88a) (01/26/88)	0	---	---	---	---	---

TABLE 7-4

HISTORICAL DATA SUMMARY - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 9 - PESTICIDE CONTROL AREA
NSWC CRANE, INDIANA
PAGE 5 OF 5

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
SULFATE	141/141	10000-2100000	---	09-09 (88a) (01/28/88)	11	500000	---	---	---	---
SULFIDE	5/12	21-66	0.02	09-11 (92) (07/14/92)	5	---	---	---	2	---
TOTAL COLIFORM (phm)	19/23	3-175	0	09-09 (81) (12/14/81), 09-09 (82a) (03/05/82)	0	---	---	---	---	---
TOTAL ORGANIC CARBON	168/190	1000-86000	1-2	09-09 (82c) (07/27/82)	0	---	---	---	---	---
TOTAL ORGANIC HALOGENS	117/143	7.8-2880	0.005-0.01	09-01 (91c) (07/08/91)	0	---	---	---	---	---

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable by not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.
18 Nitrite.

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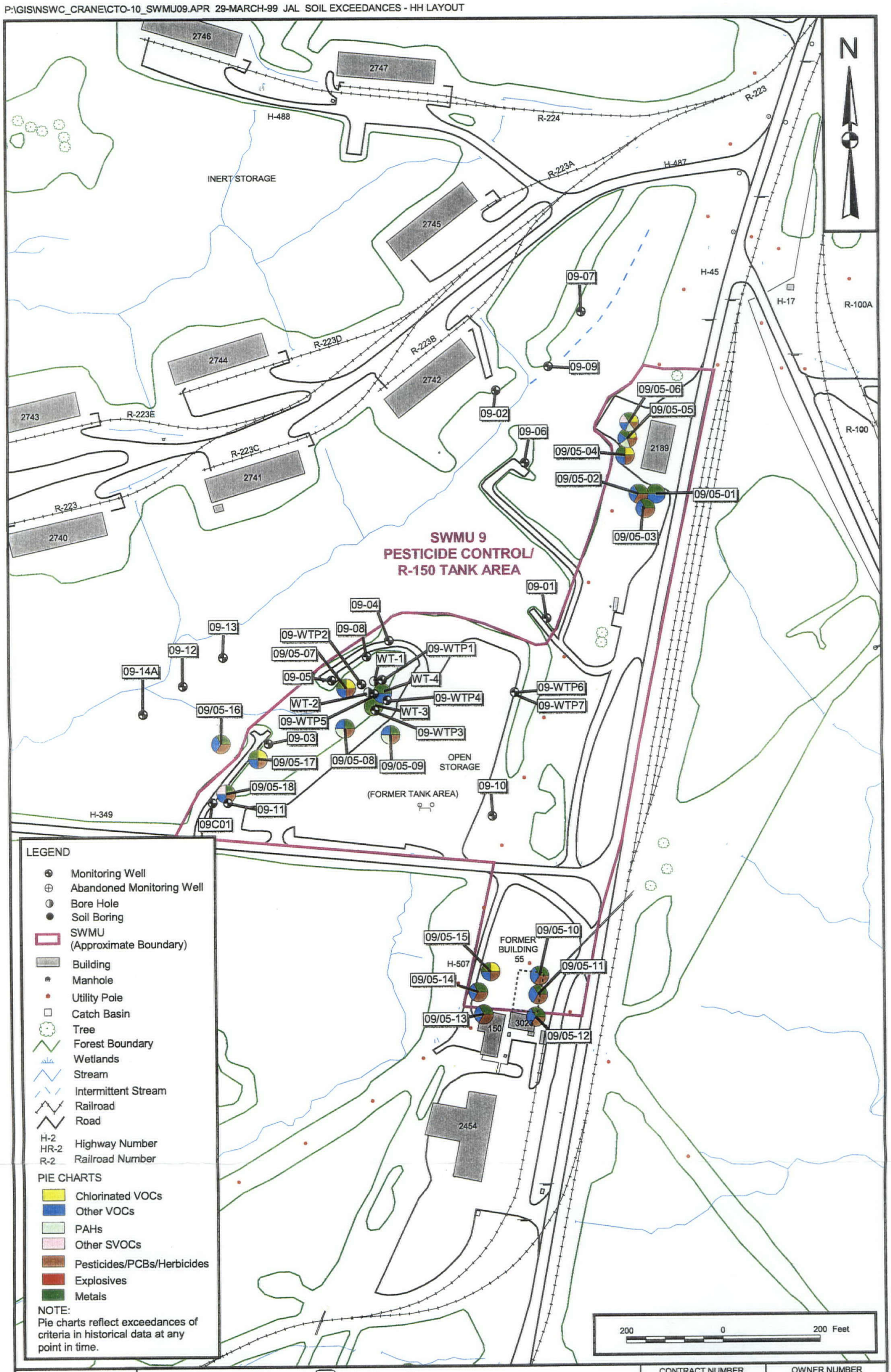
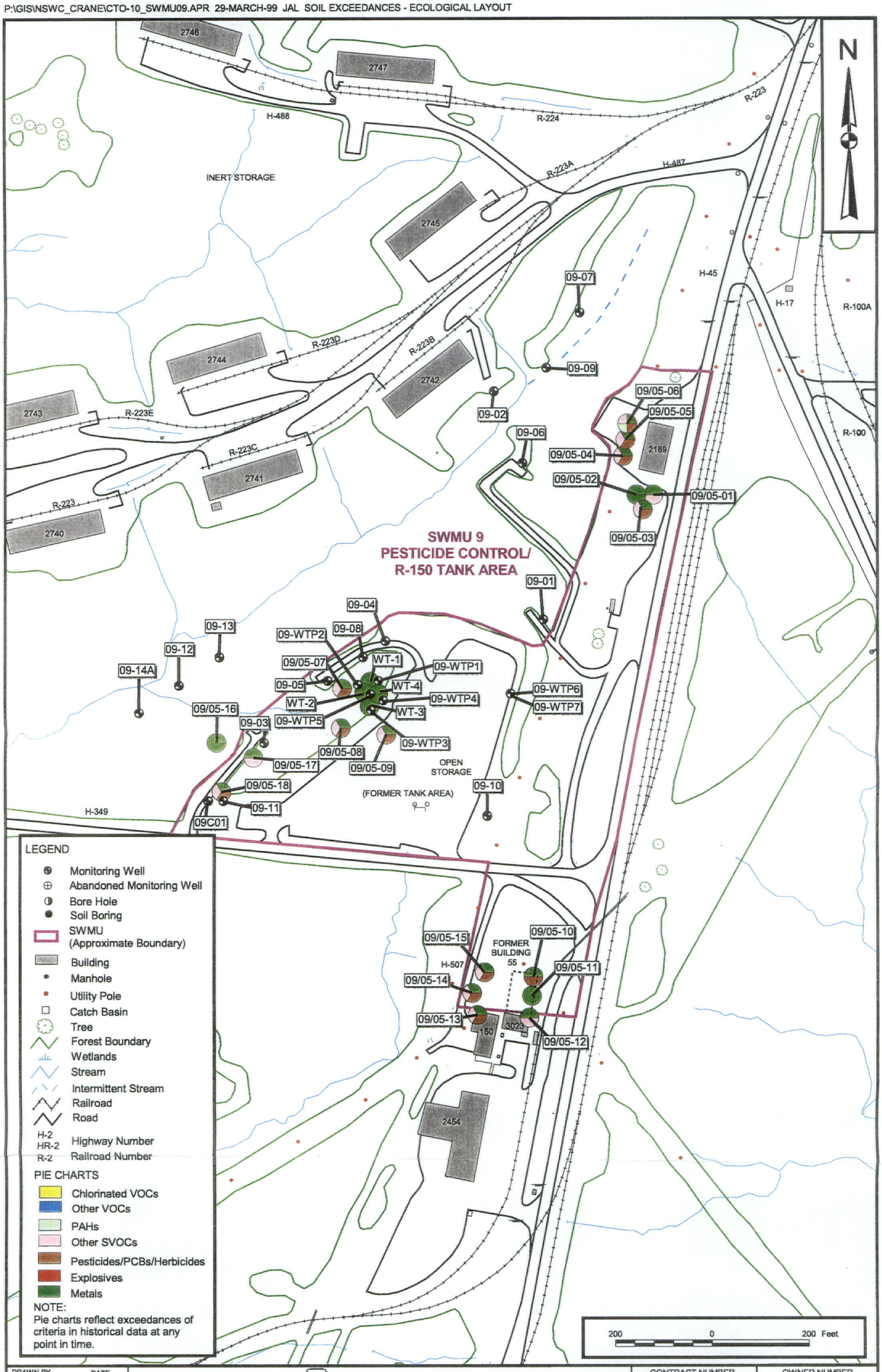
P:\GIS\NSWC_CRANE\CTO-10_SWMU09.APR 29-MARCH-99 JAL SOIL EXCEEDANCES - HH LAYOUT



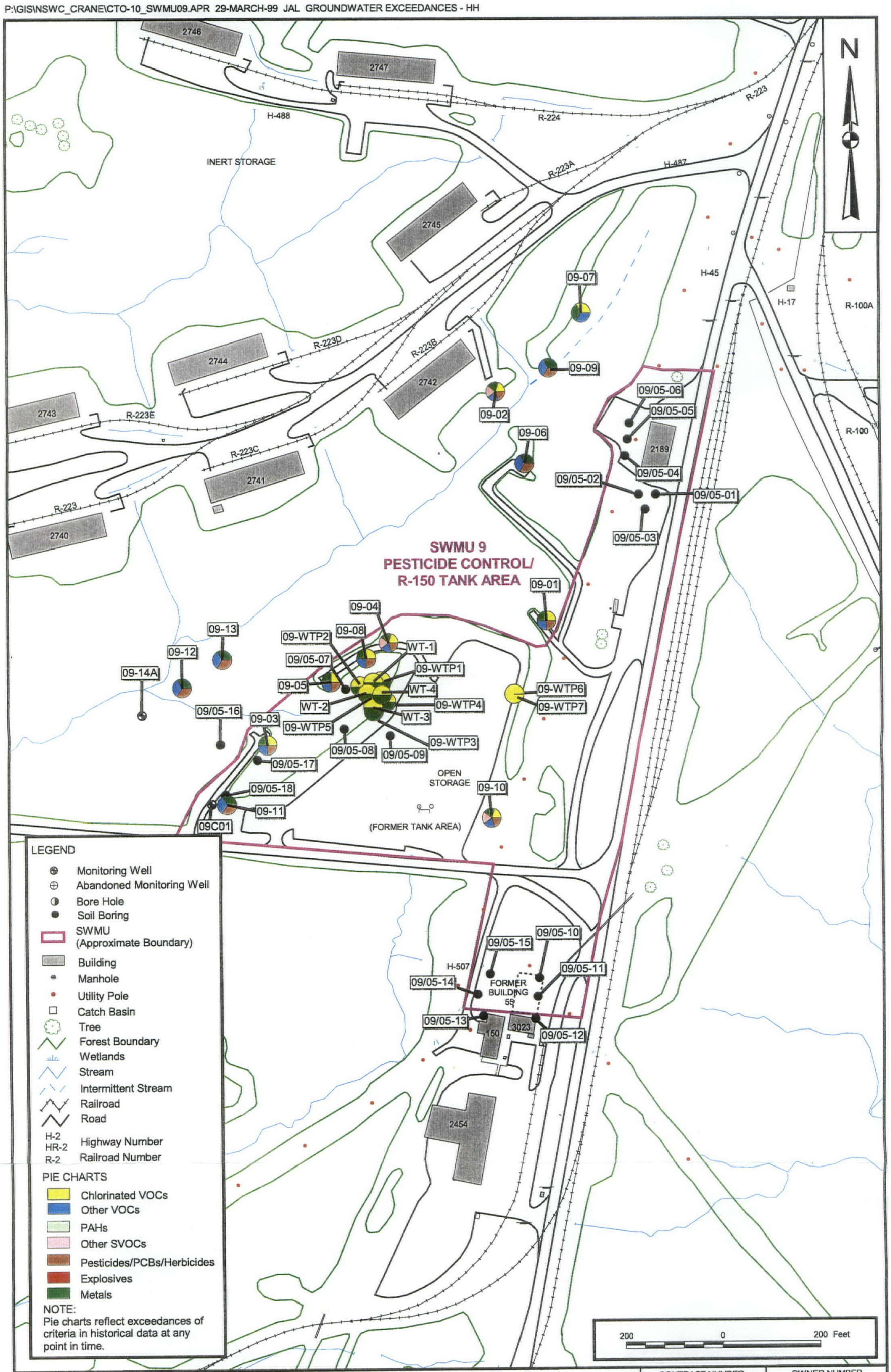
DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER 0010
J. LAMEY	3/5/99		APPROVED BY K. M. Goedker	DATE 10/14/99
CHECKED BY	DATE	SOIL EXCEEDANCES - HUMAN HEALTH SWMU 9 - PESTICIDE CONTROL/R-150 TANK AREA NSWC CRANE, INDIANA	APPROVED BY	DATE
COST/SCHEDULE-AREA			DRAWING NO. FIGURE 7-3	REV
SCALE AS NOTED				

P:\GIS\NSWC_CRANE\CTO-10_SWMU09.APR 29-MARCH-99 JAL SOIL EXCEEDANCES - ECOLOGICAL LAYOUT



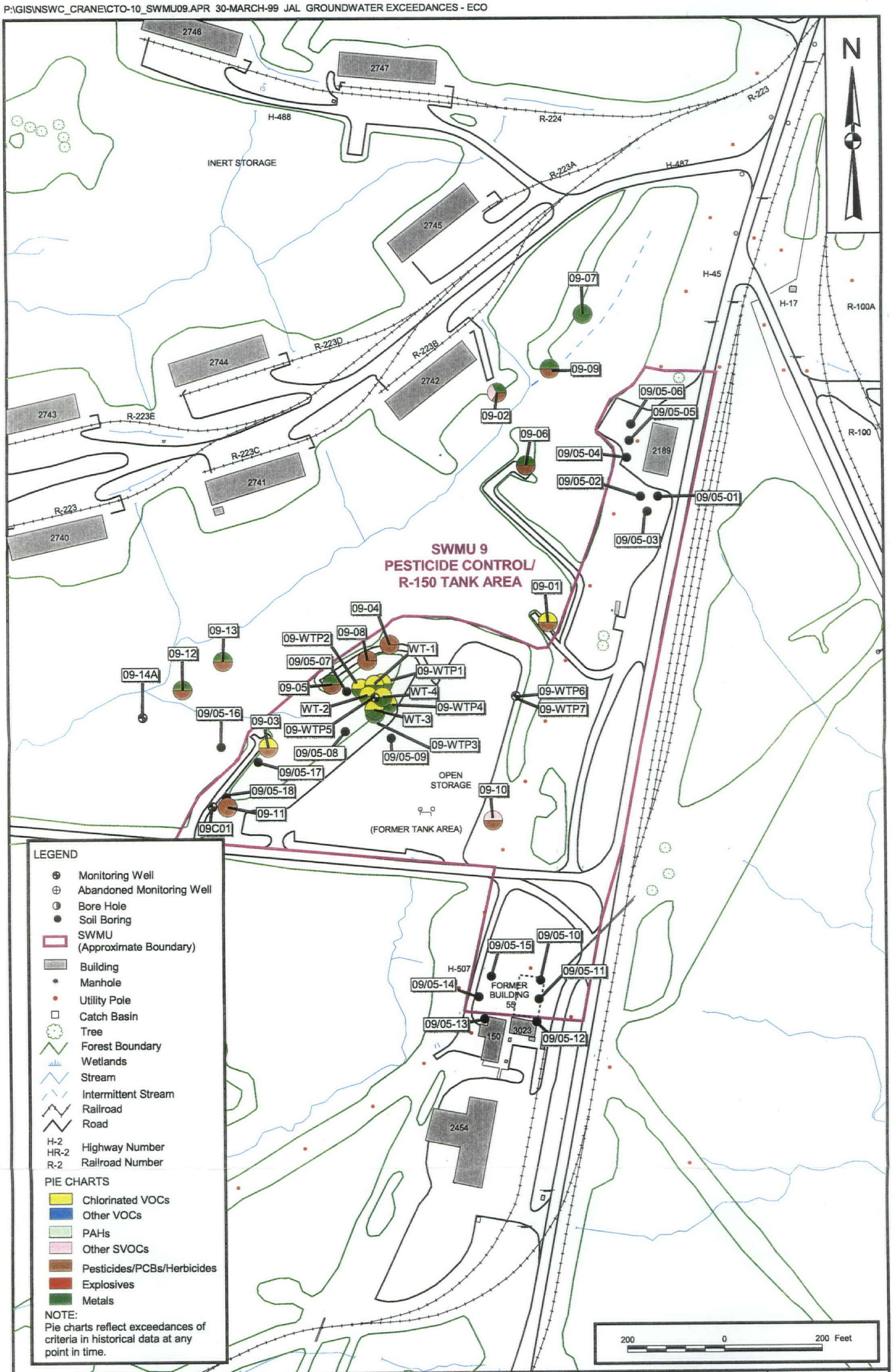
DRAWN BY J. LAMEY	DATE 3/5/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7141	OWNER NUMBER 0010
CHECKED BY	DATE	SOIL EXCEEDANCES - ECOLOGICAL SWMU 9 - PESTICIDE CONTROL/R-150 TANK AREA NSWC CRANE, INDIANA	APPROVED BY K. M. Amedu	DATE 10/14/99
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 7-4	REV

P:\GIS\NSWC_CRANE\CTO-10_SWMU09.APR 29-MARCH-99 JAL GROUNDWATER EXCEEDANCES - HH



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
J. LAMEY	3/5/99		7141	0010
CHECKED BY	DATE	GROUND WATER EXCEEDANCES - HUMAN HEALTH SWMU 9 - PESTICIDE CONTROL/R-150 TANK AREA NSWC CRANE, INDIANA	APPROVED BY K. M. Sanchez	DATE 10/14/99
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 7-5	REV

P:\GIS\NSWC_CRANE\CTO-10_SWMU09.APR 30-MARCH-99 JAL GROUNDWATER EXCEEDANCES - ECO



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
J. LAMEY	3/30/99		7141	0010
CHECKED BY	DATE	GROUND WATER EXCEEDANCES - ECOLOGICAL SWMU 9 - PESTICIDE CONTROL/R-150 TANK AREA NSWC CRANE, INDIANA	APPROVED BY	DATE 10/14/99
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 7-6	REV

human and ecological screening criteria). These chemicals are not detected constituents of interest for the surface and subsurface soil.

Benzene, 1,2-dichloropropane, trans-1,3-dichloropropene, and Aroclor-1254 were detected in the environmental samples collected from the Pesticide Control/R-150 Tank Area. These chemicals were detected sporadically in the ground water at the site. These chemicals may be present at low levels (i.e., less than 5 µg/L) in the ground water as a result of historical Basewide management practices. Historically, it was common practice to treat areas alongside roadways with a mixture of herbicides and waste fuel oils. Benzene, 1,2-dichloropropane, 1,3-dichloropropenes (cis- and trans-), and Aroclor-1254 have been detected in the ground water at SWMU 4, 9, and 10, which implies that these chemicals may not be site-related constituents. However, these chemicals have been conservatively identified as detected chemicals of interest for the site.

Chloroform, methylene chloride, bis(2-ethylhexyl)phthalate, and di-n-butylphthalate were detected in the soil and/or ground water samples collected at the site. Several reported concentrations of these chemicals exceeded risk-based criteria, as illustrated on Figures 7-3 through 7-6. These chemicals were detected in the laboratory and field QC blanks associated with the site samples. Therefore, they are not considered to be site-related constituents and were eliminated as parameters of interest. These chemicals were also reported at similar concentrations in environmental samples collected at SWMUs 4, 5, and 10, supporting the conclusion that the presence of these chemicals are attributable to contamination introduced through sampling (decontamination or ambient conditions) or laboratory analysis.

Several pesticides were detected in the soils and ground water throughout the site at concentrations greater than the lowest screening criteria. In addition, reported soil concentrations of one herbicide (dinoseb) exceeded risk-based screening criteria. Detections of pesticides in the soils do not correspond with detections of pesticides in the ground water. During the soils investigation, relatively high concentrations of pesticides were observed in the quality control blank samples associated with the environmental samples, which may explain why ground water and soil concentrations do not correlate. Some reported concentrations of pesticides at the site may be a result of contamination introduced through sampling (decontamination or ambient conditions) or laboratory analysis. Although there are some questions regarding the presence of pesticides in the site media, these chemicals are directly related to historical site activities and have been identified as detected chemicals of interest for the site.

Several PAHs were found in the surface and subsurface soil samples collected at borings 09/05-05 and 09/05-06, located immediately west of Building 2189. Total petroleum hydrocarbons (TPH) was also

detected at elevated concentrations (i.e., in excess of 100 mg/kg) in the samples collected from these two borings. The borings are located in close proximity to Highway 45, two access roads for the site, and a gravel parking lot. PAHs are ubiquitous and are typically found near roadways as byproducts of vehicular exhaust. In addition, the presence of PAHs at these locations may be attributable to the demolition of Building 2189 (i.e., small fragments of construction rubble may be present around the building). The presence of TPH is this area may also be attributable to anthropogenic sources. Based on the localized area of elevated PAHs and TPH at the site and the fact that these chemicals were not detected in ground water, they might not be site-related constituents. However, for conservative purposes, these chemicals have been identified as detected chemicals of interest for the site.

Alpha-chlordane, 4,4'-DDD, and endosulfan II were identified as parameters of interest for ground water solely on the basis that reported concentrations exceeded surface water screening criteria for ecological receptors. As mentioned previously, this is a conservative comparison and serves to overestimate potential impacts to surface water as a result of ground water discharge. These chemicals may not be present in the surface water at the site, but are identified as chemicals of interest for the site for conservative purposes.

7.4.2 Inorganic Constituents

A variety of inorganics was found in the soil and ground water at the Pesticide Control/R-150 Tank Area. Those inorganics detected at concentrations in excess of the lowest screening criteria are, as follows:

- Soil: Arsenic, barium, cadmium, chromium (total), lead, mercury, nickel, selenium, and zinc

- Ground Water: Antimony, arsenic, cadmium, chromium (total), cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, zinc, nitrate/nitrite, sulfate, and sulfide

The four grab water samples collected from open bore holes around the R-150 Tank in 1983 contained elevated levels (i.e., in excess of risk-based screening criteria) of arsenic, cadmium, chromium, copper, lead, mercury, nickel, iron, manganese, and zinc. The water samples collected from the bore holes were turbid, and elevated concentrations of inorganics in these samples are considered to be a result of sediment present in the samples. Cadmium, copper, lead, and mercury were detected only detected in the samples collected from the bore holes; these chemicals were not detected in the ground water samples collected from the site. These inorganics may not be site-related constituents, but have been identified as detected parameters of interest for conservative purposes.

Cobalt, selenium, and silver were identified as parameters of interest for ground water solely on the basis that reported concentrations exceeded surface water screening criteria for ecological receptors. As mentioned previously, this is a conservative comparison and serves to overestimate potential impacts to surface water as a result of ground water discharge. These chemicals may not be present in the surface water at the site, but are identified as chemicals of interest for the site for conservative purposes.

7.4.3 Summary of Detected Chemicals of Interest

The following constituents are detected chemicals of interest for soil and ground water at the Pesticide Control/R-150 Tank Area:

- Soil: Anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, 4,4'-DDT, aldrin, alpha-BHC, beta-BHC, dieldrin, dinoseb, disulfoton, endrin aldehyde, heptachlor, methoxychlor, methyl parathion, phorate, Aroclor-1242, Aroclor-1254, various inorganics, and TPH

- Ground Water: Benzene, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,2-dichloropropane, 1,1,1-trichloroethene, 1,1,2,2-tetrachloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,2-dichloroethenes (cis- and trans-), tetrachloroethene, trichloroethene, vinyl chloride, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, Aroclor-1254, beta-BHC, endosulfan II, heptachlor, and various inorganics

Because of the uncertainty associated with the historical analytical data, all constituents reported at concentration in excess of risk-based criteria were included in the list of detected chemicals of interest for the site. This list was used to develop appropriate chemical categories to be included in the analytical program for the proposed field investigation, which is presented in the following section.

7.5 PROPOSED INVESTIGATION

The proposed field investigation for SWMU 9, Pesticide Control/R-150 Tank Area was developed based on a site-specific CSM. The general methodology used to develop the proposed investigation (and CSM) was presented in Section 4.0. This section of the Work Plan provides the rationale for the proposed site-specific investigation.

7.5.1 Conceptual Site Model

The CSM for the Pesticide Control/R-150 Tank Area, which defines the contaminant source, transport mechanisms, exposure routes, and potential receptors for the site is presented as Figure 7-7. Based on a review of the existing data for the site, a release of hazardous constituents to the surrounding soil has occurred as a result of historical site operations (i.e., pesticide management operations and waste solvents storage). The historical data also indicate that residual contaminants in the soil have migrated to ground water via infiltration/percolation. Additional release mechanisms, which are also expected to contribute to the contaminant transport, include discharge of ground water to surface water/sediment (unnamed tributaries), deposition via surface water runoff, and generation of fugitive dust and volatile emissions from soil.

Likely future land use at the Pesticide Control/R-150 Tank Area is expected to be similar to current land use. Pesticide management activities no longer occur at the site and the R-150 Tank has been removed from the site. As mentioned previously, the site is currently inactive.

Based on the general scenarios and receptor classes identified in Section 4.0, the following potential receptors may be exposed to contaminated media at the site:

- Trespassers (ages 6 to 17 years) – Likely receptor under current and future land use. Although access to the Base is controlled, once inside the Base, access to the site is not limited by any physical constraints (i.e., the site is not patrolled or enclosed by a fence). This receptor may be exposed to potentially contaminated surface soil, air and surface water and sediment in the unnamed tributaries located near the site.

- Maintenance Workers – Likely receptor under current and future land use. Under current land use, some portions of the site, near the access road, are maintained. This receptor may be exposed to potentially contaminated surface soil and air. Exposure to ground water at the site and surface water and sediment in the unnamed tributary which leads to Boggs Creek is not expected to occur.

- Construction Workers – Potential receptor under future land use. No construction activities are currently planned at the site. However, the site could be developed or a small, short-term construction project, such as a utility installation, could result in exposure to potentially contaminated media. This receptor may be exposed to surface and subsurface soil, air and ground water.

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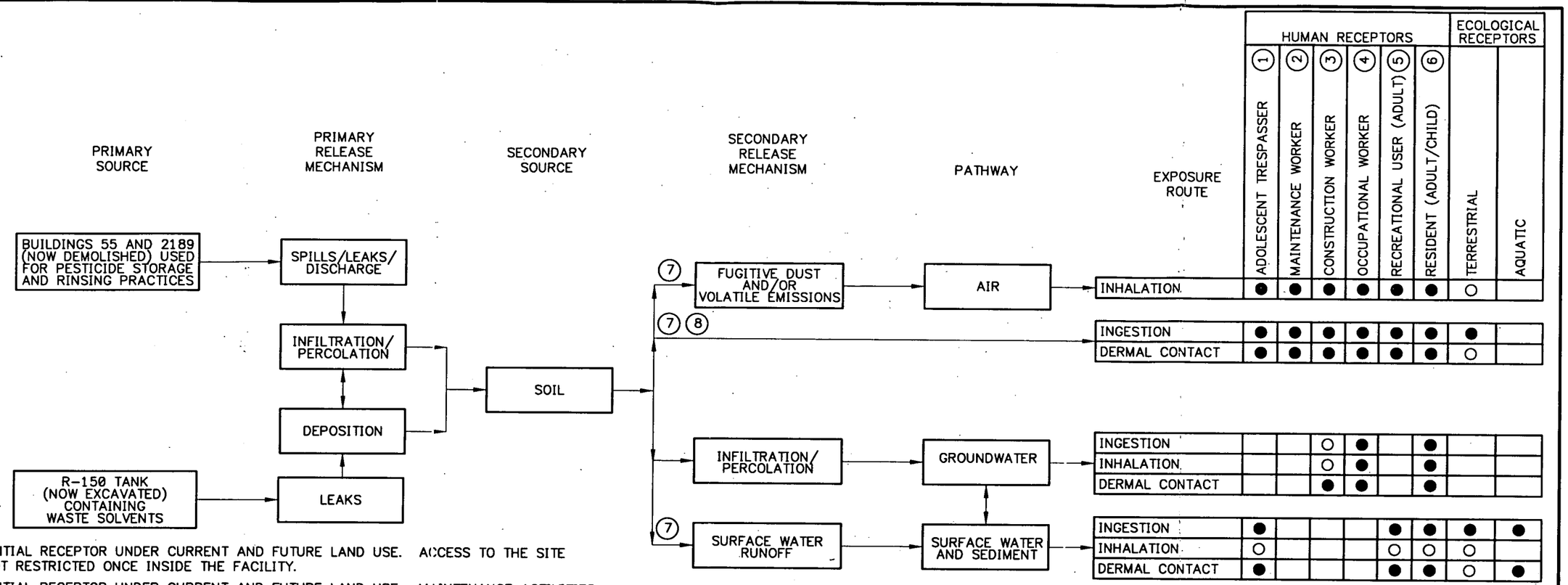

KEY

1. POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. ACCESS TO THE SITE IS NOT RESTRICTED ONCE INSIDE THE FACILITY.
2. POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. MAINTENANCE ACTIVITIES CURRENTLY OCCUR NEAR FORMER LOCATION OF BUILDINGS 55 AND 2189.
3. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. SITE COULD BE DEVELOPED.
4. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. SITE COULD BE DEVELOPED FOR OCCUPATIONAL USE.
5. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. BASE COULD CLOSE AND BE TURNED INTO A STATE PARK.
6. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. EVALUATED FOR DECISION-MAKING PURPOSES.
7. UNDER CURRENT LAND USE, INCOMPLETE FOR THE TANK SOURCE BECAUSE SOURCE WAS CONFINED TO THE SUBSURFACE AND HAS SINCE BEEN REMOVED.
8. FOODCHAIN MODELING WILL BE CONDUCTED FOR ECOLOGICAL RECEPTORS.

● EXPOSURE PATHWAY TO BE EVALUATED IN RISK ASSESSMENT.

○ RELATIVELY INSIGNIFICANT POTENTIAL EXPOSURE PATHWAY COMPARED TO OTHER PATHWAYS EVALUATED IN THE RISK ASSESSMENT. RISKS NOT EVALUATED QUANTITATIVELY.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 3/3/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE NONE

CONCEPTUAL SITE MODEL
SWMU 9-PESTICIDE CONTROL/
R-150 TANK AREA
NSWC CRANE, INDIANA

CONTRACT NO. 7141
APPROVED BY K.M. Snider DATE 10/18/99
APPROVED BY DATE
DRAWING NO. FIGURE 7-7
REV. 0

FORM CADD NO. SDV_BH12.DGN - REV 0 - 1/20/98

- Occupational Workers – Potential receptor under future land use. The site could be developed and used for occupational purposes. This receptor may be exposed to surface soil, air and ground water.

- Recreational Users – Potential receptor under future land use. If the Facility were to close, the most likely scenario is that the property would be converted into a state park. This receptor may be exposed to potentially contaminated surface soil, air and surface water and sediment in the unnamed tributaries located near the site. However, it is highly unlikely that NSWC Crane would close because principal Base operations, the demilitarization of munitions, are critical to the support of the U.S. Naval fleet.

- Residents - Potential receptor under future land use. The site could be developed for residential land use, if the Facility were to close. Future residents may be exposed to potentially contaminated surface soil, air, ground water, and surface water and sediment. Although this scenario is highly unlikely, a future residential scenario is typically evaluated in the risk assessment for decision-making purposes. For example, the need for deed restrictions at a site may be eliminated, prior to site closure, if minimal risks are estimated for residential receptors.

- Ecological Receptors - Under current and future land use, various ecological receptors, terrestrial and aquatic, are also likely to come in contact with site media. Terrestrial receptors may contact potentially contaminated surface soil and ingest contaminated prey items and/or surface water. Aquatic receptors may be exposed to potentially contaminated surface water, prey, and sediment.

Details regarding the assumed receptor characteristics (intake rate, frequency and duration of exposure, body weight, etc.) are defined in Sections 10.0 and 11.0 of this Work Plan, which present the methodologies for the human health and ecological risk assessments.

7.5.2 Proposed Sampling and Analysis

The primary objective of the proposed field investigation is to collect field and laboratory data needed to evaluate the potential risks for those human and ecological receptors identified in the CSM. Figure 7-8 identifies the proposed sample locations. Table 7-5 summarizes the proposed sampling and analysis for SWMU 9, the Pesticide Control/R-150 Tank Area, including overall objectives and objectives for the selection of a particular sampling point. The remainder of this section provides the rationale for proposed sampling and analysis program.

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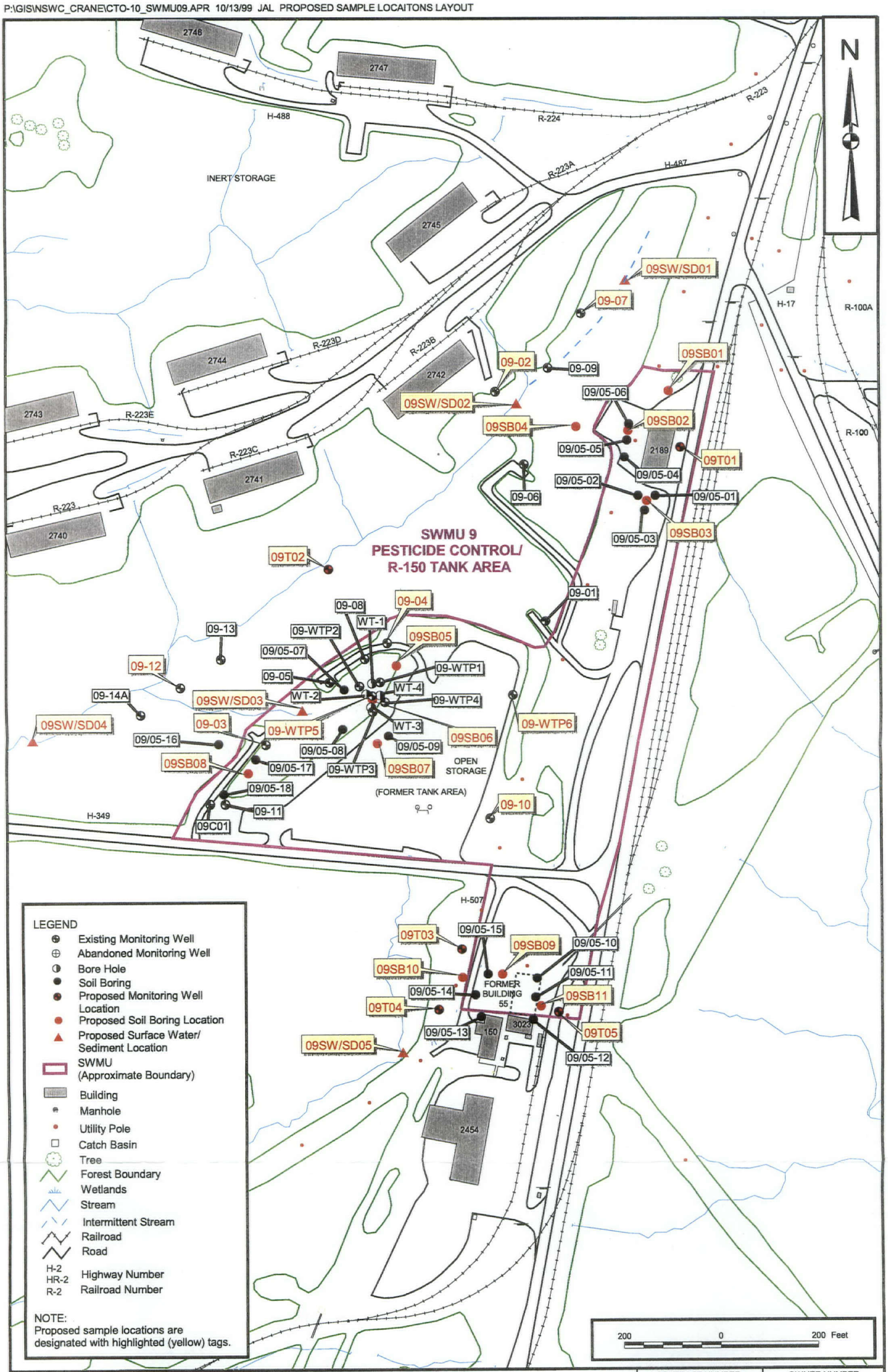
P:\GIS\NSWC_CRANE\CTO-10_SWMU09.APR 10/13/99 JAL PROPOSED SAMPLE LOCAITONS LAYOUT



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
J. LAMEY	3/19/99		7141	0010
CHECKED BY	DATE	PROPOSED SAMPLE LOCATIONS SWMU 9 - PESTICIDE CONTROL/R-150 TANK AREA NSWC CRANE, INDIANA	APPROVED BY K.M. Snecher	DATE 10/14/99
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 7-8	REV

TABLE 7-5

SUMMARY OF OBJECTIVES/PROPOSED SAMPLING
SWMU 9 - PESTICIDE CONTROL / R-150 TANK AREA
NSWC CRANE, INDIANA

OVERALL OBJECTIVES FOR SAMPLING PROGRAM

TYPE OF PROGRAM / SAMPLING OBJECTIVE	PARAMETER TYPE	TARGET CONSTITUENTS[1][2]	OBJECTIVE FOR ANALYSIS	LIMIT OF DETECTION	EVALUATIONS TO BE PERFORMED
Type: RCRA Risk Assessment to fulfill requirements of RCRA Part B permit. Objectives: Determine human health and ecological risks for potential receptors exposed to site media under current and future land use. Determine if there has been a release of hazardous constituents to off-SWMU surface water and sediment.	Field (Soil, Ground Water and Surface Water)	Dissolved Oxygen Oxidation Reduction Potential pH Specific Conductivity Temperature Turbidity PID Reading[3]	Evaluate general water quality. Determine if well water is equivalent to formation water (i.e., stability). To determine the appropriate subsurface soil interval (PID reading).	As per selected field instrumentation. Instrumentation will be calibrated according to the manufacturer's manuals.	Qualitatively used to evaluate general water quality.
	Laboratory (Soil, Ground Water, Surface Water, and Sediment)	Appendix IX VOCs Appendix IX SVOCs Appendix IX Pesticides/PCBs Appendix IX Herbicides Appendix IX Inorganics (total and dissolved[4]) Miscellaneous Inorganics[5] (total and dissolved[4])	To obtain a representative presentation of the nature and quantity of constituents that were released to media by past operational activities.	Reporting limit low enough to meet Federal/State ARARs/TBCs and evaluate adverse human health and environmental impacts.	Comparison of constituents found in site media to risk-based screening criteria to determine if these media were affected by past site activities. Comparison of inorganic site soil data to established Basewide background levels for similar soil types. Estimate human health risks, as outlined in Section 10.0, Figure 10-1. Estimate ecological risks, as outlined in Section 11.0, Figure 11-1.
		Hardness[6] TSS[6]	Evaluate surface water conditions.	As per chosen laboratory methods.	To be used to assess potential risks for ecological receptors.
		CEC[7] pH[7] TOC[7][8]	Evaluate soil and/or sediment conditions.	As per chosen laboratory methods.	For soil, evaluate the potential for contaminant migration from the site and the potential for risks outside the site boundaries. For sediment, to be used to assess potential risks for ecological receptors.

SPECIFIC OBJECTIVES FOR SAMPLING LOCATIONS

MEDIUM	SAMPLE COLLECTION TECHNIQUE	SAMPLING POINT[9]		
		SAMPLE LOCATION	COMMENT	OBJECTIVE OF LOCATION
Surface/Subsurface Soil	Grab surface soil sample; specific collection technique identified in FSP, Section 2.4.2.1. Grab subsurface soil sample; specific collection technique identified in FSP, Section 2.4.2.3.	09SB01 through 09SB04	Three locations surrounding Building 2189 and 1 location west of Building 2189 where ground surface slopes towards an unnamed tributary. Samples collected at ground surface (0 to 2 feet bgs) and at a discrete depth from 2 to 10 feet (interval based on PID readings)[10]. Two samples per location for a total of 8 samples.	Evaluate contaminant concentrations at varying depths at Building 2189 and along migration pathways. Soil depths reflect the exposure pathways for the identified potential receptors.
		09SB05 through 09SB08	Four locations in the vicinity of the R-150 Tank area. Samples collected at ground surface (0 to 2 feet bgs) and at a discrete depth from 2 to 10 feet bgs (interval based on PID readings)[10]. Two samples per location for a total of 8 samples.	Evaluate contaminant concentrations at varying depths in the general vicinity of the R-150 Tank area. Soil depths reflect the exposure pathways for the identified potential receptors.
		09SB09 through 09SB11	Two locations north/northwest of Building 3023 (former location of Building 55) and 1 location northwest of Building 3023 where ground surface slopes towards an unnamed tributary. Samples collected at ground surface (0 to 2 feet bgs) and at a discrete depth (interval based on PID readings)[10]. Two samples per location for a total of 4 samples.	Evaluate contaminant concentrations at varying depths at the former location of Building 55 and along migration pathways. Soil depths reflect the exposure pathways for the identified receptors.
Ground Water	Grab sample; specific collection technique identified in FSP, Section 2.4.1.	09T01	Install and sample new monitoring well east of Building 2189.	Evaluate ground water quality at a location immediately upgradient of Building 2189.
		09-02 and 09-07	Sample existing monitoring wells northwest-west of Building 2189.	Evaluate ground water quality at locations affected by site activities downgradient of Building 2189.
		09-WTP6 and 09-10	Sample existing monitoring wells at locations east of the R-150 Tank area.	Evaluate ground water quality at a location immediately upgradient of the R-150 Tank area.
		09-03, 09-04, and 09-WTP5	Sample existing wells at R-150 Tank area.	Evaluate ground water quality at locations affected by site activities.
		09-12 and 09T02	Sample existing well, 09-12, and install and sample new monitoring well, 09-16, at location northwest-west of tank.	Evaluate ground water quality at locations downgradient of the R-150 Tank.
		09T05	Install and sample new monitoring well northeast of Building 3023 (former location of Building 55).	Evaluate ground water quality at a location immediately upgradient of the former location of Building 55.
		09T03 and 09T04	Install and sample new monitoring wells north/northwest of Building 3023.	Evaluate ground water quality at locations affected by site activities downgradient of the former location of Building 55.
Surface Water/Sediment[11]	Grab sample; specific collection technique identified in the FSP, Section 2.4.3 (surface water) and 2.4.4 (sediment).	09SW/SD01	Location in unnamed tributary northwest of Building 3023.	Evaluate surface water/sediment quality at a location immediately upstream of the site.
		09SW/SD02, 09SW/SD03, and 09SW/SD05	Locations within site boundaries in an unnamed tributary west-southwest of Building 2189, the R-150 Tank area, and Building 3023 (former location of Building 55).	Evaluate surface water/sediment quality at a location affected by site activities.
		09SW/SD04	Location outside of western site boundary in unnamed tributary.	Evaluate surface water/sediment quality at locations immediately downstream of the majority of the site (Building 2189 and the R-150 Tank area).

ARARs Applicable, Relevant, and Appropriate Requirements
CEC Cation Exchange Capacity
FSP Field Sampling Plan
QAPP Quality Assurance Project Plan
PCBs Polychlorinated biphenyls
PID Photoionization detector
SVOCs Semivolatile Organic Compounds
TBCs To Be Considered Values
TOC Total Organic Carbon
TSS Total Suspended Solids
VOCs Volatile Organic Compounds

1 The list of specific chemicals included as target constituents is identified in the QAPP, Section 1.0, Table 1-1. Constituents to be analyzed for all samples, all matrices collected, unless otherwise noted.
2 Cyanide and tin were not included in the list of target constituents for this site since these chemicals have not been detected during historical site investigations. Associated sample quantitation limits for the historical data were less than human health and ecological criteria, indicating that if these chemicals were present at concentrations of potential concern they would have been detected at the site during historical investigations.
3 Soil samples only will be monitored with an PID. The other identified field parameters will be collected for ground water and surface water.
4 Total and dissolved inorganic analyses will be performed for surface water samples.
5 Miscellaneous inorganics include calcium, iron, magnesium, manganese, potassium, and sodium.
6 Analyses performed on surface water samples only.
7 Analyses to be performed on 30 percent of the soil samples collected.
8 TOC analyses will be conducted for all sediment samples.
9 Proposed sampling locations are identified on Figure 7-8.
10 If ground water is encountered prior to 10 feet bgs, a soil sample will be collected from a depth above the water table.
11 Due to the intermittent flow, surface water may not be available at all sample locations.

As depicted on Table 7-5, environmental samples collected from the site will be analyzed for a comprehensive field and laboratory analytical program. Field parameters will be collected for ground water and surface water samples. Typical water quality indicator parameters, such as turbidity, will be collected in the field. Soil samples will be screened for VOCs using monitoring equipment (PID).

The analytical program for the Pesticide Control/R-150 Tank Area was developed based on the chemical categories represented by the list of detected chemicals of interest identified for the site in Section 7.6. Soil, sediment, surface water, and ground water samples will be collected and analyzed for the full list of Appendix IX constituents (VOCs, SVOCs, pesticides, PCBs, inorganics), as well as other miscellaneous inorganics. Surface water samples also will be analyzed for total and dissolved inorganics, hardness, and TSS and sediment samples will be analyzed for TOC to assist in assessing potential risks for ecological receptors. Additionally, soil characteristic parameters (CEC, pH, and TOC), will be collected to determine the likelihood of the potential fate and transport of contaminants at the site (and the potential for risks outside the site boundaries). Ground water samples will not be analyzed for dissolved inorganics since low flow sampling procedures will be used to eliminate turbidity concerns.

As noted previously, Figure 7-8 illustrates the proposed sampling locations for the field investigation at the Pesticide Control/ R-150 Tank Area. Locations to be sampled are located in three distinct areas of the site: Building 55, Building 2189, and the R-150 Tank area. The rationale for the collection of these samples is, as follows:

- Surface/Subsurface Soil (Borings) (22): To assess the potential risks associated with residual soil contamination at SWMU 9, soil borings will be installed at the site. Three borings will be placed around the former location of Building 2189; one additional boring will be placed west of the building at a location where the ground surface slopes toward an unnamed tributary. Four borings will be installed at locations dispersed throughout the R-150 Tank area. Two borings will be placed around the former location of Building 55; one additional boring will be placed west of the former building at a location where the ground surface slopes toward an unnamed tributary. A sample will be collected from the surface (0 to 2 feet bgs) and at a subsurface depth (not greater than 10 feet bgs) to be determined in the field using screening techniques (i.e., from a depth correlated with the highest PID readings).

- Ground Water (13): Eight existing monitoring wells (09-02, 09-03, 09-04, 09-07, 09-10, 09-12, 09-WTP5, and 09-WTP6) will be sampled to assess the potential risks associated with the migration of soil constituents to ground water. A total of five new monitoring wells will be installed at the site

and sampled during this field effort. One well, 09T01, will be located east of the former location of Building 2189 to assess upgradient water quality conditions. Well 09T02 will be placed immediately downgradient of the R-150 Tank area (i.e., west-northwest of the excavated tank). Three other wells, 09T03 through 09T05, will be placed near the former location of Building 55, such that upgradient and downgradient conditions at the building can be evaluated.

- Surface Water and Sediment (10) – To assess the potential risks associated with migration (ground water discharge and surface runoff) of ground water and soil chemicals to surface water and sediment, collocated surface water and sediment samples will be collected from five locations. Four sampling points will be located in the unnamed tributary west of the former location of Building 2189 and the R-150 Tank. Locations in the tributary will be sampled to evaluate upstream and downstream locations and to monitor the stream at locations potentially affected by surface water runoff and/or ground water discharge. Surface water and sediment samples will also be collected from a location potentially affected by surface water runoff and/or ground water discharge from Building 55.

The associated FSP, presented in Appendix A, provides details on the field sampling procedures (installation of soil borings and monitoring wells and collection of samples) to be used at the site. The associated HASP is contained in Appendix B. The QAPP, located in Appendix C, provides details on the analytical methodologies to be used for the proposed field investigation.

The data collected during the proposed field investigation will be used to assess potential risks for human and ecological receptors exposed to site media under current and/or future land use. A description of how the data obtained during the proposed field investigation will be managed prior to use in the risk assessment is presented in Section 9.0. General methodologies and techniques used to calculate potential risks for the site are provided in Sections 10.0 (human health) and 11.0 (ecological).

8.0 SWMU 10 – ROCKEYE

The proposed field investigation for SWMU 10, Rockeye, needed to fulfill the overall objectives of this CTO (i.e., the completion of human health and ecological risk assessments), is provided in this section.

Section 8.1 presents a brief background of activities, which have occurred at the site. The physical setting (geology, hydrology, topography, etc.) is contained in Section 8.2. A brief synopsis of the previous site investigations and hazard identification based on the historical site data are presented in Sections 8.3 and 8.4, respectively. Section 8.5 summarizes the proposed field investigation for the site.

8.1 BACKGROUND

As described in the RFI Phase III Ground Water Release Characterization Report (USACE, 1998b), Rockeye, an active site, is a munitions production facility and not a storage, treatment, or disposal site. Operations at the site began in the mid 1950s as a press-loading operation for 3-inch projectiles using Composition A-3 explosive (RDX and wax). In 1967-1968, the munitions facility was converted to a case-filling operation for the production of the MK20 series antitank Rockeye cluster bomb. The Rockeye bomb is a 500-lb unit that contains 247 steel-cased bomblets, each holding a 0.4-pound blend of Octal Type II and Composition B high explosives. Octal Type II contains 70 percent HMX (octahydro-1,3,5,7-tetranitro-1,2,5,7-tetrazocine, which is cyclotetramethylene tetranitramine) and 30 percent TNT (2,4,6-trinitrotoluene). Composition B is 60 percent RDX (hexahydro-1,3,5-trinitro-1,3,5triazine, which is cyclo-trimethyl-trinitramine or "cyclonite"), 39 percent TNT, and 1 percent wax. The wax is used as a desensitizer.

As part of loading operations, the production facility generates a large volume of wastewater, which is collected in sumps surrounding the buildings at the site. The sumps are periodically pumped and the residue is trucked to the Ammunition Burning Ground for disposal. Prior to 1978, when the sumps became full of explosive-contaminated wastewater, the wastewater was discharged via drainage pipes to the local intermittent tributaries located near the site. On the north and east side of the production facility, the wastewater was released to tributaries of Sulphur Creek, on the south side the water was released to Turkey Creek, and on the west side the water was released to a tributary of Furst Creek.

In the spring of 1978, an activated carbon water treatment facility (Building 3044) was constructed to purify the wastewater for recycled usage. In addition to a water treatment system, a scrubber system to remove contaminated particulates was designed and installed. In the tray wash area of the production

facility, explosive-contaminated trays are steam cleaned. Before the scrubber was installed, emissions were discharged directly to the atmosphere outside the production buildings. With the installation of the pollution abatement equipment, the release of explosive-contaminated waters has declined.

8.2 PHYSICAL SETTING

Rockeye is a 10-acre site located on a flattened ridge crest that separates Sulphur Creek and Boggs Creek in the north central portion of the Base. The site is located on Highway 45, approximately 2 miles south of North Gate No. 1. The site map for SWMU 10, Rockeye is presented as Figure 8-1.

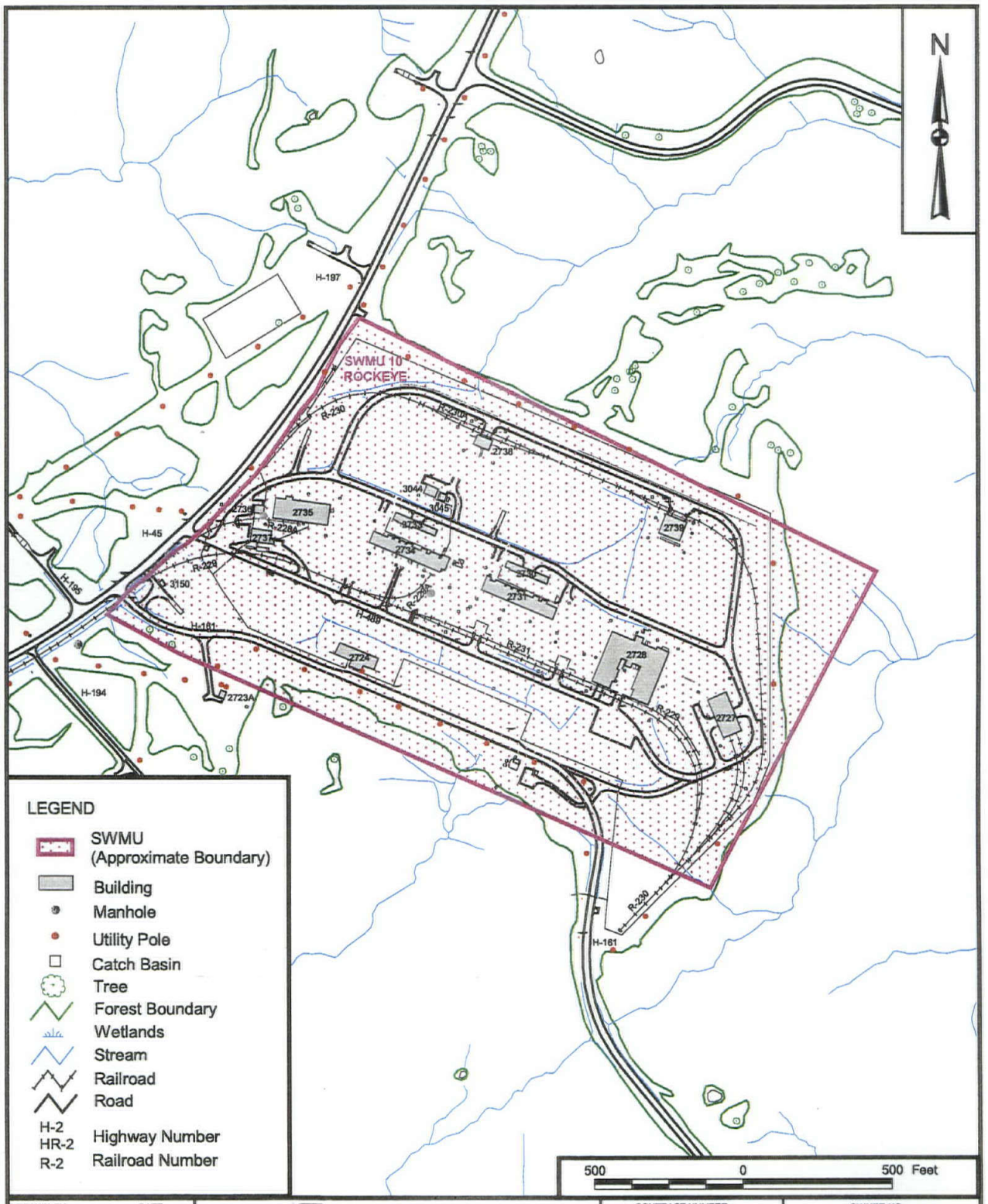
The site geologic profile in the immediate area of the loading, assembling, and packaging facility consists of 1 to 12 feet of soil overburden, which is underlain by Pennsylvanian age sedimentary rocks of the Raccoon Creek Group Mansfield Formation. Sedimentary rocks immediately underlying this site consist of interbedded sandstone, clay, shale, and coal beds. All the rock types are characterized by rapid lateral variations in thickness. The dominant rock type in the area is quartz sandstone bedrock. This sandstone varies in thickness from 20 feet to less than 1 inch. The shale bedrock varies in thickness from 10 feet to less than 1 inch. The coal beds are not continuous at the site and are less than 5 feet in thickness.

The soils at the site range from 0.5 feet to almost 17 feet. To level out the site, fill was placed in the eroded stream valleys. Consequently, soil is thicker in these areas. The soil types that compose Rockeye are predominantly clays with lesser amount of sand and silt. The fill material contains clay and gravel. The subsurface clays and silts contain sassafras root and natural organic debris. The clay represents the residual soil, a weathering product of the shale and sandstone.

Residual soil also is found as silt with scattered sandstone fragments. Because the soil is mostly compacted clay, which is impermeable, most precipitation (rainfall) would exit the site as surface runoff. During periods of infiltration, the soil acts as a slow conduit for water and constituent movement.

Several discrete aquifers were identified at Rockeye. An unconsolidated shallow aquifer is present at the site. Three aquifers (upper, middle, and lower) have been identified in the Pennsylvanian aged rock. Additionally, deeper aquifers in the Mississippian rock geologic unit were identified. These aquifers include the Golconda/Haney Limestone, Big Clifty Sandstone, and Beech Creek Limestone, with the Beech Creek aquifer being the deepest aquifer.

The lower Pennsylvanian aquifer consists of saturated, primarily massive, cross-bedded and wavey-bedded sandstones of the Pennsylvanian sequence. The lower aquifer is consistently present throughout



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NO.
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CHECKED BY	DATE	SITE MAP SWMU 10 - ROCKEYE NSWC CRANE, INDIANA	APPROVED BY	DATE 5/7/99
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. Figure 8-1	REV

P:\GIS\NSWC_CRANE\CTO-10_SWMU10.APR 4/28/99 JAL SITE MAP LAYOUT

the site. The surface of the lower aquifer is irregular with radial drainage centered about a high in the southeast corner of the facility. The high is elongated to the northwest, following the general trend of the drainage divide defined by topography. Ground water flow in the lower aquifer across Rockeye is northwest and north. The top of the lower aquifer is deep (about 50 feet bgs) beneath Rockeye, but is projected to intercept the gullies draining the site to the northeast and south. The erosional gullies on the south side and northeast slope of the site do not drain the lower aquifer until the actual lower aquifer sandstone is breached. This is much lower than the top of the lower aquifer. No springs or seeps that would indicate drainage of the aquifer have been identified in either the south or northeast gully. It is probable that near-surface residual clay soils prevent ground water from contacting the free surface in the gully banks.

In general, the surface of the ground water table for the upper and middle Pennsylvanian aquifers roughly parallel the topographic surface. The middle and upper aquifers are hydraulically connected. They merge in the northeast portion of the site near wells 10C32 and 10C33 (at the east-west divide) and wells 10C29 and 10C49 (at the north-south divide). Because the two aquifers ultimately act as one with respect to ground water flow and potential contaminant migration, historical ground water data from the wells of both aquifers (upper and middle) were combined and referred to as the upper/middle Pennsylvanian aquifer (Table 8-5).

Individually, the flow in the upper Pennsylvanian aquifer across Rockeye is primarily to the northeast, ultimately discharging to the middle aquifer and then moving downgradient to the northeast. There are components of flow radially away from the highs in the southwest and southeast corners of the site. The upper aquifer is represented by sandstones and siltstones at depths usually 20 to 25 feet bgs. The middle aquifer is limited in lateral extent, confined primarily to the north-central portion of the site. Based on available evidence, ground water moves very slowly through the soil downward, then laterally along the soil/rock interface until it reaches fractured rock and enters the rock aquifer system.

Surface flow away from Rockeye is to the northeast, southwest and southeast. The upper/middle Pennsylvanian aquifer is intercepted by the surface drainage ways below the ridge to the northeast and southeast. Drainage from Rockeye to the north goes toward an unnamed tributary of Sulphur Creek. Drainage to the south and southwest goes into (and is the origin of) Turkey Creek, which flows into Boggs Creek. Drainage to the west goes to an unnamed tributary of Furst Creek.

8.3 PREVIOUS INVESTIGATIONS

This section includes a brief description of the historical data collection activities conducted at SWMU 10, Rockeye. Soil and ground water samples were collected at the locations illustrated in Figure 8-2. A tabular summary of the previous investigations completed for the site is presented in Table 8-1.

Various investigations were completed at the site from 1981 to 1987 as part of several multi-site investigations. The first of which was the IAS, which began in April 1981 in response to the NACIP Program. The NEESA completed the IAS in May 1983 with assistance from the Ordnance Environmental Support Agency and the U.S. ACE WES. The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations.

The IAS consisted of the installation of a total of 26 monitoring wells throughout the site. Initially, two wells were installed. Both wells were at the base of the ridge approximately 360 feet east of Rockeye, near Highway 165. During the installation of these wells, soil samples were collected and tested for various soil characteristics. In September 1983, 24 additional monitoring wells were installed around the perimeter of the site. These wells were typically shallow, ranging in depth from 50 feet bgs or less. Both quarterly and semi-annual sampling events were conducted on all 26 wells. These analyses were mainly for water quality parameters and explosives. Table 8-1 summarizes the constituents that were included in the analytical program. Based on the initial conclusions of this ground water study, Rockeye was not determined to represent an immediate human health and environmental threat. However, the site was recommended for further study to evaluate potential long-term impacts.

In response to the recommendation from the IAS, a RFI Phase II Soil Characterization study was performed in 1990. The objective of this study was to determine soil conditions around the site and to identify and characterize the constituents that may have been released to the soil (U.S. ACE WES, 1998d). The investigation included the collection and analysis of surface and subsurface samples, predominantly in areas where wastewater from the munitions production lines was released and would likely have made contact with the soil (e.g., sumps, open ditches, etc.). Thirteen soil borings were advanced at Rockeye, and 24 soil samples were collected from these borings. Surface soil samples were collected on a sampling grid (with locations approximately 5 feet apart from each other) at Areas A through E (Figure 8-2) near the drainage areas that lead away from the site. Additionally, surface samples were collected around the drainage ditches in Areas F and G. One surface soil sample was collected in Area H, at an air vent discharge area at Building 2734.

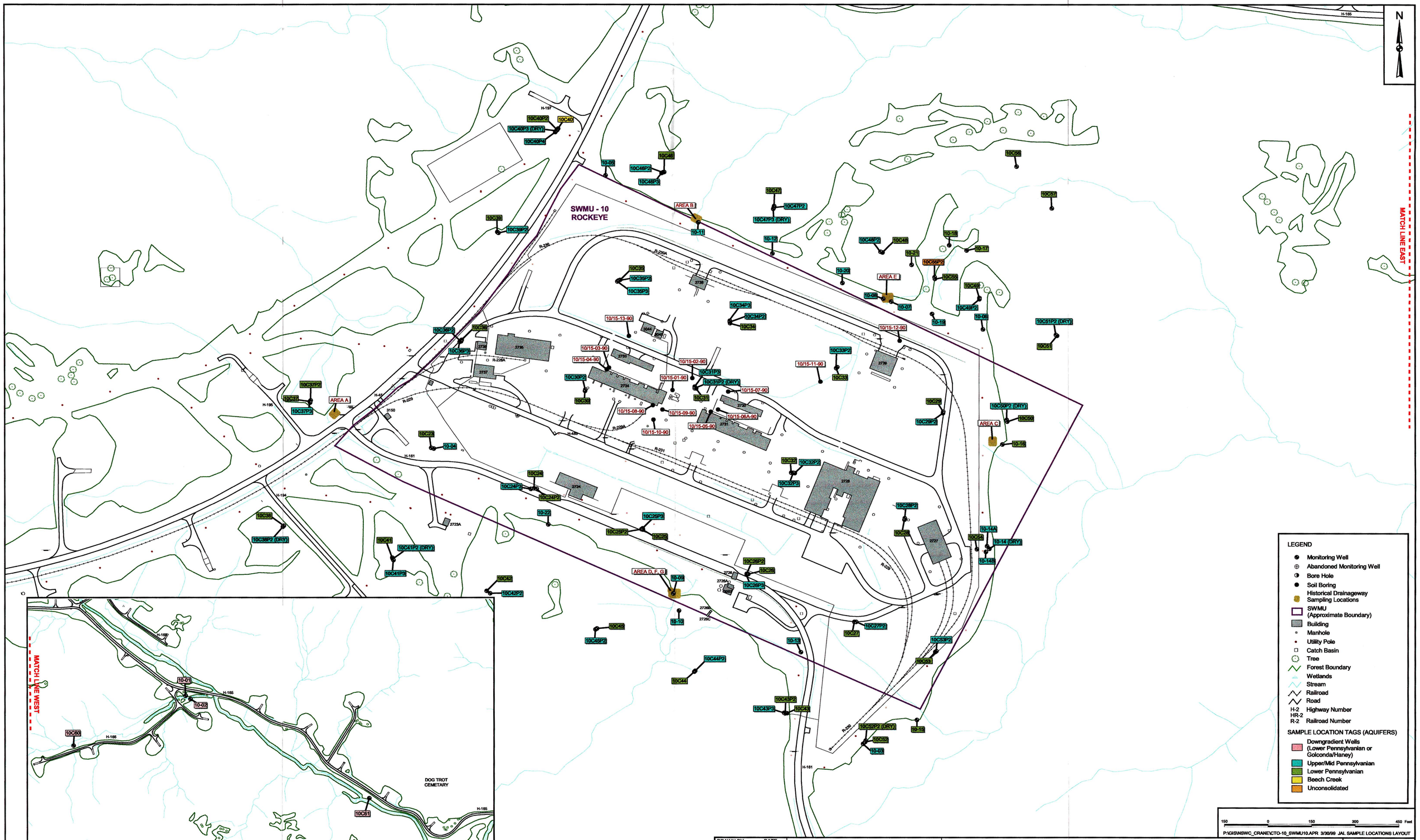
TABLE 8-1

SUMMARY OF HISTORICAL SITE INVESTIGATIONS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

INVESTIGATION (REPORT/REFERENCE)	EXTENT OF INVESTIGATION			RESULTS OF INVESTIGATION	
	SUMMARY	DATE OF SAMPLING	ANALYTICAL PROGRAM (PARAMETER/ANALYTICAL METHOD)	DETECTED PARAMETERS OF INTEREST	CONCLUSIONS
General Basewide Investigations[1] (1981-1987)	Installation of 2 monitoring wells in 1981. Physical soil testing was performed to define hydrogeological characteristics	January - April 1982	Miscellaneous Physical Soil Testing (cation exchange Capacity, grain size, Atterberg limits, density, water content, and permeability tests) -- Various Methods	NA	Geology consists of clay with lesser amounts of sand and silt. Soils at at the site range from 0.5 ft to 17 feet bgs. The average depth to ground water (upper aquifer) is approximately 17 feet bgs with fluctuations based on topography. Ground water in the area tends to flow toward the intermittent streams that drain the site. Drainage from the north goes to Sulfur Creek; the south to Turkey Creek; and the west to Furst Creek. Ground water flows mainly to the north/northeast.
	Installation of 22 wells located around the perimeter of the site. Quarterly/semiannual ground water monitoring instituted to identify the presence or absence of contamination.	February 1983 - June 1986[3]	Explosives -- SW-846 Method 8330	Explosives (2,4,6-TNT, 2,4-DNT, 2,6-DNT, and RDX)	The primary areas of surface contamination are around the sumps and drainage ways. Explosives contamination was noted in the monitoring wells northeast of the site. The presence of explosives in wells 10-01 and 10-02 indicates that surface streams are an important transport mechanisms. On-site wells near surface streams contained explosives.
RFI Phase II Soils Release Characterization for SWMU 10/15 Rockeye, Naval Surface Warfare Center Crane, Indiana (U.S. ACE WES, 1998d)	Installation of 13 soil borings and collection of 23 soil samples. Collect surface samples in 8 areas in a 5 ft grid pattern. Sampling performed to determine whether a chemical release has occurred at the site (I.e., identify residual contaminant concentrations in soil).	September - October 1990	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Explosives -- SW-846 Method 8330 Inorganics -- SW-846 Methods 6010/7060	Surface soil - SVOCs (aniline and N-nitrosodi-methylamine), PAHs, explosives (2,4-DNT, 2,6-DNT, 2,4,6-TNT, HMX, and RDX) and various inorganics (mainly Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Ni, Sn, and Zn) Subsurface Soil - VOCs (1,1,1-TCA, 1,1,2-TCA) and various inorganics (mainly Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Ni, and Zn)	The bedrock surface is irregular. The soil types are mainly clay with lesser amounts of sand and silt. Much of the soil encountered is fill and contained natural organic debris. Because of the clay soil type, most of the rainfall would tend to exit as runoff and not migrate downward to ground water. Ground water flow is affected by the drainage divide. Ground water generally moves toward the creeks. Analytes of major concern are the explosives, which were found in the sumps, surface drainage ways and surface soils. No pattern was noted for those VOCs detected at the site. Most of the SVOCs/PAHs were found in one sample at Area H (collected from an air vent discharge are from one from an air vent discharge area from one building). Inorganics in subsurface soil were found at levels representative of background. Inorganics were detected at concentrations above background in soil samples collected from drainage ways. However, there is not sufficient information to determine whether these inorganics were a result of site activities. Detects of methylene chloride and phthalates are thought to be attributable to laboratory contamination.
Final Report RFI Phase III Ground Water Release Characterization Report, SWMU 10 Rockeye Facility, Naval Surface Warfare Center, Crane, Indiana (U.S. ACE WES, 1998b)	Drilling of 2 borings and installation of 83 monitoring wells. Cluster wells were located at 10C23 through 10C53 and 10C55. Borings were used only to determine the structure trends across the base. Monitoring wells were used to determine subsurface hydrogeology and vertical extent of constituents.	March 1991 - January 1992[4] May 1992 [5]	VOCs -- SW-846 Method 8240 SVOCs -- SW-846 Method 8270 Organochlorine Pesticides/PCBs -- SW-846 Method 8080 Organophosphorus Pesticides -- SW-846 Method 8140 Herbicides -- SW-846 Method 8150 Explosives -- SW-846 Method 8330 Inorganics + CN -- SW-846 Methods 6010/7060/7471/7740 Water Quality Parameters - Various EPA Methods	VOCs (benzene and chloroform), explosives (1.3,5-trinitrobenzene, amino-dinitrotoluenes 2,4,6-TNT, 2,4-DNT, 2,6-DNT, and RDX), PCBs (Aroclor-1254), pesticides (mainly DDD, DDE, DDT, alpha-chlordane, beta-BHC, dieldrin, endosulfan II, endrin, gamma-chlordane, heptachlor, heptachlor epoxide, and methoxy-chlor), dinoseb, inorganics (mainly, Al, SB, As, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, Tl, Zn), cyanide, chloride, nitrate, and nitrite	Three discrete aquifers were identified: the upper, middle, and lower in the Pennsylvanian aged rock. Also, deeper aquifers in the Mississippian geologic unit were identified (Beech and Golconda aquifers). Benzene, Aroclor-1254, and low levels of pesticides and herbicides were found throughout the site. Many of these detected were found in 1991, but were not confirmed in later sampling. Explosives were found predominantly in the northeast wells; these detections confirm earlier studies. Inorganics were found in most wells in all three Pennsylvanian aquifers. Most inorganics were identified as statistically significant, especially in the upper aquifer. However, the presence of these inorganics are thought to be attributable to natural conditions of low pH produced by depositional conditions of the aquifer rock. Detects of acetone, methylene chloride, and phthalates are considered to be laboratory contaminants.

Al	Aluminum	Co	Cobalt	Fe	Iron	PAHS	Polynuclear Aromatic Hydrocarbons	Sb	Antimony	VOCs	Volatile Organic Compounds
As	Arsenic	Cu	Copper	Hg	Mercury	Pb	Lead	Se	Selenium	Va	Vanadium
Ba	Barium	Cr	Chromium	Mn	Manganese	PCBs	Polychlorinated Biphenyls	Sn	Tin	Zn	Zinc
Be	Beryllium	CN	Cyanide	Ni	Nickel	RFI	RCRA Facility Investigation	SVOCs	Semivolatile Organic Compounds		
Cd	Cadmium	DNT	Dinitrotoluene	NA	Not applicable	RCRA	Resource Conservation and Recovery Act	Tl	Thallium		
								TNT	Trinitrotoluene		

1 Includes, but is not limited to, Hydrogeologic Investigations at Waste Disposal Sites (U.S. ACE WES, 1982) and Navy Assessment and Control of Installation Pollutants, Confirmation Study (HMTC, June 1985).
2 Quarterly monitoring. Upon initiation of monitoring program, not all 22 wells were installed. As wells were installed, they were added to the monitoring program.
3 Semiannual monitoring. Upon initiation of the monitoring program, not all 22 wells were installed. As wells were installed, they were added to the monitoring program.
4 This sampling effort included Appendix IX constituents and explosives.
5 This sampling effort included metals, explosives, nitrogen compounds, cyanide and sulfide.



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J. LAMEY	3/5/99
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HISTORICAL SAMPLE LOCATIONS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO.	OWNER NO.
7141	0010
APPROVED BY	DATE
R.C. Turnbull	10-19-99
APPROVED BY	DATE
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FIGURE 8-2	

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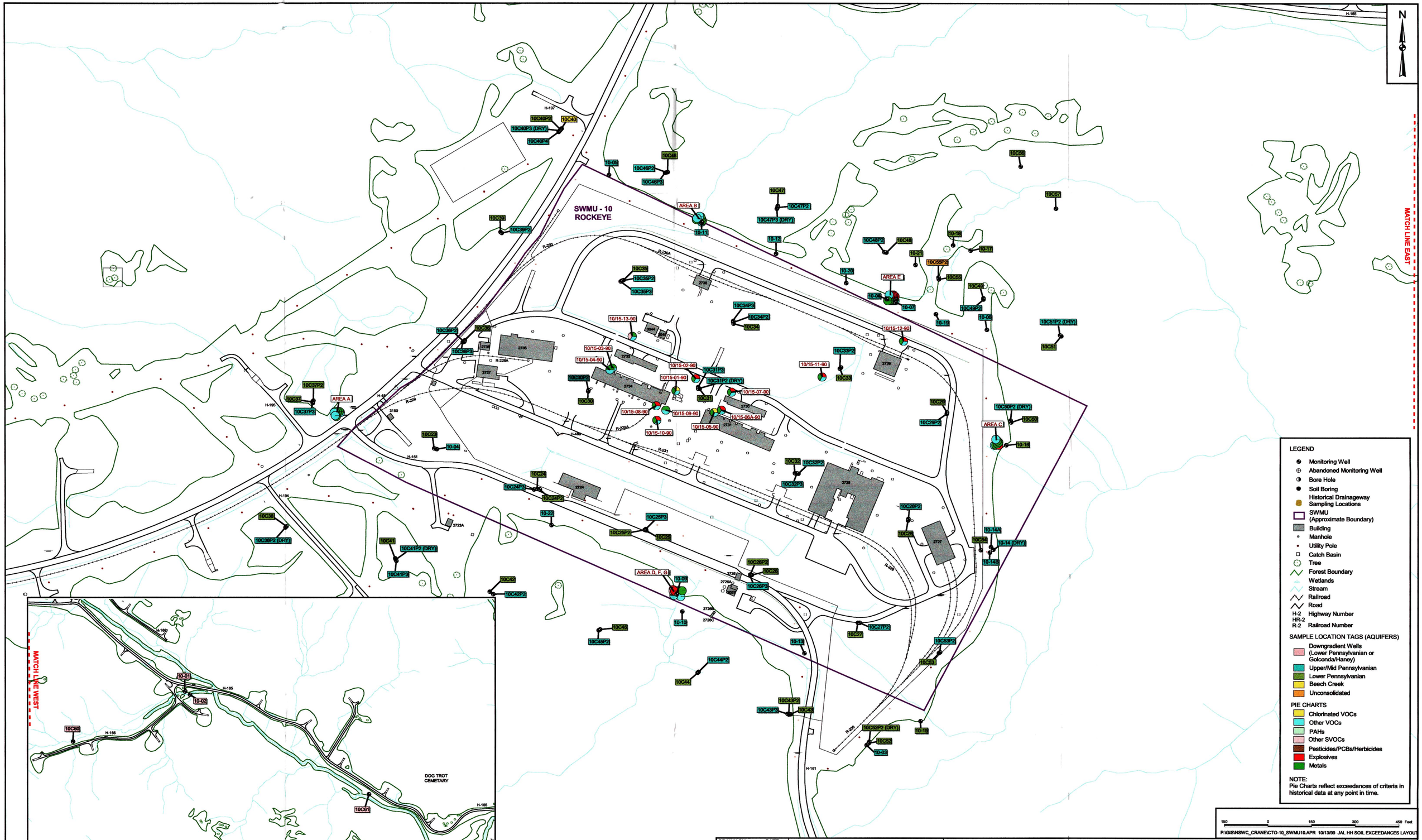

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COST/SCHEDULE-AREA	
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AS NOTED	

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SOIL EXCEEDANCES - HUMAN HEALTH
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO.	OWNER NO.
7141	0010
APPROVED BY	DATE
	10/18/99
APPROVED BY	DATE
DRAWING NO.	REV.
FIGURE 8-3	

Subsurface samples collected for the RFI Phase II Soil Characterization study were analyzed for a comprehensive analytical program. All surface soil samples were analyzed for explosives; some of the surface soil samples were also analyzed for a comprehensive list of constituents. Table 8-1 contains a summary of the analyses performed during the previous site investigations.

A RFI Phase III Ground Water Characterization study (U.S. ACE WES, 1998b) commenced at the SWMU 10 in March 1991. This study included the installation of two soil borings and 83 monitoring wells. The two borings extended beneath the site into the Mississippian-age rocks to determine the structure trends across the site by correlating identifiable and consistent geologic units. The wells were installed and placed in locations that provide aerial coverage to characterize subsurface hydrogeology at and around the site. Also, the wells were completed at various depths to determine the vertical extent of potential contamination. These wells were installed at depths ranging from 100 feet or less. Cluster wells were installed at locations 10C23 through 10C53 and 10C55. These cluster well sites have between two to four wells at each location (Figure 8-2). Seventeen well clusters containing two wells, 13 clusters containing three wells, and one cluster containing four wells were installed. The remaining six wells were installed as single wells. Wells 10C42, 10C43, 10C52, and 10-3 are background wells, that are located outside the fence on the southern side of the site. All wells were included in the quarterly and semi-annual monitoring program. All ground water samples collected during this program were field filtered; no total inorganic analyses are available.

The RFI Phase III Ground Water Characterization study included five rounds of sampling and analysis for RCRA Appendix IX parameters and explosives. Beginning in 1991, a comprehensive list of parameters was analyzed during the semi-annual monitoring (for the 83 wells and the previous 26 wells). Table 8-1 summarizes the analytical program. All ground water samples collected were field filtered. After three rounds of sampling results, it was concluded that ground water samples collected during subsequent monitoring efforts would be analyzed for only metals, nitrogen compounds, cyanide/sulfide, and explosives constituents.

8.4 HAZARD IDENTIFICATION

The hazard identification characterizes those constituents that may be attributable to historical operations at the site. Based on knowledge of site practices and an interpretation of the historical data (i.e., comparison of detected constituents to risk-based screening criteria), a list of detected chemicals of interest was developed for SWMU 10, Rockeye. Detected chemicals of interest are defined as those chemicals, excluding blank contaminants, present at concentrations greater than risk-based screening

criteria. Discussions of those constituents detected at concentrations in excess of current human health and ecological screening criteria are provided in Sections 8.4.1 (organics) and 8.4.2 (inorganics). A summary of the detected parameters of interest is contained in Section 8.4.3.

Historical site data were compared to human health and ecological criteria to identify chemicals of interest. Summaries of the comparison of historical site data to human health and ecological risk-based criteria are presented in Tables 8-2 (surface soil), 8-3 (subsurface soil), 8-4 (ground water, unconsolidated aquifers), 8-5 (ground water, upper Pennsylvanian aquifer), 8-6 (ground water, lower Pennsylvanian aquifer), 8-7 (ground water, Beech Creek aquifer), and 8-8 (ground water, downgradient wells in Lower Pennsylvanian and Golconda aquifers). A brief description of the screening criteria used was provided in Section 4.2 of this Work Plan.

Figures 8-3 through 8-8 depict those locations where exceedances of human health and ecological risk-based criteria have been noted during previous investigations. Separate figures are provided for soil (surface and subsurface combined) and ground water (for the various aquifers). For each sample matrix, separate figures are presented to illustrate human health and ecological exceedances.

Because ground water in the Pennsylvania aquifers at the site discharges to various unnamed tributaries and surface water/sediment samples have not been collected from the site, historical ground water data were compared to ecological screening criteria for surface water. The comparison is considered to be conservative, because it does not include the dilution of contaminants in the creek. Thus, those chemicals identified as detected chemicals of interest based solely on the comparison of ground water data to surface water criteria may not actually be present in the surface water at concentrations of potential concern.

8.4.1 Organic Constituents

Based on the historical site data and known site operations, explosives are the primary chemicals of interest for SWMU 10, Rockeye. The specific explosives identified as detected chemicals of interest consist of amino-dinitrotoluenes, 2,4-dinitrotoluene, 2,6-dinitrotoluene, HMX, RDX, 1,3,5-trinitrobenzene, and 2,4,6-trinitrotoluene. Similar explosives were detected in the ground water and soil during the previous site investigations.

Explosives were detected in the soil samples collected at the site. The highest concentrations of these chemicals were found in the surface soil samples collected from locations along the drainageways

TABLE 8-2

SUMMARY OF HISTORICAL DATA - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
PAGE 1 OF 3

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
Volatile Organics (mg/kg)												
1,1,1-TRICHLOROETHANE	0/21	---	0.0052-0.0087	---	0	---	1200	0.1	770	2400	1.9	29.8
1,1,2,2-TETRACHLOROETHANE	0/21	---	0.0052-0.0087	---	0	3	0.6	0.0002	0.38	5.4	0.007	0.12722
1,1,2-TRICHLOROETHANE	0/21	---	0.0052-0.0087	---	0	11	1	0.0009	0.84	10	0.03	28.6
1,1-DICHLOROETHANE	0/21	---	0.0052-0.0087	---	0	7800	1300	1	590	1400	5.6	20.1
1,1-DICHLOROETHENE	0/21	---	0.005-0.0087	---	0	1	0.07	0.003	0.054	0.73	0.058	8.28
1,2-DICHLOROETHANE	0/21	---	0.0052-0.0087	---	0	7	0.4	0.001	0.35	4	0.024	21.2
1,2-DICHLOROPROPANE	0/21	---	0.0052-0.0087	---	0	9	15	0.001	0.35	5	0.03	32.7
2-BUTANONE	1/21	0.021	0.1-0.17	A-4-1 (90) (9/8/90)	0	---	---	---	7300	20000	10	89.6
2-HEXANONE	0/21	---	0.052-0.087	---	0	---	---	---	---	---	---	12.6
4-METHYL-2-PENTANONE	0/21	---	0.052-0.087	---	0	---	---	---	790	---	---	443
ACETONE	21/21	0.015-0.24	---	D-1-3 (90) (9/5/90)	0	7800	100000	0.8	1600	4200	3.1	2.5
BENZENE	0/21	---	0.0052-0.0087	---	0	22	0.8	0.002	0.67	9	0.34	0.25462
BROMODICHLOROMETHANE	0/21	---	0.0052-0.0087	---	0	10	3000	0.03	1.0	11	0.63	0.53978
BROMOFORM	0/21	---	0.0052-0.0087	---	0	81	53	0.04	62	290	0.75	15.9
BROMOMETHANE	0/21	---	0.01-0.017	---	0	110	10	0.01	3.9	11	0.052	0.23516
CARBON DISULFIDE	0/21	---	0.0052-0.0087	---	0	7800	720	2	360	990	10	0.09412
CARBON TETRACHLORIDE	0/21	---	0.0052-0.0087	---	0	5	0.3	0.003	0.24	3.6	0.066	2.98
CHLOROBENZENE	0/21	---	0.0052-0.0087	---	0	1600	130	0.07	1.0	150	1.3	13.1
CHLOROETHANE	0/21	---	0.01-0.017	---	0	---	---	---	3.0	---	---	---
CHLOROFORM	0/21	---	0.0052-0.0087	---	0	100	0.3	0.03	0.24	3.3	0.59	1.19
CHLOROMETHANE	0/21	---	0.01-0.017	---	0	---	---	---	1.2	---	---	10.4
CIS-1,2-DICHLOROETHENE	0/21	---	0.0052-0.0087	---	0	780	1200	0.02	43	119	0.4	0.78373[6]
CIS-1,3-DICHLOROPROPENE	0/21	---	0.0052-0.0087	---	0	4	0.1	0.0002	---	---	---	0.39786
DIBROMOCHLOROMETHANE	0/21	---	0.0052-0.0087	---	0	8	1300	0.02	1.1	---	---	2.05
ETHYLBENZENE	0/21	---	0.0052-0.0087	---	0	7800	400	0.7	230	5000	13	5.16
METHYLENE CHLORIDE	21/21	0.0059-0.48	---	B-4-1 (90) (9/10/90)	21	85	13	0.001	8.9	120	0.023	4.05
STYRENE	0/21	---	0.0052-0.0087	---	0	16000	1500	0.2	1.0	12000	3.5	4.69
TETRACHLOROETHENE	0/21	---	0.0052-0.0087	---	0	12	11	0.003	5.7	50	0.058	9.92
TOLUENE	0/21	---	0.0052-0.0087	---	0	16000	650	0.6	520	1800	12	5.45
TRANS-1,2-DICHLOROETHENE	0/21	---	0.0052-0.0087	---	0	1600	3100	0.03	63	190	0.68	0.78373
TRANS-1,3-DICHLOROPROPENE	1/21	0.0007	0.0052-0.0087	D-0-0 (90) (9/5/90)	1	4	0.1	0.0002	---	---	---	0.39786
TRICHLOROETHENE	0/21	---	0.0052-0.0087	---	0	58	5	0.003	2.8	48	0.057	12.4
VINYL ACETATE	0/21	---	0.052-0.087	---	0	78000	1000	8	430	1200	2.3	12.7
VINYL CHLORIDE	0/21	---	0.01-0.017	---	0	0.3	0.03	0.0007	0.022	0.31	0.013	0.64614
XYLENES, TOTAL	1/21	0.0007	0.0052-0.0087	B-4-1 (90) (9/10/90)	0	160000	410[6]	9[6]	210	5300	190	10
Semivolatile Organics (mg/kg)												
1,2,4-TRICHLOROBENZENE	0/37	---	0.68-3.8	---	0	780	3200	0.3	6.0	1800	5.3	11.1
1,2-DICHLOROBENZENE	0/37	---	0.68-3.8	---	0	7000	560	0.9	370	3000	17	2.96
1,2-DIPHENYLHYDRAZINE	0/37	---	0.68-3.8	---	0	---	---	---	0.61	---	---	---
1,3-DICHLOROBENZENE	0/37	---	0.68-3.8	---	0	---	---	---	13	114	0.42	37.7
1,4-DICHLOROBENZENE	0/37	---	0.68-3.8	---	0	27	---	0.1	3.0	42	2.2	0.54559
2,4,5-TRICHLOROPHENOL	0/37	---	0.68-3.8	---	0	7800	---	14	6100	18000	250	14.1
2,4,6-TRICHLOROPHENOL	0/37	---	0.68-3.8	---	0	58	200	0.008	44	390	1.5	9.94
2,4-DICHLOROPHENOL	0/37	---	0.68-3.8	---	0	230	---	0.05	1.0	550	1.1	87.5
2,4-DIMETHYLPHENOL	0/37	---	0.68-3.8	---	0	1600	---	0.4	1.0	3600	9	0.01
2,4-DINITROPHENOL	0/37	---	3.4-19	---	0	160	---	0.01	120	360	0.29	0.06086
2,6-DINITROTOLUENE	1/37	0.68	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	1	0.9	---	0.00003	61	---	---	0.03283
2-CHLORONAPHTHALENE	0/37	---	0.68-3.8	---	0	---	---	---	4900	---	---	0.01218
2-CHLOROPHENOL	0/37	---	0.68-3.8	---	0	390	53000	0.2	6.0	380	0.75	0.24266
2-METHYL-4,6-DINITROPHENOL	0/37	---	3.4-19	---	0	---	---	---	---	---	---	---
2-METHYLNAPHTHALENE	0/37	---	0.68-3.8	---	0	---	---	---	---	---	---	3.24
2-METHYLPHENOL	0/37	---	0.68-3.8	---	0	3900	---	0.8	3100	7600	14	40.4
2-NITROANILINE	0/37	---	3.4-19	---	0	---	---	---	3.5	---	---	74.1
2-NITROPHENOL	0/37	---	0.68-3.8	---	0	---	---	---	---	---	---	1.6
3,3'-DICHLOROBENZIDINE	0/37	---	1.4-7.6	---	0	1	---	0.0003	1.1	9.5	0.062	0.64636

TABLE 8-2

SUMMARY OF HISTORICAL DATA - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
3-NITROANILINE	0/37	---	3.4-19	---	0	---	---	---	---	---	---	3.16
4-BROMOPHENYL PHENYL ETHER	0/37	---	0.68-3.8	---	0	---	---	---	---	---	---	---
4-CHLORO-3-METHYLPHENOL	0/37	---	1.4-7.6	---	0	---	---	---	---	---	---	7.95
4-CHLOROANILINE	0/37	---	1.4-7.6	---	0	310	---	0.03	240	730	0.97	1.1
4-CHLOROPHENYL PHENYL ETHER	0/37	---	0.68-3.8	---	0	---	---	---	---	---	---	---
4-METHYLPHENOL	0/37	---	0.68-3.8	---	0	---	---	---	310	---	---	163
4-NITROANILINE	0/37	---	3.4-19	---	0	---	---	---	---	---	---	21.9
4-NITROPHENOL	0/37	---	3.4-19	---	0	---	---	---	490	---	---	5.12
ACENAPHTHENE	1/37	0.35	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	0	4700	---	29	3700	9500	130	682
ACENAPHTHYLENE	0/37	---	0.68-3.8	---	0	---	---	---	---	---	---	682
ANILINE	1/37	0.21	1.4-7.6	G-3 (90) (10/13/90)	1	---	---	---	85	---	---	0.05678
ANTHRACENE	1/37	0.65	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	0	23000	---	590	22000	47000	51	1480
BENZIDINE	0/37	---	3.4-19	---	0	---	---	---	0.0021	---	---	---
BENZO(A)ANTHRACENE	1/37	1.7	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	1	0.9	---	0.08	0.62	5	5	5.21
BENZO(A)PYRENE	1/37	1.2	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	1	0.09	---	0.4	0.062	0.5	0.5	1.52
BENZO(B)FLUORANTHENE	1/37	1.3	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	1	0.9	---	0.2	0.62	5	5	59.8
BENZO(G,H,I)PERYLENE	0/37	---	0.68-3.8	---	0	---	---	---	---	---	---	119
BENZO(K)FLUORANTHENE	1/37	1.1	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	0	9	---	2	6.2	50	39	1480
BENZOIC ACID	0/37	---	3.4-19	---	0	310000	---	20	100000	730000	590	---
BENZYL ALCOHOL	0/37	---	1.4-7.6	---	0	---	---	---	18000	---	---	65.8
BIS(2-CHLOROETHOXY)METHANE	0/37	---	0.68-3.8	---	0	---	---	---	---	---	---	0.30209
BIS(2-CHLOROETHYL)ETHER	0/37	---	0.68-3.8	---	0	0.6	0.2	0.00002	0.21	1.6	0.0007	23.7
BIS(2-CHLOROISOPROPYL) ETHER	0/37	---	0.68-3.8	---	0	---	---	---	6.9	31	0.027	---
BIS(2-ETHYLHEXYL)PHTHALATE	26/37	0.05-1.3	0.74-3.8	10/15-05-90 #1 (90) (9/14/90)	3	46	31000	180	35	300	300	0.92594
BUTYLBENZYL PHTHALATE	0/37	---	0.68-3.8	---	0	16000	930	810	12000	36000	930	0.23889
CHRYSENE	1/37	2.4	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	0	88	---	8	62	500	26	4.73
DIBENZO(A,H)ANTHRACENE	0/37	---	0.68-3.8	---	0	0.09	---	0.08	6100	0.5	0.5	18.4
DIBENZOFURAN	1/37	0.19	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	0	---	---	---	1200	---	---	---
DIETHYL PHTHALATE	13/37	0.05-2.2	0.68-3.8	A-0-0 (90) (9/8/90)	0	63000	2000	23	0.062	150000	450	24.8
DIMETHYL PHTHALATE	2/37	0.05-0.15	0.68-3.8	A-0-0 (90) (9/8/90)	0	---	---	---	290	---	---	734
DI-N-BUTYL PHTHALATE	24/37	0.04-0.58	0.74-3.8	G-3 (90) (10/13/90)	8	7800	2300	270	49000	18000	2300	0.14979
DI-N-OCTYL PHTHALATE	6/37	0.049-1.3	0.69-3.8	10/15-05-90 #1 (90) (9/14/90)	0	1600	10000	10000	100000	3700	2000	709
FLUORANTHENE	2/37	0.03-3.9	0.69-1.2	10/15-14-90 #1 (90) (9/22/90)	0	3100	---	210	2300	6300	880	122
FLUORENE	1/37	0.39	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	0	3100	---	28	2600	6300	170	122
HEXACHLOROBENZENE	0/37	---	0.68-3.8	---	0	0.4	1	0.1	3.0	2.7	2.2	0.19678
HEXACHLOROBUTADIENE	0/37	---	0.68-3.8	---	0	8	8	0.1	6.0	36	16	0.03976
HEXACHLOROCYCLOPENTADIENE	0/37	---	0.68-3.8	---	0	550	10	20	420	1300	400	0.75537
HEXACHLOROETHANE	0/37	---	0.68-3.8	---	0	46	55	0.02	35	183	2.8	0.59634
INDENO(1,2,3-CD)PYRENE	0/37	---	0.68-3.8	---	0	0.9	---	0.7	0.62	5	3	109
ISOPHORONE	0/37	---	0.68-3.8	---	0	670	4600	0.03	510	4500	5.3	139
NAPHTHALENE	0/37	---	0.68-3.8	---	0	3100	---	4	0.069	3200	0.7	0.09939
NITROBENZENE	0/37	---	0.68-3.8	---	0	39	92	0.007	0.0095	91	0.028	1.31
N-NITROSODIMETHYLAMINE	2/37	0.079-0.13	0.68-1.2	10/15-14-90 #1 (90) (9/22/90)	2	---	---	---	9.0	---	---	0.0000321
N-NITROSO-DI-N-PROPYLAMINE	0/37	---	0.66-3.8	---	0	0.09	---	0.000002	56	0.61	0.0006	0.54368
N-NITROSODIPHENYLAMINE	0/37	---	0.68-3.8	---	0	130	---	0.06	20	810	9.7	0.54514
PENTACHLOROPHENOL	0/37	---	3.4-19	---	0	3	---	0.001	3.0	20	0.028	0.11927
PHENANTHRENE	7/37	0.02-5.5	0.74-1.2	10/15-14-90 #1 (90) (9/22/90)	0	---	---	---	---	---	---	45.7
PHENOL	0/37	---	0.68-3.8	---	0	47000	---	5	37000	89000	110	120
PYRENE	2/37	0.04-5.9	0.69-1.2	10/15-14-90 #1 (90) (9/22/90)	0	2300	---	210	2300	5500	570	78.5
Energetics (mg/kg)												
1,3,5-TRINITROBENZENE	1/136	0.08	0.25	0/15-07-90 #1 (90)-AVG (10/13/9	0	---	---	---	16	---	---	---
1,3-DINITROBENZENE	2/136	0.104-0.195	0.25	B-4-0 (90) (9/10/90)	0	---	---	---	120	---	---	0.6547
2,4,6-TRINITROTOLUENE	8/136	0.07-295	0.25	10/15-14-90 #1 (90) (9/22/90)	1	---	---	---	1800	---	---	---
2,4-DINITROTOLUENE	1/136	0.099	0.25-0.99	C-0-3 (90) (9/13/90)	1	0.9	---	0.00004	6.1	---	---	1.28
HMX	24/136	0.155-19600	2.2	G-3 (90) (10/13/90)	1	---	---	---	3100	---	---	---
RDX	7/136	0.140-3350	1	10/15-14-90 #1 (90) (9/22/90)	1	---	---	---	4.4	---	---	---
TETRYL	0/136	---	0.25-0.65	---	0	---	---	---	610	---	---	---

TABLE 8-2

SUMMARY OF HISTORICAL DATA - SURFACE SOIL (0 TO 2 FEET BGS)
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
Inorganics (mg/kg)												
ALUMINUM	41/41	3470-17500	---	10/15-14-90 #1 (90) (9/22/90)	0	---	---	---	76000	---	---	---
ANTIMONY	12/41	1.56-4.44	1.5	10/15-11-90 #2 (90) (10/12/90)	12	31	---	0.3	31	138	5.4	0.1423
ARSENIC	41/41	2.3-82.2	---	F-2 (90) (9/25/90)	41	0.4	750	1	0.39	3.9	3.9	5.7
BARIUM	41/41	9.7-210	---	F-1 (90) (9/25/90)	41	5500	690000	82	5400	24000	1600	1.04
BERYLLIUM	40/41	0.2-1.8	0.2	10/15-13-90 #2 (90) (10/13/90)	40	0.1	1300	3	150	1.9	1.9	1.06
CADMIUM	31/41	0.799-7.1	0.4	F-2 (90) (9/25/90)	31	78	1800	0.4	37	12	7.5	0.00222
CHROMIUM (TOTAL)	41/41	8.2-99.9	---	F-2 (90) (9/25/90)	41	390	270	2	210	470	38	0.4
COBALT	39/41	3.6-70.2	3	10/15-13-90 #2 (90) (10/13/90)	39	---	---	---	4700	---	---	0.14033
COPPER	36/41	1.5-21.4	0.599-0.6	D-0-0 (90) (9/5/90)	38	---	---	---	2900	13000	580	0.3132
IRON	41/41	9760-132000	---	F-2 (90) (9/25/90)	9	---	---	---	23000	---	---	---
LEAD	41/41	13-158	---	F-2 (90) (9/25/90)	41	400	---	---	400	350	81	0.05373
MAGNESIUM	41/41	386-5850	---	E-4-0 (90) (9/6/90)	0	---	---	---	---	---	---	---
NICKEL	41/41	4.8-27.2	---	F-2 (90) (9/25/90)	40	1600	13000	7	1600	6900	130	13.6
TIN	1/41	8.49	7.59-7.62	B-1-2 (90) (9/10/90)	1	---	---	---	45000	---	---	7.62
ZINC	41/41	15-146	---	F-2 (90) (9/25/90)	41	23000	---	620	23000	104000	10000	6.62

--- Not applicable/Not available.

BGS Below ground surface
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
OSWER Office of Solid Waste and Emergency Response
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SSL Soil Screening Level
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, May 1996.
2 Because of karst geologic conditions present at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
3 U.S. EPA, Region 9, May 1998.
4 IDEM, October 1997.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 trans-1,2-Dichloroethene.
7 1,3-Dichloropropene.
8 o-Xylene.
9 m-Xylene.
10 Hexavalent chromium.
11 OSWER soil screening level for residential land use (U.S. EPA, July 1994).

TABLE 8-3

SUMMARY OF HISTORICAL DATA - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
Volatile Organics (mg/kg)												
1,1,1-TRICHLOROETHANE	1/10	0.011	0.0057-0.025	10/15-01-90 #2V (90) (9/14/90)	0	---	1200	0.1	770	1000	1.93	29.8
1,1,2,2-TETRACHLOROETHANE	0/10	---	0.0056-0.025	---	0	3	0.6	0.0002	0.38	5.37	0.00696	0.12722
1,1,2-TRICHLOROETHANE	1/10	0.001	0.0056-0.025	10/15-05-90 #2V (90) (9/14/90)	1	11	1	0.0009	0.84	10.2	0.0304	28.6
1,1-DICHLOROETHANE	0/10	---	0.0056-0.025	---	0	7800	1300	1	590	1000	11.8	20.1
1,1-DICHLOROETHENE	0/10	---	0.0056-0.025	---	0	1	0.07	0.003	0.054	0.726	0.0579	8.28
1,2-DICHLOROETHANE	0/10	---	0.0056-0.025	---	0	7	0.4	0.001	0.35	3.99	0.0238	21.2
1,2-DICHLOROPROPANE	0/10	---	0.0056-0.025	---	0	9	15	0.001	0.35	4.94	0.0298	32.7
2-BUTANONE	1/10	0.02	0.11-0.5	10/15-09-90 #1 (90) (10/14/90)	0	---	---	---	7300	1000	11.4	89.6
2-HEXANONE	0/10	---	0.056-0.25	---	0	---	---	---	---	---	---	12.6
4-METHYL-2-PENTANONE	0/10	---	0.056-0.25	---	0	---	---	---	790	---	---	443
ACETONE	8/10	0.007-0.42	0.11-0.12	10/15-08-90 #1 (90) (10/14/90)	0	7800	100000	0.8	1600	1000	3.09	2.5
BENZENE	0/10	---	0.0056-0.025	---	0	22	0.8	0.002	0.67	8.98	0.0338	0.25462
BROMODICHLOROMETHANE	0/10	---	0.0056-0.025	---	0	10	3000	0.03	1.0	11.3	0.632	0.53978
BROMOFORM	0/10	---	0.0056-0.025	---	0	81	53	0.04	62	290	0.752	15.9
BROMOMETHANE	0/10	---	0.011-0.05	---	0	110	10	0.01	3.9	34.8	0.122	0.23516
CARBON DISULFIDE	0/10	---	0.0056-0.025	---	0	7800	720	2	360	725	19.1	0.09412
CARBON TETRACHLORIDE	0/10	---	0.0056-0.025	---	0	5	0.3	0.003	0.24	3.53	0.0659	2.98
CHLOROBENZENE	0/10	---	0.0056-0.025	---	0	1600	130	0.07	1.0	474	1.3	13.1
CHLOROETHANE	0/10	---	0.011-0.05	---	0	---	---	---	3.0	---	---	---
CHLOROFORM	0/10	---	0.0056-0.025	---	0	100	0.3	0.03	0.24	3.33	0.586	1.19
CHLOROMETHANE	0/10	---	0.011-0.05	---	0	---	---	---	1.2	---	---	10.4
CIS-1,2-DICHLOROETHENE	0/10	---	0.0056-0.025	---	0	780	1200	0.02	43	118	0.4	0.78373[6]
CIS-1,3-DICHLOROPROPENE	0/10	---	0.0056-0.025	---	0	4	0.1	0.0002	---	1.36[7]	0.00909[7]	0.39786
DIBROMOCHLOROMETHANE	0/10	---	0.0056-0.025	---	0	8	1300	0.02	1.1	---	---	2.05
ETHYLBENZENE	0/10	---	0.0056-0.025	---	0	7800	400	0.7	230	395	13.4	5.16
METHYLENE CHLORIDE	10/10	0.0077-0.21	---	10/15-05-90 #2V (90) (9/14/90)	10	85	13	0.001	8.9	124	0.0231	4.05
STYRENE	0/10	---	0.0056-0.025	---	0	16000	1500	0.2	1.0	1000	3.53	4.69
TETRACHLOROETHENE	0/10	---	0.0056-0.025	---	0	12	11	0.003	5.7	50.2	0.0577	9.92
TOLUENE	0/10	---	0.0056-0.025	---	0	16000	650	0.6	520	654	11.7	5.45
TRANS-1,2-DICHLOROETHENE	0/10	---	0.0056-0.025	---	0	1600	3100	0.03	63	192	0.679	0.78373
TRANS-1,3-DICHLOROPROPENE	0/10	---	0.0056-0.025	---	0	4	0.1	0.0002	---	1.36[7]	0.00909[7]	0.39786
TRICHLOROETHENE	0/10	---	0.0056-0.025	---	0	58	5	0.003	2.8	48.3	0.057	12.4
VINYL ACETATE	0/10	---	0.056-0.25	---	0	78000	1000	8	430	1000	7.85	12.7
VINYL CHLORIDE	0/10	---	0.011-0.05	---	0	0.3	0.03	0.0007	0.022	0.304	0.0135	0.64614
XYLENES, TOTAL	0/10	---	0.0056-0.025	---	0	160000	410[8]	9[8]	210	413[8]	189[8]	10
Semivolatile Organics (mg/kg)												
1,2,4-TRICHLOROBENZENE	0/11	---	0.75-0.82	---	0	780	3200	0.3	6.0	1000	5.29	11.1
1,2-DICHLOROBENZENE	0/11	---	0.75-0.82	---	0	7000	560	0.9	370	595	17.2	2.96
1,2-DIPHENYLHYDRAZINE	0/11	---	0.75-0.82	---	0	---	---	---	0.61	---	---	---
1,3-DICHLOROBENZENE	0/11	---	0.75-0.82	---	0	---	---	---	13	878	12	37.7
1,4-DICHLOROBENZENE	0/11	---	0.75-0.82	---	0	27	---	0.1	3.0	41.9	2.16	0.54559
2,4,5-TRICHLOROPHENOL	0/11	---	0.75-0.82	---	0	7800	---	14	6100	1000	248	14.1
2,4,6-TRICHLOROPHENOL	0/11	---	0.75-0.82	---	0	58	200	0.008	44	387	1.49	9.94
2,4-DICHLOROPHENOL	0/11	---	0.75-0.82	---	0	230	---	0.05	1.0	547	1.08	87.5
2,4-DIMETHYLPHENOL	0/11	---	0.75-0.82	---	0	1600	---	0.4	1.0	1000	9	0.01
2,4-DINITROPHENOL	0/11	---	3.8-4.1	---	0	160	---	0.01	120	365	0.292	0.06086
2,6-DINITROTOLUENE	0/11	---	0.75-0.82	---	0	0.9	---	0.00003	61	6.26	0.00847	0.03283
2-CHLORONAPHTHALENE	0/11	---	0.75-0.82	---	0	---	---	---	4900	---	---	0.01218
2-CHLOROPHENOL	0/11	---	0.75-0.82	---	0	390	53000	0.2	6.0	382	0.752	0.24266
2-METHYL-4,6-DINITROPHENOL	0/11	---	3.8-4.1	---	0	---	---	---	---	---	---	---
2-METHYLNAPHTHALENE	0/11	---	0.75-0.82	---	0	---	---	---	---	---	---	3.24
2-METHYLPHENOL	0/11	---	0.75-0.82	---	0	3900	---	0.8	3100	1000	13.9	40.4
2-NITROANILINE	0/11	---	3.8-4.1	---	0	---	---	---	3.5	10.9	0.0568	74.1
2-NITROPHENOL	0/11	---	0.75-0.82	---	0	---	---	---	---	---	---	1.6
3,3'-DICHLOROBENZIDINE	0/11	---	1.5-1.6	---	0	1	---	0.0003	1.1	9.46	0.33	0.64636
3-NITROANILINE	0/11	---	3.8-4.1	---	0	---	---	---	---	---	---	3.16

TABLE 8-3

SUMMARY OF HISTORICAL DATA - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[5]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
4-BROMOPHENYL PHENYL ETHER	0/11	—	0.75-0.82	—	0	—	—	—	—	—	—	—
4-CHLORO-3-METHYLPHENOL	0/11	—	1.5-1.6	—	0	—	—	—	—	—	—	7.95
4-CHLOROANILINE	0/11	—	1.5-1.6	—	0	310	—	0.03	240	730	0.97	1.1
4-CHLOROPHENYL PHENYL ETHER	0/11	—	0.75-0.82	—	0	—	—	—	—	—	—	—
4-METHYLPHENOL	0/11	—	0.75-0.82	—	0	—	—	—	310	—	—	163
4-NITROANILINE	0/11	—	3.8-4.1	—	0	—	—	—	—	—	—	21.9
4-NITROPHENOL	0/11	—	3.8-4.1	—	0	—	—	—	490	—	—	5.12
ACENAPHTHENE	0/11	—	0.75-0.82	—	0	4700	—	29	3700	9500	130	682
ACENAPHTHYLENE	0/11	—	0.75-0.82	—	0	—	—	—	—	—	—	682
ANILINE	0/11	—	1.5-1.6	—	0	—	—	—	85	—	—	0.05678
ANTHRACENE	0/11	—	0.75-0.82	—	0	23000	—	590	22000	47000	51	1480
BENZIDINE	0/11	—	3.8-4.1	—	0	—	—	—	0.0021	—	—	—
BENZO(A)ANTHRACENE	0/11	—	0.75-0.82	—	0	0.9	—	0.08	0.62	5	5	5.21
BENZO(A)PYRENE	0/11	—	0.75-0.82	—	0	0.09	—	0.4	0.062	0.5	0.5	1.52
BENZO(B)FLUORANTHENE	0/11	—	0.75-0.82	—	0	0.9	—	0.2	0.62	5	5	59.8
BENZO(G,H,I)PERYLENE	0/11	—	0.75-0.82	—	0	—	—	—	—	—	—	119
BENZO(K)FLUORANTHENE	0/11	—	0.75-0.82	—	0	9	—	2	6.2	50	39	1480
BENZOIC ACID	0/11	—	3.8-4.1	—	0	310000	—	20	100000	730000	590	—
BENZYL ALCOHOL	0/11	—	1.5-1.6	—	0	—	—	—	18000	—	—	65.8
BIS(2-CHLOROETHOXY)METHANE	0/11	—	0.75-0.82	—	0	—	—	—	—	—	—	0.30209
BIS(2-CHLOROETHYL)ETHER	0/11	—	0.75-0.82	—	0	0.6	0.2	0.00002	0.21	1.6	0.0007	23.7
BIS(2-CHLOROISOPROPYL) ETHER	0/11	—	0.75-0.82	—	0	—	—	—	6.9	31	0.027	—
BIS(2-ETHYLHEXYL)PHTHALATE	10/11	0.061-1.2	0.76	10/15-12-90 #3 (90) (10/12/90)	1	46	31000	180	35	300	300	0.92594
BUTYLBENZYL PHTHALATE	2/11	0.049-0.066	0.75-0.82	10/15-10-90 #3 (90) (10/14/90)	0	16000	930	810	12000	36000	930	0.23889
CHRYSENE	0/11	—	0.75-0.82	—	0	88	—	8	62	500	26	4.73
DIBENZO(A,H)ANTHRACENE	0/11	—	0.75-0.82	—	0	0.09	—	0.08	6100	0.5	0.5	18.4
DIBENZOFURAN	0/11	—	0.75-0.82	—	0	—	—	—	1200	—	—	—
DIETHYL PHTHALATE	0/11	—	0.75-0.82	—	0	63000	2000	23	0.062	150000	450	24.8
DIMETHYL PHTHALATE	0/11	—	0.75-0.82	—	0	—	—	—	290	—	—	734
DI-N-BUTYL PHTHALATE	8/11	0.068-0.14	0.75-0.81	10/15-13-90 #3 (90) (10/13/90)	0	7800	2300	270	49000	18000	2300	0.14979
DI-N-OCTYL PHTHALATE	1/11	0.056	0.75-0.82	10/15-10-90 #4 (90) (10/14/90)	0	1600	10000	10000	100000	3700	2000	709
FLUORANTHENE	0/11	—	0.75-0.82	—	0	3100	—	210	2300	6300	880	122
FLUORENE	0/11	—	0.75-0.82	—	0	3100	—	28	2600	6300	170	122
HEXACHLOROBENZENE	0/11	—	0.75-0.82	—	0	0.4	1	0.1	3.0	2.7	2.2	0.19678
HEXACHLOROBUTADIENE	0/11	—	0.75-0.82	—	0	8	8	0.1	6.0	36	16	0.03976
HEXACHLOROCYCLOPENTADIENE	0/11	—	0.75-0.82	—	0	550	10	20	420	1300	400	0.75537
HEXACHLOROETHANE	0/11	—	0.75-0.82	—	0	48	55	0.02	35	183	2.8	0.59634
INDENO(1,2,3-CD)PYRENE	0/11	—	0.75-0.82	—	0	0.9	—	0.7	0.62	5	3	109
ISOPHORONE	0/11	—	0.75-0.82	—	0	670	4600	0.03	510	4500	5.3	139
NAPHTHALENE	0/11	—	0.75-0.82	—	0	3100	—	4	0.069	3200	0.7	0.09939
NITROBENZENE	0/11	—	0.75-0.82	—	0	39	92	0.007	0.0095	91	0.028	1.31
N-NITROSODIMETHYLAMINE	0/11	—	0.75-0.82	—	0	—	—	—	9.0	—	—	0.0000321
N-NITROSO-DI-N-PROPYLAMINE	0/11	—	0.75-0.82	—	0	0.09	—	0.000002	56	0.61	0.0006	0.54368
N-NITROSODIPHENYLAMINE	0/11	—	0.75-0.82	—	0	130	—	0.06	20	810	9.7	0.54514
PENTACHLOROPHENOL	0/11	—	3.8-4.1	—	0	3	—	0.001	3.0	20	0.028	0.11927
PHENANTHRENE	0/11	—	0.75-0.82	—	0	—	—	—	—	—	—	45.7
PHENOL	0/11	—	0.75-0.82	—	0	47000	—	5	37000	89000	110	120
PYRENE	0/11	—	0.75-0.82	—	0	2300	—	210	2300	5500	570	78.5
Energetics (mg/kg)												
1,3,5-TRINITROBENZENE	2/11	0.16-0.202	0.25	10/15-12-90 #4 (90) (10/12/90)	0	—	—	—	16	—	—	—
1,3-DINITROBENZENE	0/11	—	0.25	—	0	—	—	—	120	—	—	0.6547
2,4,6-TRINITROTOLUENE	2/11	0.955-1.4	0.25	10/15-12-90 #4 (90) (10/12/90)	0	—	—	—	1800	—	—	—
2,4-DINITROTOLUENE	0/11	—	0.25	—	0	0.9	—	0.00004	6.1	—	—	1.28
HMX	4/11	0.151-42.7	2.2	10/15-12-90 #4 (90) (10/12/90)	0	—	—	—	3100	—	—	—
RDX	1/11	0.058	1	10/15-11-90 #3 (90) (10/12/90)	0	—	—	—	4.4	—	—	—
TETRYL	0/11	—	0.65	—	0	—	—	—	610	—	—	—
Inorganics (mg/kg)												

TABLE 8-3

SUMMARY OF HISTORICAL DATA - SUBSURFACE SOIL (> 2 FEET BGS)
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	U.S. EPA Generic SSL[1]			U.S. EPA Region 9 Residential Soil PRG[3]	IDEM Tier 1 Default Cleanup Level[4]		U.S. EPA Region 5 Soil EDQL[8]
						Ingestion	Inhalation	Migration to Ground Water[2]		Surface Soil	Subsurface Soil	
ALUMINUM	11/11	8890-18700	---	10/15-10-90 #4 (90) (10/14/90)	0	---	---	---	76000	---	---	---
ANTIMONY	8/11	1.89-3.33	1.5	10/15-11-90 #3 (90) (10/12/90)	8	31	---	0.3	31	138	5.4	0.1423
ARSENIC	11/11	1.62-6.27	---	10/15-10-90 #4 (90) (10/14/90)	11	0.4	750	1	0.39	3.9	3.9	5.7
BARIUM	11/11	19.5-102	---	10/15-11-90 #3 (90) (10/12/90)	11	5500	690000	82	5400	24000	1600	1.04
BERYLLIUM	11/11	0.2-2.1	---	10/15-13-90 #3 (90) (10/13/90)	11	0.1	1300	3	150	1.9	1.9	1.06
CADMIUM	5/11	0.5-2.3	0.4	10/15-12-90 #4 (90) (10/12/90)	5	78	1800	0.4	37	12	7.5	0.00222
CHROMIUM (TOTAL)	11/11	12.2-34.2	---	10/15-08-90 #1 (90) (10/14/90)	11	390	270	2	210	470	38	0.4
COBALT	11/11	3.3-29.8	---	10/15-10-90 #4 (90) (10/14/90)	11	---	---	---	4700	---	---	0.14033
COPPER	6/11	1.2-11.4	0.599-0.6	10/15-13-90 #3 (90) (10/13/90)	6	---	---	---	2900	13000	580	0.3132
IRON	11/11	10600-42900	---	10/15-10-90 #4 (90) (10/14/90)	4	---	---	---	23000	---	---	---
LEAD	11/11	12.2-43.2	---	10/15-10-90 #4 (90) (10/14/90)	11	400	---	---	400	350	81	0.05373
MAGNESIUM	11/11	563-2540	---	10/15-08-90 #1 (90) (10/14/90)	0	---	---	---	---	---	---	---
NICKEL	11/11	4.4-16.7	---	10/15-10-90 #4 (90) (10/14/90)	9	1600	13000	7	1600	6900	130	13.6
TIN	0/11	---	7.6	---	0	---	---	---	45000	---	---	7.62
ZINC	11/11	10.7-109	---	10/15-12-90 #3 (90) (10/12/90)	11	23000	---	620	23000	104000	10000	6.62

--- Not applicable/Not available.

BGS Below ground surface
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
OSWER Office of Solid Waste and Emergency Response
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SSL Soil Screening Level
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, May 1996.
2 Because of karst geologic conditions present at NSWC Crane, the value associated with a dilution and attenuation factor of 1 is presented.
3 U.S. EPA, Region 9, May 1998.
4 IDEM, October 1997.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 trans-1,2-Dichloroethene.
7 1,3-Dichloropropene.
8 o-Xylene.
9 m-Xylene.
10 Hexavalent chromium.
11 OSWER soil screening level for residential land use (U.S. EPA, July 1994).

TABLE 8-4

SUMMARY OF HISTORICAL DATA - GROUND WATER, UNCONSOLIDATED AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/3	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/3	---	5	---	0	---	0.055	0.9	---	13
1,1,2-TRICHLOROETHANE	0/3	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/3	---	5	---	0	---	810	990	---	47
1,1-DICHLOROETHENE	0/3	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/3	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/3	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/3	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/3	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/3	---	50	---	0	---	160	---	---	3680
ACETONE	3/3	2.1-8.1	---	10C55P2 (91b) (06/01/91)	0	---	610	770	---	78000
BENZENE	1/3	10	5	10C55P2 (91a) (03/16/91)	1	5	0.41	5	---	114
BROMODICHLOROMETHANE	0/3	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/3	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/3	---	10	---	0	---	8.7	11	---	---
CARBON DISULFIDE	0/3	---	5	---	0	---	1000	1300	---	84.1
CARBON TETRACHLORIDE	0/3	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/3	---	5	---	0	100	110	100	20[7]	10
CHLOROETHANE	0/3	---	10	---	0	---	4.6	---	---	230000
CHLOROFORM	0/3	---	5	---	0	80[6]	0.16	100	---	79
CHLOROMETHANE	0/3	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/3	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/3	---	5	---	0	---	0.081(8)	---	---	7.9
DIBROMOCHLOROMETHANE	0/3	---	5	---	0	80[6]	0.13	---	---	6400
ETHYLBENZENE	0/3	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	3/3	2.6-7	---	10C55P2 (92a) (01/09/92)	1	5	4.3	5	---	430
STYRENE	0/3	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/3	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	0/3	---	5	---	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/3	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/3	---	5	---	0	---	0.081(8)	---	---	7.9
TRICHLOROETHENE	0/3	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/3	---	50	---	0	---	410	550	---	248.03
VINYL CHLORIDE	0/3	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	0/3	---	5	---	0	10000	1400(9)	10000	---	117

TABLE 8-4

SUMMARY OF HISTORICAL DATA - GROUND WATER, UNCONSOLIDATED AQUIFER
SWMU 10 - ROCKEYE
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/3	---	10	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/3	---	10	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/3	---	10	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/3	---	10	---	0	600	5.5	22	---	87
1,4-DICHLOROBENZENE	0/3	---	10	---	0	75	0.50	75	---	43
2,4,5-TRICHLOROPHENOL	0/3	---	10	---	0	---	3600	3600	1[7]	---
2,4,6-TRICHLOROPHENOL	0/3	---	10	---	0	---	6.1	77	2[7]	2
2,4-DICHLOROPHENOL	0/3	---	10	---	0	---	110	110	0.3[7]	18
2,4-DIMETHYLPHENOL	0/3	---	10	---	0	---	730	730	400[7]	100.17
2,4-DINITROPHENOL	0/3	---	50	---	0	---	73	73	---	4.07
2-CHLORONAPHTHALENE	0/3	---	10	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/3	---	10	---	0	---	30	38	0.1[7]	8.8
2-METHYL-4,6-DINITROPHENOL	0/3	---	50	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/3	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/3	---	10	---	0	---	1800	1800	---	---
2-NITROANILINE	0/3	---	50	---	0	---	2.1	---	---	---
2-NITROPHENOL	0/3	---	10	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/3	---	20	---	0	---	0.15	1.9	---	99.75
3-NITROANILINE	0/3	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/3	---	10	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/3	---	20	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/3	---	20	---	0	---	150	150	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/3	---	10	---	0	---	---	---	---	---
4-METHYLPHENOL	0/3	---	10	---	0	---	180	---	---	---
4-NITROANILINE	0/3	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/3	---	50	---	0	---	290	---	20[7]	35
ACENAPHTHENE	0/3	---	10	---	0	---	370	460	---	9.9
ACENAPHTHYLENE	0/3	---	10	---	0	---	---	---	---	4840
ANILINE	0/3	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/3	---	10	---	0	---	1800	43	---	0.029
BENZIDINE	0/3	---	50	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/3	---	10	---	0	---	0.092	1.2	---	0.839
BENZO(A)PYRENE	0/3	---	10	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/3	---	10	---	0	---	0.092	1.2	---	9.07
BENZO(G,H,I)PERYLENE	0/3	---	10	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/3	---	10	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/3	---	50	---	0	---	150000	150000	---	---

TABLE 8-4

SUMMARY OF HISTORICAL DATA - GROUND WATER, UNCONSOLIDATED AQUIFER
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
BENZYL ALCOHOL	0/3	---	20	---	0	---	11000	---	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/3	---	10	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/3	---	10	---	0	---	0.0098	0.15	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/3	---	10	---	0	---	0.96	4.2	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	2/3	2.5-4	10	10C55P2 (91a) (03/16/91)	2	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/3	---	10	---	0	---	7300	2700	---	49
CHRYSENE	0/3	---	10	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/3	---	10	---	0	---	3600	3600	---	0.0016
DIBENZOFURAN	0/3	---	10	---	0	---	730	20	---	20
DIETHYL PHTHALATE	0/3	---	10	---	0	---	0.0092	0.12	---	3
DIMETHYL PHTHALATE	0/3	---	10	---	0	---	24	---	---	73
DI-N-BUTYL PHTHALATE	0/3	---	10	---	0	---	29000	29000	---	3
DI-N-OCTYL PHTHALATE	0/3	---	10	---	0	---	360000	---	---	30
FLUORANTHENE	0/3	---	10	---	0	---	1500	210	---	8.1
FLUORENE	0/3	---	10	---	0	---	240	310	---	3.9
HEXACHLOROBENZENE	0/3	---	10	---	0	1	0.042	1	---	0.00000547
HEXACHLOROBUTADIENE	0/3	---	10	---	0	---	0.86	7.3	---	0.134
HEXACHLOROCYCLOPENTADIENE	0/3	---	10	---	0	50	260	50	1[7]	77.04
HEXACHLOROETHANE	0/3	---	10	---	0	---	4.8	36	---	30.5
INDENO(1,2,3-CD)PYRENE	0/3	---	10	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/3	---	10	---	0	---	71	900	---	900
NAPHTHALENE	0/3	---	10	---	0	---	0.0096	0.12	---	44
NITROBENZENE	0/3	---	10	---	0	---	0.0013	---	30[7]	740
N-NITROSODIMETHYLAMINE	0/3	---	10	---	0	---	14	170	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/3	---	10	---	0	---	6.2	8.3	---	---
N-NITROSODIPHENYLAMINE	0/3	---	10	---	0	---	3.4	4.3	---	13
PENTACHLOROPHENOL	0/3	---	50	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/3	---	10	---	0	---	---	---	---	2.1
PHENOL	0/3	---	10	---	0	---	22000	22000	3000[7]	100
PYRENE	0/3	---	10	---	0	---	180	140	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	0/4	---	20	---	0	---	1100		---	---
1,3-DINITROBENZENE	0/4	---	20	---	0	---	3.7		---	2.36
2,4,6-TRINITROTOLUENE	4/4	14-44	---	10C55P2 (91b) (06/01/91)	4	---	2.2		---	---
2,4-DINITROTOLUENE	1/4	2	10-20	10C55P2 (91b) (06/01/91)	1	---	73		---	230
2,6-DINITROTOLUENE	0/4	---	10-20	---	0	---	37		---	42
HMX	4/4	220-412	---	10C55P2 (91b) (06/01/91)	0	---	1800		---	---
RDX	4/4	88-116	---	10C55P2 (92a) (01/09/92)	4	---	0.61		---	---
TETRYL	0/4	---	50	---	0	---	360		---	---

TABLE 8-4

SUMMARY OF HISTORICAL DATA - GROUND WATER, UNCONSOLIDATED AQUIFER
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	0/3	---	2.2-2.3	---	0	---	360		---	686.33
2,4,5-TP (SILVEX)	1/3	1	2-2.2	10C55P2 (91a) (03/16/91)	0	50	290	---	---	326.64
2,4-D	1/3	0.33	13-14	10C55P2 (91a) (03/16/91)	0	70	360	---	---	---
4,4'-DDD	0/2	---	0.11	---	0	---	0.28	3.6	---	0.0011
4,4'-DDE	0/2	---	0.04	---	0	---	0.2	2.5	---	4.96E-09
4,4'-DDT	0/2	---	0.12	---	0	---	0.2	2.5	0.001	0.000952
ALDRIN	0/2	---	0.04	---	0	---	0.004	0.05	---	0.0185
ALPHA-BHC	0/2	---	0.03	---	0	---	0.011	0.14	---	12.38
ALPHA-CHLORDANE	1/2	0.02	0.05	10C55P2 (91b) (06/01/91)	1	2[10]	0.19(10)	0.0043(10)	0.0043[10]	0.00029[10]
AROCLOR-1016	0/2	---	0.6-0.7	---	0	0.5[11]	0.96	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1221	0/2	---	0.6-0.7	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1232	0/2	---	0.6-0.7	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1242	0/2	---	0.6-0.7	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1248	0/2	---	0.6-0.7	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1254	0/2	---	1.3	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1260	0/2	---	1.3	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
BETA-BHC	0/2	---	0.06	---	0	---	0.037	0.47	---	0.495
DELTA-BHC	0/2	---	0.09	---	0	---	---	---	---	666.67
DIELDRIN	0/2	---	0.02	---	0	---	0.0042	0.053	0.056	0.000026
DINOSEB	1/3	0.19	0.78-0.8	10C55P2 (91a) (03/16/91)	0	7	37		---	0.39
DISULFOTON	0/2	---	0.69	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/2	---	0.14	---	0	---	220	220	0.056	0.003
ENDOSULFAN II.	0/2	---	0.04	---	0	---	220(12)	220(12)	0.056	0.003
ENDOSULFAN SULFATE	0/2	---	0.65-0.66	---	0	---	---	---	---	2.22
ENDRIN	0/2	---	0.06	---	0	2	11	2	0.036	0.002
ENDRIN ALDEHYDE	1/2	0.08	0.23	10C55P2 (91b) (06/01/91)	0	---	---	---	---	0.15
ETHYL PARATHION	0/2	---	0.59	---	0	---	---	---	---	---
FAMPHUR	0/2	---	1.2	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/2	---	0.04	---	0	0.2	0.052	0.2	---	0.01
GAMMA-CHLORDANE	0/2	---	0.05	---	0	2[10]	0.19(10)	---	0.0043[10]	0.00029[10]
HEPTACHLOR	0/2	---	0.03	---	0	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/2	---	0.82-0.83	---	0	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/2	---	5.9	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/2	---	1.7-1.8	---	0	40	180	40	0.03	0.005
METHYL PARATHION	0/2	---	1.2	---	0	---	9.1	---	---	---
PHORATE	0/2	---	0.4	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/2	---	2.4	---	0	3	0.061	3	0.0002	0.0002

TABLE 8-4

SUMMARY OF HISTORICAL DATA - GROUND WATER, UNCONSOLIDATED AQUIFER
SWMU 10 - ROCKEYE
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Dissolved Inorganics (ug/L)										
ALUMINUM	0/4	---	10-30	---	0	50 to 200[13]	36000	---	87	---
ANTIMONY	3/4	7.8-12.1	3	10C55P2 (91b) (06/01/91)	3	6	15	6	---	31
ARSENIC	0/4	---	2	---	0	50	0.045	50	150	53
BARIUM	4/4	26-46	---	10C55P2 (92b) (05/14/92)	0	2000	2600	2000	---	5000
BERYLLIUM	0/4	---	1	---	0	4	73	4	---	7.6
CADMIUM	0/4	---	0.2-6	---	0	5	18	5	2.2	0.66
CALCIUM	4/4	15200-22600	---	10C55P2 (92a) (01/09/92)	0	---	---	---	---	---
CHROMIUM (TOTAL)	0/4	---	5	---	0	100	180(14)	100	11[14]	42
COBALT	2/4	13-22	6-10	10C55P2 (92b) (05/14/92)	2	---	2200	---	---	5
COPPER	3/4	5-18	5	10C55P2 (91a) (03/16/91)	3	1300[15]	1400	1300	9	5
CYANIDE	3/4	6-7	5	10C55P2 (92a) (01/09/92)	0	200	730(16)	---	5.2[16]	5.2
IRON	2/4	18-49	10-40	10C55P2 (91b) (06/01/91)	0	300[13]	11000	---	1000	---
LEAD	0/4	---	1	---	0	15[15]	4	15	2.5	1.3
MAGNESIUM	4/4	3730-5080	---	10C55P2 (91b) (06/01/91)	0	---	---	---	---	---
MANGANESE	4/4	8-257	---	10C55P2 (91b) (06/01/91)	2	50[13]	880	---	---	---
MERCURY	0/4	---	0.2	---	0	2	11	2	0.77	0.0013
NICKEL	2/4	7-10	5	10C55P2 (91a) (03/16/91)	0	100	730	100	52	29
POTASSIUM	1/4	707	200-1000	10C55P2 (92b) (05/14/92)	0	---	---	---	---	---
SELENIUM	0/4	---	2	---	0	50	180	50	5	5
SILVER	0/4	---	1	---	0	100[13]	180	180	---	1
SODIUM	4/4	4370-10500	---	10C55P2 (92b) (05/14/92)	0	---	---	---	---	---
THALLIUM	0/4	---	2	---	0	2	2.9(17)	2	---	0.56
TIN	0/4	---	35-50	---	0	---	22000	---	---	73
VANADIUM	0/4	---	5-10	---	0	---	260	---	---	19
ZINC	0/4	---	5-10	---	0	5000[13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L)										
NITRATE, AS NITROGEN	1/1	832000	---	10C55P2 (92b) (05/14/92)	1	10000	10000	---	---	---
NITRITE, AS NITROGEN	1/1	7000	---	10C55P2 (92b) (05/14/92)	0	1000	1000	---	---	---
SULFIDE	0/4	---	20000	---	0	---	---	---	2	---

TABLE 8-4

SUMMARY OF HISTORICAL DATA - GROUND WATER, UNCONSOLIDATED AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable by not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.

TABLE 8-5

SUMMARY OF HISTORICAL DATA - GROUND WATER, UPPER/MIDDLE PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	1/132	1.1	5	10-14B (91a) (03/16/91)	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/132	---	5	---	0	---	0.055	0.9	---	13
1,1,2-TRICHLOROETHANE	0/132	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/132	---	5	---	0	---	810	990	---	47
1,1-DICHLOROETHENE	0/132	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/132	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/132	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	2/132	6-8	100	10C46P2 (92a) (01/09/92)	0	---	1900	2500	---	7100
2-HEXANONE	0/132	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/132	---	50	---	0	---	160	---	---	3680
ACETONE	99/132	1-65	100	10-05 (92a) (01/09/92)	0	---	610	770	---	78000
BENZENE	40/132	0.6-23	5	10C36P3 (91a) (03/16/91)	40	5	0.41	5	---	114
BROMODICHLOROMETHANE	0/132	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/132	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/132	---	10	---	0	---	8.7	11	---	---
CARBON DISULFIDE	0/132	---	5	---	0	---	1000	1300	---	84.1
CARBON TETRACHLORIDE	0/132	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/132	---	5	---	0	100	110	100	20[7]	10
CHLOROETHANE	0/132	---	10	---	0	---	4.6	---	---	230000
CHLOROFORM	3/132	0.2-0.5	5	10C30P2 (91b) (06/01/91)	3	80[6]	0.16	100	---	79
CHLOROMETHANE	0/132	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/132	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/132	---	5	---	0	---	0.081(8)	---	---	7.9
DIBROMOCHLOROMETHANE	0/132	---	5	---	0	80[6]	0.13	---	---	6400
ETHYLBENZENE	1/132	0.6	5	10C39P2 (91b) (06/01/91)	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	131/132	0.9-72	5	10C41P3 (91a) (03/16/91)	79	5	4.3	5	---	430
STYRENE	1/132	3	5	10C45P2 (92a) (01/09/92)	0	100	1600	100	---	56
TETRACHLOROETHENE	0/132	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	2/132	1-7.2	5	10C39P2 (91b) (06/01/91)	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/132	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/132	---	5	---	0	---	0.081(8)	---	---	7.9
TRICHLOROETHENE	0/132	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	1/132	1	50	10-08 (92a) (01/09/92)	0	---	410	550	---	248.03
VINYL CHLORIDE	0/132	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	3/132	2-5.4	5	10C39P2 (91b) (06/01/91)	0	10000	1400(9)	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/131	---	10-31	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/131	---	10-31	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/131	---	10-31	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/131	---	10-31	---	0	600	5.5	22	---	87

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SUMMARY OF HISTORICAL DATA - GROUND WATER, UPPER/MIDDLE PENNSYLVANIAN AQUIFER
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
1,4-DICHLOROBENZENE	0/131	---	10-31	---	0	75	0.50	75	---	43
2,4,5-TRICHLOROPHENOL	0/131	---	10-31	---	0	---	3600	3600	1[7]	---
2,4,6-TRICHLOROPHENOL	0/131	---	10-31	---	0	---	6.1	77	2[7]	2
2,4-DICHLOROPHENOL	0/131	---	10-31	---	0	---	110	110	0.3[7]	18
2,4-DIMETHYLPHENOL	0/131	---	10-31	---	0	---	730	730	400[7]	100.17
2,4-DINITROPHENOL	0/131	---	50-160	---	0	---	73	73	---	4.07
2-CHLORONAPHTHALENE	0/131	---	10-31	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/131	---	10-31	---	0	---	30	38	0.1[7]	8.8
2-METHYL-4,6-DINITROPHENOL	0/131	---	50-160	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/131	---	10-31	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/131	---	10-31	---	0	---	1800	1800	---	---
2-NITROANILINE	0/131	---	50-160	---	0	---	2.1	---	---	---
2-NITROPHENOL	0/131	---	10-31	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/131	---	20-62	---	0	---	0.15	1.9	---	99.75
3-NITROANILINE	0/131	---	50-160	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/131	---	10-31	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/131	---	10-62	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/131	---	20-62	---	0	---	150	150	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/131	---	10-31	---	0	---	---	---	---	---
4-METHYLPHENOL	0/131	---	10-31	---	0	---	180	---	---	---
4-NITROANILINE	0/131	---	50-160	---	0	---	---	---	---	---
4-NITROPHENOL	0/131	---	50-160	---	0	---	290	---	20[7]	35
ACENAPHTHENE	0/131	---	10-31	---	0	---	370	460	---	9.9
ACENAPHTHYLENE	0/131	---	10-31	---	0	---	---	---	---	4840
ANILINE	0/131	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/131	---	10-31	---	0	---	1800	43	---	0.029
BENZIDINE	0/131	---	50-160	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/131	---	10-31	---	0	---	0.092	1.2	---	0.839
BENZO(A)PYRENE	0/131	---	10-31	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/131	---	10-31	---	0	---	0.092	1.2	---	9.07
BENZO(G,H,I)PERYLENE	0/131	---	10-31	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/131	---	10-31	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/131	---	50-160	---	0	---	150000	150000	---	---
BENZYL ALCOHOL	0/131	---	20-62	---	0	---	11000	---	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/131	---	10-31	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/131	---	10-31	---	0	---	0.0098	0.15	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/131	---	10-31	---	0	---	0.96	4.2	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	88/131	0.7-13	10-31	10C36P2 (91a) (03/16/91)	42	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	2/131	3.9-5.6	10-31	10C31P3 (92a) (01/09/92)	0	---	7300	2700	---	49
CHRYSENE	0/131	---	10-31	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/131	---	10-31	---	0	---	0.0092	0.12	---	0.0016

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SUMMARY OF HISTORICAL DATA - GROUND WATER, UPPER/MIDDLE PENNSYLVANIAN AQUIFER
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
DIBENZOFURAN	0/131	---	10-31	---	0	---	24	---	---	20
DIETHYL PHTHALATE	31/131	1.4-58	10-31	10C34P3 (92a) (01/09/92)	**20**	---	29000	29000	---	3
DIMETHYL PHTHALATE	2/131	4.2-4.6	10-31	10C34P3 (92a) (01/09/92)	0	---	360000	---	---	73
DI-N-BUTYL PHTHALATE	19/131	0.89-17	1-31	10C40P4 (92a) (01/09/92)	**6**	---	3600	3600	---	3
DI-N-OCTYL PHTHALATE	6/131	1.3-3.8	10-31	10C46P3 (91a) (03/16/91)	0	---	730	20	---	30
FLUORANTHENE	0/131	---	10-31	---	0	---	1500	210	---	8.1
FLUORENE	0/131	---	10-31	---	0	---	240	310	---	3.9
HEXACHLOROBENZENE	0/131	---	10-31	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/131	---	10-31	---	0	---	0.86	7.3	---	0.134
HEXACHLOROCYCLOPENTADIENE	0/131	---	10-31	---	0	50	260	50	1[7]	77.04
HEXACHLOROETHANE	0/131	---	10-31	---	0	---	4.8	36	---	30.5
INDENO(1,2,3-CD)PYRENE	0/131	---	10-31	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/131	---	10-31	---	0	---	71	900	---	900
NAPHTHALENE	0/131	---	10-31	---	0	---	0.0096	0.12	---	44
NITROBENZENE	0/131	---	10-31	---	0	---	0.0013	---	30[7]	740
N-NITROSODIMETHYLAMINE	0/131	---	10-31	---	0	---	14	170	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/131	---	10-31	---	0	---	6.2	8.3	---	---
N-NITROSODIPHENYLAMINE	0/131	---	10-31	---	0	---	3.4	4.3	---	13
PENTACHLOROPHENOL	0/131	---	50-160	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/131	---	10-31	---	0	---	---	---	---	2.1
PHENOL	0/131	---	10-31	---	0	---	22000	22000	3000[7]	100
PYRENE	0/131	---	10-31	---	0	---	180	140	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	1/191	1.2	0-20	10-08 (89) (04/26/89)	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/191	---	1-20	---	0	---	3.7	---	---	2.36
2,4,6-TRINITROTOLUENE	13/245	3.5-160	2-20	10-07 (83c) (09/06/83)	**13**	---	2.2	---	---	---
2,4-DINITROTOLUENE	1/202	3.9	2-31	10-08 (91b) (06/01/91)	**1**	---	73	---	---	230
2,6-DINITROTOLUENE	1/202	4.5	1-31	10-08 (91b) (06/01/91)	**1**	---	37	---	---	42
2-AMINO-4,6-DINITROTOLUENE	2/26	13.5-18.1	2	10-08 (89) (04/26/89)	0	---	---	---	---	---
4-AMINO-2,6-DINITROTOLUENE	2/26	13.3-22.1	2	10-08 (89) (04/26/89)	0	---	---	---	---	---
HMX	17/243	11-215	10-50	10-08 (91b) (06/01/91)	0	---	1800	---	---	---
RDX	23/244	10-370	5-20.8	10-07 (86) (02/09/86)	**23**	---	0.61	---	---	---
TETRYL	0/192	---	10-50	---	0	---	360	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	22/126	0-1.9	1.9-3.1	10C26P3 (91a) (03/16/91)	0	---	360	---	---	686.33
2,4,5-TP (SILVEX)	42/126	0-4.7	1.6-3.1	10C47P2 (91b) (06/01/91)	0	50	290	---	---	326.64
2,4-D	12/126	0-1.2	11-19	10-09 (91a) (03/16/91)	0	70	360	---	---	---
4,4'-DDD	3/112	0-0.06	0.1-0.18	10-22 (91a) (03/16/91)	**2**	---	0.28	3.6	---	0.0011
4,4'-DDE	0/112	---	0.04-0.06	---	0	---	0.2	2.5	---	4.96E-09
4,4'-DDT	3/112	0.02-0.09	0.11-0.16	10C46P2 (91b) (06/01/91)	**3**	---	0.2	2.5	0.001	0.001
ALDRIN	0/112	---	0.01-0.06	---	0	---	0.004	0.05	---	0.0185
ALPHA-BHC	1/112	0.01	0.03-0.04	10C37P3 (92a) (01/09/92)	0	---	0.011	0.14	---	12.38

TABLE 8-5

SUMMARY OF HISTORICAL DATA - GROUND WATER, UPPER/MIDDLE PENNSYLVANIAN AQUIFER
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
ALPHA-CHLORDANE	4/112	0.01-0.03	0.05-0.5	10C45P2 (92a) (01/09/92)	**4**	2[10]	0.19(10)	0.0043(10)	0.0043[10]	0.00029[10]
AROCLOR-1016	0/112	---	0.5-0.9	---	0	0.5[11]	0.96	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1221	0/112	---	0.5-0.9	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1232	0/112	---	0.5-0.9	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1242	0/112	---	0.5-0.9	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1248	0/112	---	0.5-0.9	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1254	30/112	0.08-1.3	1-1.8	10C29P2 (91a) (03/16/91)	**30**	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1260	0/112	---	1-1.8	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
BETA-BHC	0/112	---	0.06-0.08	---	0	---	0.037	0.47	---	0.495
DELTA-BHC	0/112	---	0.09-0.87	---	0	---	---	---	---	666.67
DIELDRIN	0/112	---	0.02-0.03	---	0	---	0.0042	0.053	0.056	0.000026
DINOSEB	17/126	0-0.29	0.67-1.1	10C27P2 (91a) (03/16/91)	0	7	37	---	---	0.39
DISULFOTON	0/112	---	0.38-0.9	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/112	---	0.13-0.19	---	0	---	220	220	0.056	0.003
ENDOSULFAN II	1/112	0.04	0.04-0.42	10-03 (92a) (01/09/92)	**1**	---	220(12)	220(12)	0.056	0.003
ENDOSULFAN SULFATE	1/112	0.09	0.62-0.9	10C34P2 (92a) (01/09/92)	0	---	---	---	---	2.22
ENDRIN	0/112	---	0.06-0.58	---	0	2	11	2	0.036	0.002
ENDRIN ALDEHYDE	9/112	0-0.1	0.01-0.32	10-11 (91b) (06/01/91)	0	---	---	---	---	0.15
ETHYL PARATHION	1/112	0.1	0.57-58000	10C34P2 (91a) (03/16/91)	0	---	---	---	---	---
FAMPHUR	2/112	0.08-0.28	1.1-1.6	10C28P2 (91a) (03/16/91)	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	1/112	0.01	0.04-0.4	10C34P3 (92a) (01/09/92)	0	0.2	0.052	0.2	---	0.01
GAMMA-CHLORDANE	4/112	0.01-0.07	0.05-0.07	10C36P3 (92a) (01/09/92)	**4**	2[10]	0.19(10)	---	0.0043[10]	0.00029[10]
HEPTACHLOR	10/112	0.01-0.03	0.01-0.29	10-14B (91b) (06/01/91)	**10**	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	1/112	0.01	0.78-1.1	10-03 (91a) (03/16/91)	**1**	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/112	---	5.7-8.2	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	1/112	0.29	1.7-2.4	10C36P2 (92a) (01/09/92)	**1**	40	180	40	0.03	0.005
METHYL PARATHION	1/112	0.08	1.1-1.9	10C34P2 (91a) (03/16/91)	0	---	9.1	---	---	---
PHORATE	0/112	---	0.38-0.74	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/112	---	1-3.3	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	88/177	10-109000	10-31	10C39P2 (92a) (01/09/92)	**72**	50 to 200[13]	36000	---	87	---
ANTIMONY	116/177	3-24.2	3	10C35P3 (91b) (06/01/91)	**86**	6	15	6	---	31
ARSENIC	27/177	2.1-46	2-4	10-11 (92b) (05/14/92)	**27**	50	0.045	50	150	53
BARIUM	91/177	10-96	10-20	10-06 (91b) (06/01/91)	0	2000.	2600	2000	---	5000
BERYLLIUM	62/177	1-20	1-2	10C36P2 (91a) (03/16/91)	**62**	4	73	4	---	7.6
CADMIUM	60/177	0.22-58	0.2-6	10C39P2 (91a) (03/16/91)	**41**	5	18	5	2.2	0.66
CALCIUM	177/177	1220-948000	---	10C35P3 (91a) (03/16/91)	0	---	---	---	---	---
CHROMIUM (TOTAL)	16/177	5-19	5-12	10C39P2 (91a) (03/16/91)	**5**	100	180(14)	100	11[14]	42
COBALT	158/177	6-640	5-20	10C25P3 (92a) (01/09/92)	**158**	---	2200	---	---	5
COPPER	81/177	5-209	5	10C37P3 (92a) (01/09/92)	**77**	1300[15]	1400	1300	9	5
CYANIDE	2/173	0-8	5	10-08 (91b) (06/01/91)	**1**	200	730(16)	---	5.2[16]	5.2

TABLE 8-5

SUMMARY OF HISTORICAL DATA - GROUND WATER, UPPER/MIDDLE PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
IRON	153/177	11-214000	10-40	10-04 (92a) (01/09/92)	**104**	300[13]	11000	---	1000	---
LEAD	47/177	1-41.3	1-2	10C39P2 (91a) (03/16/91)	**36**	15[15]	4	15	2.5	1.3
MAGNESIUM	177/177	1040-787000	---	10C31P3 (91a) (03/16/91)	0	---	---	---	---	---
MANGANESE	172/177	9-35300	5	10C31P3 (91b) (06/01/91)	**150**	50[13]	880	---	---	---
MERCURY	10/177	0.2-19.4	0.2-2	10C39P2 (91a) (03/16/91)	**10**	2	11	2	0.77	0.0013
NICKEL	151/177	5-1670	5-6	10C39P2 (92a) (01/09/92)	**97**	100	730	100	52	29
POTASSIUM	157/177	315-113000	1000-2500	10C42P2 (92b) (05/14/92)	0	---	---	---	---	---
SELENIUM	7/177	2-9.9	2-20	10C28P2 (91b) (06/01/91)	**4**	50	180	50	5	5
SILVER	0/177	---	1-10	---	0	100[13]	180	180	---	1
SODIUM	177/177	2100-344000	---	10C35P3 (91a) (03/16/91)	0	---	---	---	---	---
THALLIUM	1/177	3	1-8	10-22 (92b) (05/14/92)	**1**	2	2.9(17)	2	---	0.56
TIN	2/177	31	25-60	10C44P2 (91a) (03/16/91)	0	---	22000	---	---	73
VANADIUM	6/177	8-22	5-20	10C36P2 (92b) (05/14/92)	**1**	---	260	---	---	19
ZINC	126/177	6-2140	5-10	10C39P2 (92a) (01/09/92)	**74**	5000[13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L)										
CHLORIDE	---	---	---	---	0	250000[13]	---	---	230000	---
NITRATE, AS NITROGEN	36/45	21000-989000	20000	10C27P2 (92b) (05/14/92)	**36**	10000	10000	---	---	---
NITRITE, AS NITROGEN	26/45	5000-82000	5000	10C37P3 (92b) (05/14/92)	**26**	1000	1000	---	---	---
ORGANIC BROMINE	---	---	---	---	0	---	---	---	---	---
ORGANIC CHLORINE	---	---	---	---	0	---	---	---	---	---
ORGANIC IODINE	---	---	---	---	0	---	---	---	---	---
pH (standard units)	---	---	---	---	0	---	---	---	6.5-9	---
PHENOLS	---	---	---	---	0	---	---	---	---	---
SPECIFIC CONDUCTIVITY (umho/cm)	---	---	---	---	0	---	---	---	---	---
SULFATE	---	---	---	---	0	500000	---	---	---	---
SULFIDE	45/173	12000-1220000	1000-65000	10C43P3 (91a) (03/16/91)	0	---	---	---	2	---
TOTAL ORGANIC CARBON	---	---	---	---	0	---	---	---	---	---

TABLE 8-5

SUMMARY OF HISTORICAL DATA - GROUND WATER, UPPER/MIDDLE PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable by not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.

TABLE 8-6

SUMMARY OF HISTORICAL DATA - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/134	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/134	---	5	---	0	---	0.055	0.9	---	13
1,1,2-TRICHLOROETHANE	0/134	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/134	---	5	---	0	---	810	990	---	47
1,1-DICHLOROETHENE	0/134	---	5-50	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/134	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/134	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/134	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/134	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/134	---	50	---	0	---	160	---	---	3680
ACETONE	105/134	1-71	100	10C56 (92a) (01/09/92)	0	---	610	770	---	78000
BENZENE	37/134	0.7-14	5	10C41 (91a) (03/16/91)	37	5	0.41	5	---	114
BROMODICHLOROMETHANE	0/134	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/134	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/134	---	10	---	0	---	8.7	11	---	---
CARBON DISULFIDE	0/134	---	5	---	0	---	1000	1300	---	84.1
CARBON TETRACHLORIDE	0/134	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/134	---	5	---	0	100	110	100	20[7]	10
CHLOROETHANE	0/134	---	10	---	0	---	4.6	---	---	230000
CHLOROFORM	8/134	1.4-8.1	5	10C51 (91a) (03/16/91)	8	80[6]	0.16	100	---	79
CHLOROMETHANE	0/134	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/134	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/134	---	5	---	0	---	0.081(8)	---	---	7.9
DIBROMOCHLOROMETHANE	0/134	---	5	---	0	80[6]	0.13	---	---	6400
ETHYLBENZENE	0/134	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	129/134	0.6-71	5	10C45 (92a) (01/09/92)	74	5	4.3	5	---	430
STYRENE	0/134	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/134	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	2/134	0.2-0.8	5	10-16 (91b) (06/01/91)	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/134	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/134	---	5	---	0	---	0.081(8)	---	---	7.9
TRICHLOROETHENE	0/134	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/134	---	50	---	0	---	410	550	---	248.03
VINYL CHLORIDE	0/134	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	3/134	0.7-24	5	10C51 (92a) (01/09/92)	0	10000	1400(9)	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/133	---	10	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/133	---	10	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/133	---	10	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/133	---	10	---	0	600	5.5	22	---	87
1,4-DICHLOROBENZENE	0/133	---	10	---	0	75	0.50	75	---	43
2,4,5-TRICHLOROPHENOL	0/133	---	10	---	0	---	3600	3600	1[7]	---
2,4,6-TRICHLOROPHENOL	0/133	---	10	---	0	---	6.1	77	2[7]	2
2,4-DICHLOROPHENOL	0/133	---	10	---	0	---	110	110	0.3[7]	18
2,4-DIMETHYLPHENOL	0/133	---	10	---	0	---	730	730	400[7]	100.17

TABLE 8-6

SUMMARY OF HISTORICAL DATA - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
2,4-DINITROPHENOL	0/133	---	50	---	0	---	73	73	---	4.07
2-CHLORONAPHTHALENE	0/133	---	10	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/133	---	10	---	0	---	30	38	0.1[7]	8.8
2-METHYL-4,6-DINITROPHENOL	0/133	---	50	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/133	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/133	---	10	---	0	---	1800	1800	---	---
2-NITROANILINE	0/133	---	50	---	0	---	2.1	---	---	---
2-NITROPHENOL	0/133	---	10	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/133	---	20	---	0	---	0.15	1.9	---	99.75
3-NITROANILINE	0/133	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/133	---	10	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/133	---	10-20	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/133	---	20	---	0	---	150	150	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/133	---	10	---	0	---	---	---	---	---
4-METHYLPHENOL	0/133	---	10	---	0	---	180	---	---	---
4-NITROANILINE	0/133	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/133	---	50	---	0	---	290	---	20[7]	35
ACENAPHTHENE	0/133	---	10	---	0	---	370	460	---	9.9
ACENAPHTHYLENE	0/133	---	10	---	0	---	---	---	---	4840
ANILINE	0/133	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/133	---	10	---	0	---	1800	43	---	0.029
BENZIDINE	0/133	---	50	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/133	---	10	---	0	---	0.092	1.2	---	0.839
BENZO(A)PYRENE	0/133	---	10	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/133	---	10	---	0	---	0.092	1.2	---	9.07
BENZO(G,H,I)PERYLENE	0/133	---	10	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/133	---	10	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/133	---	50	---	0	---	150000	150000	---	---
BENZYL ALCOHOL	0/133	---	20	---	0	---	11000	---	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/133	---	10	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/133	---	10	---	0	---	0.0098	0.15	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/133	---	10	---	0	---	0.96	4.2	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	103/133	0.7-19	10	10C56 (92a) (01/09/92)	75	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	4/133	1.6-11	10	10C37 (92a) (01/09/92)	0	---	7300	2700	---	49
CHRYSENE	0/133	---	10	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/133	---	10	---	0	---	0.0092	0.12	---	0.0016
DIBENZOFURAN	0/133	---	10	---	0	---	24	---	---	20
DIETHYL PHTHALATE	29/133	0.7-47	10	10C54 (92a) (01/09/92)	19	---	29000	29000	---	3
DIMETHYL PHTHALATE	1/133	3.2	10	10C54 (92a) (01/09/92)	0	---	360000	---	---	73
DI-N-BUTYL PHTHALATE	25/133	0.5-19	1-10	10C37 (92a) (01/09/92)	5	---	3600	3600	---	3
DI-N-OCTYL PHTHALATE	14/133	1-5.8	10	10C36 (92a) (01/09/92)	0	---	730	20	---	30
FLUORANTHENE	0/133	---	10	---	0	---	1500	210	---	8.1
FLUORENE	0/133	---	10	---	0	---	240	310	---	3.9
HEXACHLOROBENZENE	0/133	---	10	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/133	---	10	---	0	---	0.86	7.3	---	0.134
HEXACHLOROCYCLOPENTADIENE	0/133	---	10	---	0	50	260	50	1[7]	77.04

TABLE 8-6

SUMMARY OF HISTORICAL DATA - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
HEXACHLOROETHANE	0/133	---	10	---	0	---	4.8	36	---	30.5
INDENO(1,2,3-CD)PYRENE	0/133	---	10	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/133	---	10	---	0	---	71	900	---	900
NAPHTHALENE	0/133	---	10	---	0	---	0.0096	0.12	---	44
NITROBENZENE	0/133	---	10	---	0	---	0.0013	---	30[7]	740
N-NITROSODIMETHYLAMINE	0/133	---	10	---	0	---	14	170	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/133	---	10	---	0	---	6.2	8.3	---	---
N-NITROSODIPHENYLAMINE	0/133	---	10	---	0	---	3.4	4.3	---	13
PENTACHLOROPHENOL	0/133	---	50	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/133	---	10	---	0	---	---	---	---	2.1
PHENOL	0/133	---	10	---	0	---	22000	22000	3000[7]	100
PYRENE	0/133	---	10	---	0	---	180	140	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	5/191	19-43.1	1-20	10-17 (89) (04/26/89)	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/191	---	1-20	---	0	---	3.7	---	---	2.36
2,4,6-TRINITROTOLUENE	17/207	3.8-6300	2-200	10-17 (86) (02/09/86)	17	---	2.2	---	---	---
2,4-DINITROTOLUENE	2/199	3.2-20	2-20	10-17 (92a) (01/09/92)	2	---	73	---	---	230
2,6-DINITROTOLUENE	1/199	25.3	1-20	10-17 (89) (04/26/89)	1	---	37	---	---	42
2-AMINO-4,6-DINITROTOLUENE	2/21	3.4-205	0.2-2	10-17 (89) (04/26/89)	0	---	---	---	---	---
4-AMINO-2,6-DINITROTOLUENE	2/21	0-198	2	10-17 (89) (04/26/89)	0	---	---	---	---	---
HMX	17/206	26-1100	2-650	10-17 (86) (02/09/86)	0	---	1800	---	---	---
RDX	22/205	6-8200	5-7200	10-17 (86) (02/09/86)	22	---	0.61	---	---	---
TETRYL	0/191	---	10-50	---	0	---	360	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	18/123	0-0.98	1.9-2.6	10-17 (91a) (03/16/91)	0	---	360	---	---	686.33
2,4,5-TP (SILVEX)	48/123	0.19-5.1	1.6-2.2	10C26P2 (91b) (06/01/91)	0	50	290	---	---	326.64
2,4-D	14/123	0-0.58	11-16	10C45 (91a) (03/16/91)	0	70	360	---	---	---
4,4'-DDD	1/116	0	0.1-1.1	10C44 (91a) (03/16/91)	0	---	0.28	3.6	---	0.0011
4,4'-DDE	2/116	0.02-0.03	0.04-0.08	10C39 (91b) (06/01/91)	2	---	0.2	2.5	---	4.96E-09
4,4'-DDT	8/116	0.01-0.17	0.11-0.23	10C47 (91b) (06/01/91)	8	---	0.2	2.5	0.001	0.001
ALDRIN	0/116	---	0.04-0.08	---	0	---	0.004	0.05	---	0.0185
ALPHA-BHC	0/116	---	0.03-0.06	---	0	---	0.011	0.14	---	12.38
ALPHA-CHLORDANE	4/116	0.01-0.12	0.05-0.5	10C36 (92a) (01/09/92)	4	2[10]	0.19(10)	0.0043(10)	0.0043[10]	0.00029[10]
AROCLOR-1016	0/116	---	0.5-1.2	---	0	0.5[11]	0.96	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1221	0/116	---	0.5-1.2	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1232	0/116	---	0.5-1.2	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1242	0/116	---	0.5-1.2	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1248	0/116	---	0.5-1.2	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1254	30/116	0.11-1.2	1.2-2.5	10C29 (91a) (03/16/91)	30	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1260	0/116	---	1-2.5	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
BETA-BHC	1/116	0.05	0.06-0.12	10C43 (92a) (01/09/92)	1	---	0.037	0.47	---	0.495
DELTA-BHC	1/116	0.02	0.09-0.87	10C56 (92a) (01/09/92)	0	---	---	---	---	666.67
DIELDRIN	3/116	0.01-0.03	0.02-0.04	10C47 (91b) (06/01/91)	3	---	0.0042	0.053	0.056	0.000026
DINOSEB	19/116	0-0.57	0.67-1.1	10-17 (91a) (03/16/91)	1	7	37	---	---	0.39
DISULFOTON	0/116	---	0.38-1.4	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/116	---	0.01-0.27	---	0	---	220	220	0.056	0.003

TABLE 8-6

SUMMARY OF HISTORICAL DATA - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
ENDOSULFAN II	1/116	0.04	0.04-0.08	10C40P2 (92a) (01/09/92)	1	---	220(12)	220(12)	0.056	0.003
ENDOSULFAN SULFATE	0/116	---	0.63-1.3	---	0	---	---	---	---	2.22
ENDRIN	3/116	0.01-0.03	0.06-0.12	10C46 (91b) (06/01/91)	3	2	11	2	0.036	0.002
ENDRIN ALDEHYDE	5/116	0.05-0.15	0.22-0.44	10C36 (92a) (01/09/92)	0	---	---	---	---	0.15
ETHYL PARATHION	0/116	---	0.57-58000	---	0	---	---	---	---	---
FAMPHUR	0/116	---	1.1-2.3	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	1/116	0.01	0.04-0.4	10C30 (91b) (06/01/91)	0	0.2	0.052	0.2	---	0.01
GAMMA-CHLORDANE	2/116	0.01-0.02	0.05-0.1	10C29 (91a) (03/16/91)	2	2[10]	0.19(10)	---	0.0043[10]	0.00029[10]
HEPTACHLOR	11/116	0.01-0.02	0.02-0.29	10C23 (92a) (01/09/92)	11	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	1/116	0.01	0.79-1.6	10C26 (91a) (03/16/91)	1	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/116	---	5.7-12	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	1/116	0.32	1.7-3.4	10C43 (92a) (01/09/92)	1	40	180	40	0.03	0.005
METHYL PARATHION	0/116	---	1.1-2.3	---	0	---	9.1	---	---	---
PHORATE	1/116	0.22	0.38-0.77	10C27 (91a) (03/16/91)	0	---	7.3	---	---	3.62
TOXAPHENE	0/116	---	1-4.6	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	69/178	10-24500	10-30	10-16 (92a) (01/09/92)	59	50 to 200[13]	36000	---	87	---
ANTIMONY	124/178	3.2-22.9	3	10C36 (91a) (03/16/91)	96	6	15	6	---	31
ARSENIC	47/178	2.1-17	2-2.4	10C47 (92a) (01/09/92)	47	50	0.045	50	150	53
BARIUM	106/178	10-113	10-20	10-17 (92b) (05/14/92)	0	2000	2600	2000	---	5000
BERYLLIUM	70/178	1-21	1-2	10-16 (91a) (03/16/91)	70	4	73	4	---	7.6
CADMIUM	64/178	0.22-30	0.2-7	10C48 (91a) (03/16/91)	22	5	18	5	2.2	0.66
CALCIUM	178/178	148-343000	---	10C24P2 (92b) (05/14/92)	0	---	---	---	---	---
CHROMIUM (TOTAL)	11/178	5-9	5-12	10C34 (92b) (05/14/92)	0	100	180(14)	100	11[14]	42
COBALT	129/178	6-879	5-20	10C50 (91a) (03/16/91)	129	---	2200	---	---	5
COPPER	65/178	5-337	5	10C53 (92a) (01/09/92)	59	1300[15]	1400	1300	9	5
CYANIDE	9/172	5-9	5	10-17 (91b) (06/01/91)	8	200	730(16)	---	5.2[18]	5.2
IRON	174/178	40-131000	10-40	10C35 (92a) (01/09/92)	160	300[13]	11000	---	1000	---
LEAD	26/178	1-29	1	10C47 (91b) (06/01/91)	17	15[15]	4	15	2.5	1.3
MAGNESIUM	178/178	2110-154000	---	10C41 (91a) (03/16/91)	0	---	---	---	---	---
MANGANESE	178/178	25-32600	---	10-01 (84a) (02/03/84)	175	50[13]	880	---	---	---
MERCURY	8/178	0.3-2.4	0.2-2	10C35 (91a) (03/16/91)	8	2	11	2	0.77	0.0013
NICKEL	139/178	5-1930	5-6	10C50 (91a) (03/16/91)	89	100	730	100	52	29
POTASSIUM	173/178	546-109000	200-2500	10C53 (91b) (06/01/91)	0	---	---	---	---	---
SELENIUM	0/178	---	2	---	0	50	180	50	5	5
SILVER	0/178	---	1-10	---	0	100[13]	180	180	---	1
SODIUM	178/178	4300-121000	---	10-02 (84a) (02/03/84)	0	---	---	---	---	---
THALLIUM	0/178	---	2-20	---	0	2	2.9(17)	2	---	0.56
TIN	1/178	40	25-60	10C46 (91a) (03/16/91)	0	---	22000	---	---	73
VANADIUM	6/178	5-19	5-20	10-18 (92a) (01/09/92)	0	---	260	---	---	19
ZINC	128/178	6-2600	5-10	10C50 (91b) (06/01/91)	70	5000[13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L)										
NITRATE, AS NITROGEN	34/45	0-198000	20000	10C23 (92b) (05/14/92)	33	10000	10000	---	---	---
NITRITE, AS NITROGEN	27/45	0-18000	5000	10C40P2 (92b) (05/14/92)	26	1000	1000	---	---	---
SULFIDE	28/172	2000-96000	20000	10-18 (92b) (05/14/92)	0	---	---	---	2	---

TABLE 8-6

SUMMARY OF HISTORICAL DATA - GROUND WATER, LOWER PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]

Note: Downgradient wells identified in the Lower Pennsylvanian Aquifer (Wells 10-01, 10-02, and 10C61) are not presented in this table, rather they are included in Table 8-8.

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S.EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable by not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.

TABLE 8-7

SUMMARY OF HISTORICAL DATA - GROUND WATER, BEECH CREEK AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	1/1	5.3	---	10C40 (91a) (03/16/91)	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/1	---	5	---	0	---	0.055	0.9	---	13
1,1,2-TRICHLOROETHANE	0/1	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/1	---	5	---	0	---	810	990	---	47
1,1-DICHLOROETHENE	0/1	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/1	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/1	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/1	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/1	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/1	---	50	---	0	---	160	---	---	3680
ACETONE	1/1	15	---	10C40 (91a) (03/16/91)	0	---	610	770	---	78000
BENZENE	0/1	---	5	---	0	5	0.41	5	---	114
BROMODICHLOROMETHANE	0/1	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/1	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/1	---	10	---	0	---	8.7	11	---	---
CARBON DISULFIDE	0/1	---	5	---	0	---	1000	1300	---	84.1
CARBON TETRACHLORIDE	0/1	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/1	---	5	---	0	100	110	100	20[7]	10
CHLOROETHANE	0/1	---	10	---	0	---	4.6	---	---	230000
CHLOROFORM	0/1	---	5	---	0	80[6]	0.16	100	---	79
CHLOROMETHANE	0/1	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/1	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/1	---	5	---	0	---	0.081(8)	---	---	7.9
DIBROMOCHLOROMETHANE	0/1	---	5	---	0	80[6]	0.13	---	---	6400
ETHYLBENZENE	0/1	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	1/1	7	---	10C40 (91a) (03/16/91)	1	5	4.3	5	---	430
STYRENE	0/1	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/1	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	0/1	---	5	---	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/1	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/1	---	5	---	0	---	0.081(8)	---	---	7.9
TRICHLOROETHENE	0/1	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/1	---	50	---	0	---	410	550	---	248.03
VINYL CHLORIDE	0/1	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	0/1	---	5	---	0	10000	1400(9)	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/1	---	10	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/1	---	10	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/1	---	10	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/1	---	10	---	0	600	5.5	22	---	87
1,4-DICHLOROBENZENE	0/1	---	10	---	0	75	0.50	75	---	43
2,4,5-TRICHLOROPHENOL	0/1	---	10	---	0	---	3600	3600	1[7]	---
2,4,6-TRICHLOROPHENOL	0/1	---	10	---	0	---	6.1	77	2[7]	2
2,4-DICHLOROPHENOL	0/1	---	10	---	0	---	110	110	0.3[7]	18
2,4-DIMETHYLPHENOL	0/1	---	10	---	0	---	730	730	400[7]	100.17
2,4-DINITROPHENOL	0/1	---	50	---	0	---	73	73	---	4.07
2-CHLORONAPHTHALENE	0/1	---	10	---	0	---	490	---	---	0.396

TABLE 8-7

SUMMARY OF HISTORICAL DATA - GROUND WATER, BEECH CREEK AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
PAGE 2 OF 5

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
2-CHLOROPHENOL	0/1	---	10	---	0	---	30	38	0.1[7]	8.8
2-METHYL-4,6-DINITROPHENOL	0/1	---	50	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/1	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/1	---	10	---	0	---	1800	1800	---	---
2-NITROANILINE	0/1	---	50	---	0	---	2.1	---	---	---
2-NITROPHENOL	0/1	---	10	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/1	---	20	---	0	---	0.15	1.9	---	99.75
3-NITROANILINE	0/1	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/1	---	10	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/1	---	20	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/1	---	20	---	0	---	150	150	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/1	---	10	---	0	---	---	---	---	---
4-METHYLPHENOL	0/1	---	10	---	0	---	180	---	---	---
4-NITROANILINE	0/1	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/1	---	50	---	0	---	290	---	---	35
ACENAPHTHENE	0/1	---	10	---	0	---	370	460	20[7]	9.9
ACENAPHTHYLENE	0/1	---	10	---	0	---	---	---	---	4840
ANILINE	0/1	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/1	---	10	---	0	---	1800	43	---	0.029
BENZIDINE	0/1	---	50	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/1	---	10	---	0	---	0.092	1.2	---	0.839
BENZO(A)PYRENE	0/1	---	10	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/1	---	10	---	0	---	0.092	1.2	---	9.07
BENZO(G,H,I)PERYLENE	0/1	---	10	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/1	---	10	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/1	---	50	---	0	---	150000	150000	---	---
BENZYL ALCOHOL	0/1	---	20	---	0	---	11000	---	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/1	---	10	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/1	---	10	---	0	---	0.0098	0.15	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/1	---	10	---	0	---	0.96	4.2	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	1/1	5.2	---	10C40 (91a) (03/16/91)	1	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/1	---	10	---	0	---	7300	2700	---	49
CHRYSENE	0/1	---	10	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/1	---	10	---	0	---	0.0092	0.12	---	0.0016
DIBENZOFURAN	0/1	---	10	---	0	---	24	---	---	20
DIETHYL PHTHALATE	0/1	---	10	---	0	---	29000	29000	---	3
DIMETHYL PHTHALATE	0/1	---	10	---	0	---	360000	---	---	73
DI-N-BUTYL PHTHALATE	0/1	---	10	---	0	---	3600	3600	---	3
DI-N-OCTYL PHTHALATE	0/1	---	10	---	0	---	730	20	---	30
FLUORANTHENE	0/1	---	10	---	0	---	1500	210	---	8.1
FLUORENE	0/1	---	10	---	0	---	240	310	---	3.9
HEXACHLOROBENZENE	0/1	---	10	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/1	---	10	---	0	---	0.86	7.3	---	0.134
HEXACHLOROCYCLOPENTADIENE	0/1	---	10	---	0	50	260	50	1[7]	77.04
HEXACHLOROETHANE	0/1	---	10	---	0	---	4.8	36	---	30.5
INDENO(1,2,3-CD)PYRENE	0/1	---	10	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/1	---	10	---	0	---	71	900	---	900
NAPHTHALENE	0/1	---	10	---	0	---	0.0096	0.12	---	44
NITROBENZENE	0/1	---	10	---	0	---	0.0013	---	30[7]	740

TABLE 8-7

SUMMARY OF HISTORICAL DATA - GROUND WATER, BEECH CREEK AQUIFER
SWMU 10 - ROCKEYE
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
N-NITROSODIMETHYLAMINE	0/1	---	10	---	0	---	14	170	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/1	---	10	---	0	---	6.2	8.3	---	---
N-NITROSODIPHENYLAMINE	0/1	---	10	---	0	---	3.4	4.3	---	13
PENTACHLOROPHENOL	0/1	---	50	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/1	---	10	---	0	---	---	---	---	2.1
PHENOL	0/1	---	10	---	0	---	22000	22000	3000[7]	100
PYRENE	0/1	---	10	---	0	---	180	140	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	0/2	---	1-20	---	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/2	---	1-20	---	0	---	3.7	---	---	2.36
2,4,6-TRINITROTOLUENE	0/2	---	2-20	---	0	---	2.2	---	---	---
2,4-DINITROTOLUENE	0/2	---	2-10	---	0	---	73	---	---	230
2,6-DINITROTOLUENE	0/2	---	1-10	---	0	---	37	---	---	42
2-AMINO-4,6-DINITROTOLUENE	0/1	---	2	---	0	---	---	---	---	---
4-AMINO-2,6-DINITROTOLUENE	0/1	---	2	---	0	---	---	---	---	---
HMX	0/2	---	20	---	0	---	1800	---	---	---
RDX	0/2	---	5-20	---	0	---	0.61	---	---	---
TETRYL	0/2	---	10-50	---	0	---	360	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	0/1	---	2	---	0	---	360	---	---	686.33
2,4,5-TP (SILVEX)	0/1	---	1.7	---	0	50	290	---	---	326.64
2,4-D	0/1	---	12	---	0	70	360	---	---	---
4,4'-DDD	0/1	---	0.11	---	0	---	0.28	3.6	---	0.0011
4,4'-DDE	0/1	---	0.04	---	0	---	0.2	2.5	---	0.001
4,4'-DDT	0/1	---	0.12	---	0	---	0.2	2.5	0.001	0.000952
ALDRIN	0/1	---	0.04	---	0	---	0.004	0.05	---	0.0185
ALPHA-BHC	0/1	---	0.03	---	0	---	0.011	0.14	---	12.38
ALPHA-CHLORDANE	0/1	---	0.05	---	0	2[10]	0.19(10)	0.0043(10)	0.0043[10]	0.00029[10]
AROCLOR-1016	0/1	---	0.6	---	0	0.5[11]	0.96	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1221	0/1	---	0.6	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1232	0/1	---	0.6	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1242	0/1	---	0.6	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1248	0/1	---	0.6	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1254	1/1	0.39	---	10C40 (91a) (03/16/91)	1	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1260	0/1	---	1.3	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
BETA-BHC	0/1	---	0.06	---	0	---	0.037	0.47	---	0.495
DELTA-BHC	0/1	---	0.09	---	0	---	---	---	---	666.67
DIELDRIN	0/1	---	0.02	---	0	---	0.0042	0.053	0.056	0.000026
DINOSEB	0/1	---	0.69	---	0	7	37	---	---	0.39
DISULFOTON	0/1	---	0.69	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/1	---	0.14	---	0	---	220	220	0.056	0.003
ENDOSULFAN II	0/1	---	0.04	---	0	---	220(12)	220(12)	0.056	0.003
ENDOSULFAN SULFATE	0/1	---	0.65	---	0	---	---	---	---	2.22
ENDRIN	0/1	---	0.06	---	0	2	11	2	0.036	0.002
ENDRIN ALDEHYDE	0/1	---	0.23	---	0	---	---	---	---	0.15
ETHYL PARATHION	0/1	---	0.59	---	0	---	---	---	---	---
FAMPHUR	0/1	---	1.2	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/1	---	0.04	---	0	0.2	0.052	0.2	---	0.01

TABLE 8-7

SUMMARY OF HISTORICAL DATA - GROUND WATER, BEECH CREEK AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
GAMMA-CHLORDANE	0/1	---	0.05	---	0	2[10]	0.19(10)	---	0.0043[10]	0.00029[10]
HEPTACHLOR	0/1	---	0.03	---	0	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/1	---	0.81	---	0	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/1	---	5.9	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/1	---	1.7	---	0	40	180	40	0.03	0.005
METHYL PARATHION	0/1	---	1.2	---	0	---	9.1	---	---	---
PHORATE	0/1	---	0.39	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/1	---	2.4	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	0/1	---	10	---	0	50 to 200[13]	36000	---	87	---
ANTIMONY	1/1	22.9	---	10C40 (91a) (03/16/91)	1	6	15	6	---	31
ARSENIC	0/1	---	2	---	0	50	0.045	50	150	53
BARIUM	1/1	10	---	10C40 (91a) (03/16/91)	0	2000	2600	2000	---	5000
BERYLLIUM	0/1	---	2	---	0	4	73	4	---	7.6
CADMIUM	1/1	12	---	10C40 (91a) (03/16/91)	1	5	18	5	2.2	0.66
CALCIUM	1/1	130000	---	10C40 (91a) (03/16/91)	0	---	---	---	---	---
CHROMIUM (TOTAL)	0/1	---	12	---	0	100	180(14)	100	11[14]	42
COBALT	1/1	17	---	10C40 (91a) (03/16/91)	1	---	2200	---	---	5
COPPER	0/1	---	5	---	0	1300[15]	1400	1300	9	5
CYANIDE	0/1	---	5	---	0	200	730(16)	---	5.2[16]	5.2[16]
IRON	1/1	384	---	10C40 (91a) (03/16/91)	1	300[13]	11000	---	1000	---
LEAD	1/1	2.8	---	10C40 (91a) (03/16/91)	1	15[15]	4	15	2.5	1.3
MAGNESIUM	1/1	56000	---	10C40 (91a) (03/16/91)	0	---	---	---	---	---
MANGANESE	1/1	41	---	10C40 (91a) (03/16/91)	0	50[13]	880	---	---	---
MERCURY	0/1	---	0.2	---	0	2	11	2	0.77	0.0013
NICKEL	0/1	---	5	---	0	100	730	100	52	29
POTASSIUM	1/1	2710	---	10C40 (91a) (03/16/91)	0	---	---	---	---	---
SELENIUM	0/1	---	2	---	0	50	180	50	5	5
SILVER	0/1	---	1	---	0	100[13]	180	180	---	1
SODIUM	1/1	89700	---	10C40 (91a) (03/16/91)	0	---	---	---	---	---
THALLIUM	0/1	---	2	---	0	2	2.9(17)	2	---	0.56
TIN	0/1	---	25	---	0	---	22000	---	---	73
VANADIUM	0/1	---	20	---	0	---	260	---	---	19
ZINC	1/1	24	---	10C40 (91a) (03/16/91)	0	5000[13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L)										
SULFIDE	1/1	51000	---	10C40 (91a) (03/16/91)	0	---	---	---	---	---

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

TABLE 8-7

SUMMARY OF HISTORICAL DATA - GROUND WATER, BEECH CREEK AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater PRG[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]

1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable by not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.
14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.

TABLE 8-8

SUMMARY OF HISTORICAL DATA - GROUND WATER, DOWNGRADIENT WELLS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
PAGE 1 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	0/12	---	5	---	0	200	790	200	---	88
1,1,2,2-TETRACHLOROETHANE	0/12	---	5	---	0	---	0.055	0.9	---	13
1,1,2-TRICHLOROETHANE	0/12	---	5	---	0	5	0.2	5	---	650
1,1-DICHLOROETHANE	0/12	---	5	---	0	---	810	990	---	47
1,1-DICHLOROETHENE	0/12	---	5	---	0	7	0.046	7	---	78
1,2-DICHLOROETHANE	0/12	---	5	---	0	5	0.12	5	---	190
1,2-DICHLOROPROPANE	0/12	---	5	---	0	5	0.16	5	---	380
2-BUTANONE	0/12	---	100	---	0	---	1900	2500	---	7100
2-HEXANONE	0/12	---	50	---	0	---	---	---	---	1710
4-METHYL-2-PENTANONE	0/12	---	50	---	0	---	160	---	---	3680
ACETONE	8/12	2.2-35	100	10C60 (92a) (01/09/92)	0	---	610	770	---	78000
BENZENE	3/12	1.4-9.2	5	10-01 (91a) (03/16/91)	3	5	0.41	5	---	114
BROMODICHLOROMETHANE	0/12	---	5	---	0	80[6]	0.18	100	---	---
BROMOFORM	0/12	---	5	---	0	80[6]	8.5	100	---	466
BROMOMETHANE	0/12	---	10	---	0	---	8.7	11	---	---
CARBON DISULFIDE	0/12	---	5	---	0	---	1000	1300	---	84.1
CARBON TETRACHLORIDE	0/12	---	5	---	0	5	0.17	5	---	5.9
CHLOROBENZENE	0/12	---	5	---	0	100	110	100	20[7]	10
CHLOROETHANE	0/12	---	10	---	0	---	4.6	---	---	230000
CHLOROFORM	0/12	---	5	---	0	80[6]	0.16	100	---	79
CHLOROMETHANE	0/12	---	10	---	0	---	1.5	---	---	---
CIS-1,2-DICHLOROETHENE	0/12	---	5	---	0	70	61	70	---	---
CIS-1,3-DICHLOROPROPENE	0/12	---	5	---	0	---	0.081(8)	---	---	7.9
DIBROMOCHLOROMETHANE	0/12	---	5	---	0	80[6]	0.13	---	---	6400
ETHYLBENZENE	0/12	---	5	---	0	700	1300	700	---	17.2
METHYLENE CHLORIDE	9/12	1.6-21	5	10-01 (92a) (01/09/92)	5	5	4.3	5	---	430
STYRENE	0/12	---	5	---	0	100	1600	100	---	56
TETRACHLOROETHENE	0/12	---	5	---	0	5	1.1	5	---	8.9
TOLUENE	0/12	---	5	---	0	1000	720	1000	---	253
TRANS-1,2-DICHLOROETHENE	0/12	---	5	---	0	100	120	100	---	310
TRANS-1,3-DICHLOROPROPENE	0/12	---	5	---	0	---	0.081(8)	---	---	7.9
TRICHLOROETHENE	0/12	---	5	---	0	5	1.6	5	---	75
VINYL ACETATE	0/12	---	50	---	0	---	410	550	---	248.03
VINYL CHLORIDE	0/12	---	10	---	0	2	0.02	2	---	9.2
XYLENES, TOTAL	0/12	---	5	---	0	10000	1400(9)	10000	---	117
Semivolatile Organics (ug/L)										
1,2,4-TRICHLOROBENZENE	0/12	---	10	---	0	70	190	70	---	69.2
1,2-DICHLOROBENZENE	0/12	---	10	---	0	600	370	600	---	11
1,2-DIPHENYLHYDRAZINE	0/12	---	10	---	0	---	0.084	---	---	---
1,3-DICHLOROBENZENE	0/12	---	10	---	0	600	5.5	22	---	87
1,4-DICHLOROBENZENE	0/12	---	10	---	0	75	0.50	75	---	43
2,4,5-TRICHLOROPHENOL	0/12	---	10	---	0	---	3600	3600	1[7]	---
2,4,6-TRICHLOROPHENOL	0/12	---	10	---	0	---	6.1	77	2[7]	2

TABLE 8-8

SUMMARY OF HISTORICAL DATA - GROUND WATER, DOWNGRADIENT WELLS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
PAGE 2 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
2,4-DICHLOROPHENOL	0/12	---	10	---	0	---	110	110	0.3[7]	18
2,4-DIMETHYLPHENOL	0/12	---	10	---	0	---	730	730	400[7]	100.17
2,4-DINITROPHENOL	0/12	---	50	---	0	---	73	73	---	4.07
2-CHLORONAPHTHALENE	0/12	---	10	---	0	---	490	---	---	0.396
2-CHLOROPHENOL	0/12	---	10	---	0	---	30	38	0.1[7]	8.8
2-METHYL-4,6-DINITROPHENOL	0/12	---	50	---	0	---	---	---	---	---
2-METHYLNAPHTHALENE	0/12	---	10	---	0	---	---	---	---	329.55
2-METHYLPHENOL	0/12	---	10	---	0	---	1800	1800	---	---
2-NITROANILINE	0/12	---	50	---	0	---	2.1	---	---	---
2-NITROPHENOL	0/12	---	10	---	0	---	---	---	---	13.5
3,3'-DICHLOROBENZIDINE	0/12	---	20	---	0	---	0.15	1.9	---	99.75
3-NITROANILINE	0/12	---	50	---	0	---	---	---	---	---
4-BROMOPHENYL PHENYL ETHER	0/12	---	10	---	0	---	---	---	---	1.5
4-CHLORO-3-METHYLPHENOL	0/12	---	20	---	0	---	---	---	3000[7]	20
4-CHLOROANILINE	0/12	---	20	---	0	---	150	150	---	231.97
4-CHLOROPHENYL PHENYL ETHER	0/12	---	10	---	0	---	---	---	---	---
4-METHYLPHENOL	0/12	---	10	---	0	---	180	---	---	---
4-NITROANILINE	0/12	---	50	---	0	---	---	---	---	---
4-NITROPHENOL	0/12	---	50	---	0	---	290	---	---	35
ACENAPHTHENE	0/12	---	10	---	0	---	370	460	20[7]	9.9
ACENAPHTHYLENE	0/12	---	10	---	0	---	---	---	---	4840
ANILINE	0/12	---	20	---	0	---	12	---	---	0.44
ANTHRACENE	0/12	---	10	---	0	---	1800	43	---	0.029
BENZIDINE	0/12	---	50	---	0	---	0.00029	---	---	---
BENZO(A)ANTHRACENE	0/12	---	10	---	0	---	0.092	1.2	---	0.839
BENZO(A)PYRENE	0/12	---	10	---	0	0.2	0.0092	0.2	---	0.014
BENZO(B)FLUORANTHENE	0/12	---	10	---	0	---	0.092	1.2	---	9.07
BENZO(G,H,I)PERYLENE	0/12	---	10	---	0	---	---	---	---	7.64
BENZO(K)FLUORANTHENE	0/12	---	10	---	0	---	0.92	0.8	---	0.0056
BENZOIC ACID	0/12	---	50	---	0	---	150000	150000	---	---
BENZYL ALCOHOL	0/12	---	20	---	0	---	11000	---	---	281.24
BIS(2-CHLOROETHOXY)METHANE	0/12	---	10	---	0	---	---	---	---	6400
BIS(2-CHLOROETHYL)ETHER	0/12	---	10	---	0	---	0.0098	0.15	---	1140
BIS(2-CHLOROISOPROPYL) ETHER	0/12	---	10	---	0	---	0.96	4.2	---	---
BIS(2-ETHYLHEXYL)PHTHALATE	2/12	1.3-9.7	10	10-02 (92a) (01/09/92)	2	6	4.8	6	---	2.1
BUTYLBENZYL PHTHALATE	0/12	---	10	---	0	---	7300	2700	---	49
CHRYSENE	0/12	---	10	---	0	---	9.2	1.6	---	0.033
DIBENZO(A,H)ANTHRACENE	0/12	---	10	---	0	---	0.0092	0.12	---	0.0016
DIBENZOFURAN	0/12	---	10	---	0	---	24	---	---	20
DIETHYL PHTHALATE	4/12	1.7-2	10	10C60 (91b) (06/01/91)	0	---	29000	29000	---	3
DIMETHYL PHTHALATE	0/12	---	10	---	0	---	360000	---	---	73
DI-N-BUTYL PHTHALATE	0/3	---	10	---	0	---	3600	3600	---	3
DI-N-OCTYL PHTHALATE	1/12	2-1	10	10-02 (91a) (03/16/91)	0	---	730	20	---	30
FLUORANTHENE	0/12	---	10	---	0	---	1500	210	---	8.1

TABLE 8-8

SUMMARY OF HISTORICAL DATA - GROUND WATER, DOWNGRADIENT WELLS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
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Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
FLUORENE	0/12	---	10	---	0	---	240	310	---	3.9
HEXACHLOROBENZENE	0/12	---	10	---	0	1	0.042	1	---	0.00024
HEXACHLOROBUTADIENE	0/12	---	10	---	0	---	0.86	7.3	---	0.134
HEXACHLOROCYCLOPENTADIENE	0/12	---	10	---	0	50	260	50	1[7]	77.04
HEXACHLOROETHANE	0/12	---	10	---	0	---	4.8	36	---	30.5
INDENO(1,2,3-CD)PYRENE	0/12	---	10	---	0	---	0.092	0.022	---	4.31
ISOPHORONE	0/12	---	10	---	0	---	71	900	---	900
NAPHTHALENE	0/12	---	10	---	0	---	0.0096	0.12	---	44
NITROBENZENE	0/12	---	10	---	0	---	0.0013	---	30[7]	740
N-NITROSODIMETHYLAMINE	0/12	---	10	---	0	---	14	170	---	---
N-NITROSO-DI-N-PROPYLAMINE	0/12	---	10	---	0	---	6.2	8.3	---	---
N-NITROSODIPHENYLAMINE	0/12	---	10	---	0	---	3.4	4.3	---	13
PENTACHLOROPHENOL	0/12	---	50	---	0	1	0.56	1	15	5.23
PHENANTHRENE	0/12	---	10	---	0	---	---	---	---	2.1
PHENOL	0/12	---	10	---	0	---	22000	22000	3000[7]	100
PYRENE	0/12	---	10	---	0	---	180	140	---	0.3
Energetics (ug/L)										
1,3,5-TRINITROBENZENE	0/14	---	1-20	---	0	---	1100	---	---	---
1,3-DINITROBENZENE	0/14	---	1-20	---	0	---	3.7	---	---	2.36
2,4,6-TRINITROTOLUENE	2/26	9-50	2-100	10-02 (84a) (02/03/84)	2	---	2.2	---	---	---
2,4-DINITROTOLUENE	0/22	---	2-100	---	0	---	73	---	---	230
2,6-DINITROTOLUENE	0/22	---	1-100	---	0	---	37	---	---	42
4-AMINO-2,6-DINITROTOLUENE	2/2	0-4.6	---	10-02 (89) (04/26/89)	0	---	---	---	---	---
HMX	11/25	13-55	20	10-92 (92b) (05/14/92)	0	---	1800	---	---	---
RDX	17/26	12/255	20	10-02 (83b) (08/02/83)	17	---	0.61	---	---	---
TETRYL	0/18	---	10	---	0	---	360	---	---	---
Pesticides/PCBs/Herbicides (ug/L)										
2,4,5-T	3/11	0.03-0.14	1.9-3.1	10C61 (91a) (03/16/91)	0	---	360	---	---	686.33
2,4,5-TP (SILVEX)	4/11	0.38-0.61	1.7-2.7	10C61 (91a) (03/16/91)	0	50	290	---	---	326.64
2,4-D	4/11	0.02-0.72	12-19	10C61 (91a) (03/16/91)	0	70	360	---	---	---
4,4'-DDD	0/11	---	0.11-0.17	---	0	---	0.28	3.6	---	0.0011
4,4'-DDE	1/11	0.02	0.04-0.06	10C60 (92a) (01/09/92)	1	---	0.2	2.5	---	0.00000000496
4,4'-DDT	0/11	---	0.12-0.18	---	0	---	0.2	2.5	0.001	0.001
ALDRIN	0/11	---	0.04-0.06	---	0	---	0.004	0.05	---	0.0185
ALPHA-BHC	0/11	---	0.03-0.05	---	0	---	0.011	0.14	---	12.38
ALPHA-CHLORDANE	1/3	0.02	0.05-0.08	10C60 (92a) (01/09/92)	1	2[10]	0.19(10)	0.0043(10)	0.0043[10]	0.00029[10]
AROCLOR-1016	0/11	---	0.6-0.98	---	0	0.5[11]	0.96	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1221	0/11	---	0.6-0.98	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1232	0/11	---	0.6-0.98	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1242	0/11	---	0.6-0.98	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1248	0/11	---	0.6-0.98	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1254	2/11	0.39-0.43	1.2-2	10C60 (91a) (03/16/91)	2	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]
AROCLOR-1260	0/11	---	1.2-2	---	0	0.5[11]	0.034(11)	0.014(11)	0.014[11]	0.000029[11]

TABLE 8-8

SUMMARY OF HISTORICAL DATA - GROUND WATER, DOWNGRADIENT WELLS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
PAGE 4 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
BETA-BHC	1/11	0.04	0.06-0.09	10C60 (92a) (01/09/92)	1	---	0.037	0.47	---	0.495
DELTA-BHC	0/11	---	0.09-0.14	---	0	---	---	---	---	666.67
DIELDRIN	0/11	---	0.02-0.03	---	0	---	0.0042	0.053	0.056	0.000026
DINOSEB	1/11	0.03	0.67-1.1	10-01 (91a) (03/16/91)	0	7	37	---	---	0.39
DISULFOTON	0/11	---	0.67-1.1	---	0	---	1.5	---	---	0.0402
ENDOSULFAN I	0/11	---	0.13-0.21	---	0	---	220	220	0.056	0.003
ENDOSULFAN II	0/11	---	0.04-0.06	---	0	---	220(12)	220(12)	0.056	0.003
ENDOSULFAN SULFATE	1/11	0.12	0.63-1	10C60 (92a) (01/09/92)	0	---	---	---	---	2.22
ENDRIN	0/11	---	0.06-0.09	---	0	2	11	2	0.036	0.002
ENDRIN ALDEHYDE	1/11	0.04	0.23-0.35	10C60 (91b) (06/01/91)	0	---	---	---	---	0.15
ETHYL PARATHION	0/11	---	0.58-0.91	---	0	---	---	---	---	---
FAMPHUR	0/11	---	1.2-1.8	---	0	---	---	---	---	---
GAMMA-BHC (LINDANE)	0/11	---	0.04-0.06	---	0	0.2	0.052	0.2	---	0.01
GAMMA-CHLORDANE	1/11	0.01	0.05-0.08	10C60 (92a) (01/09/92)	1	2[10]	0.19(10)	---	0.0043[10]	0.00029[10]
HEPTACHLOR	1/11	0.01	0.03-0.05	10C60 (92a) (01/09/92)	1	0.4	0.015	0.4	0.0038	0.00039
HEPTACHLOR EPOXIDE	0/11	---	0.8-1.3	---	0	0.2	0.0074	0.2	0.0038	0.00048
KEPONE	0/11	---	5.8-9.1	---	0	---	0.0037	---	---	0.159
METHOXYCHLOR	0/11	---	1.7-2.7	---	0	40	180	40	0.03	0.005
METHYL PARATHION	0/11	---	1.2-1.8	---	0	---	9.1	---	---	---
PHORATE	0/11	---	0.38-0.61	---	0	---	7.3	---	---	3.62
TOXAPHENE	0/11	---	2.3-3.6	---	0	3	0.061	3	0.0002	0.0002
Dissolved Inorganics (ug/L)										
ALUMINUM	0/16	63	10-30	10-02 (92a) (01/09/92)	1	50 to 200[13]	36000	---	87	---
ANTIMONY	7/16	3.3-15.7	3	10-01 (91b) (06/01/91)	5	6	15	6	---	31
ARSENIC	1/16	2.6	2	10-01 (91a) (03/16/91)	1	50	0.045	50	150	53
BARIUM	15/16	13-96	20	10C60 (92a) (01/09/92)	0	2000	2600	2000	---	5000
BERYLLIUM	0/16	---	1-2	---	0	4	73	4	---	7.6
CADMIUM	2/16	0.33-1.11	0.2-4	10-01 (92a) (01/09/92)	1	5	18	5	2.2	0.66
CALCIUM	16/16	17100-428000	---	10-01 (91a) (03/16/91)	0	---	---	---	---	---
CHROMIUM (TOTAL)	2/16	5	5	10C61 (92a) (01/09/92)	0	100	180(14)	100	11[14]	42
COBALT	5/16	7-605	6-20	10-01 (91a) (03/16/91)	5	---	2200	---	---	5
COPPER	9/16	12-171	5	10-02 (92a) (01/09/92)	9	1300[15]	1400	1300	9	5
CYANIDE	1/16	5	5	10-01 (91b) (06/01/92)	0	200	730(16)	---	5.2[16]	5.2[16]
IRON	9/17	29-18900	10-40	10-01 (91a) (03/16/92)	3	300[13]	11000	---	1000	---
LEAD	2/16	1.2-1.8	1	10-01 (92a) (01/09/92)	1	15[15]	4	15	2.5	1.3
MAGNESIUM	16/16	4480-87600	---	10-01 (91a) (03/16/91)	0	---	---	---	---	---
MANGANESE	13/18	7-10400	5	10-01 (91a) (03/16/91)	9	50[13]	880	---	---	---
MERCURY	0/16	---	0.2-2	---	0	2	11	2	0.77	0.0013
NICKEL	4/16	6-1480	5-6	10-01 (91a) (03/16/91)	1	100	730	100	52	29
POTASSIUM	16/16	1010-7250	---	10-01 (91a) (03/16/91)	0	---	---	---	---	---
SELENIUM	0/16	---	2	---	0	50	180	50	5	5
SILVER	0/16	---	1-10	---	0	100[13]	180	180	---	1
SODIUM	18/18	1570-7400	---	10-01 (91a) (03/16/91)	0	---	---	---	---	---
THALLIUM	0/16	---	2	---	0	2	2.9(17)	2	---	0.56

TABLE 8-8

SUMMARY OF HISTORICAL DATA - GROUND WATER, DOWNGRADIENT WELLS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
PAGE 5 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]
TIN	0/16	---	25-60	---	0	---	22000	---	---	73
VANADIUM	2/16	5-10	5-10	10-01 (92a) (01/09/92)	0	---	260	---	---	19
ZINC	1/16	563	6-10	10-01 (91a) (03/16/91)	1	5000[13]	11000	11000	120	58.9
Miscellaneous Parameters (ug/L)										
CHLORIDE	1/1	10000000	---	10-01 (84a) (02/03/84)	1	250000[1]	---	---	230000	---
NITRATE, AS NITROGEN	3/4	44000-680000	30000	10-02 (92b) (05/14/92)	3	10000	10000	---	---	---
NITRITE, AS NITROGEN	2/4	5000-13000	5000	10-01 (92b) (05/14/92)	2	1000	1000	---	---	---
ORGANIC BROMINE	1/4	7000	2000	10-02 (84B) (06/14/84)	0	---	---	---	---	---
ORGANIC CHLORINE	2/4	10000-20000	10000	10-01 (84B) (06/14/84)	0	---	---	---	---	---
ORGANIC IODINE	1/4	2000	2000	10-02 (84A) (02/30/84)	0	---	---	---	---	---
pH (standard units)	8/8	6.2-7.6	---	10-01 (84b) (06/14/84)	0	---	---	---	6.5-9	---
PHENOLS	0/2	---	4000	---	0	---	---	---	---	---
SPECIFIC CONDUCTIVITY (umho/cm)	4/4	160-290	---	10-02 (84b) (06/14/84)	0	---	---	---	---	---
SULFATE	2'2	18000000-28000000	---	10-02 (84a) (02/03/84)	0	500000	---	---	---	---
SULFIDE	0/16	---	20000	---	0	---	---	---	2	---
TOTAL ORGANIC CARBON	2/4	20000000-5000000	2000000	10-02 (84b) (06/14/84)	0		---	---		

Note: Includes Wells 10-01, 10-02, and 10C61 (identified as located in the Lower Pennsylvanian Aquifer), plus Well 10C60 (located in the Golconda Aquifer).

--- Not applicable/Not available.

AWQC Ambient Water Quality Criteria
EDQL Ecological Data Quality Level
IDEM Indiana Department of Environmental Management
NSWC Naval Surface Warfare Center
MCL Maximum Contaminant Level
PCBs Polychlorinated biphenyls
PRG Preliminary Remediation Goal
SWMU Solid Waste Management Unit
U.S. EPA United States Environmental Protection Agency

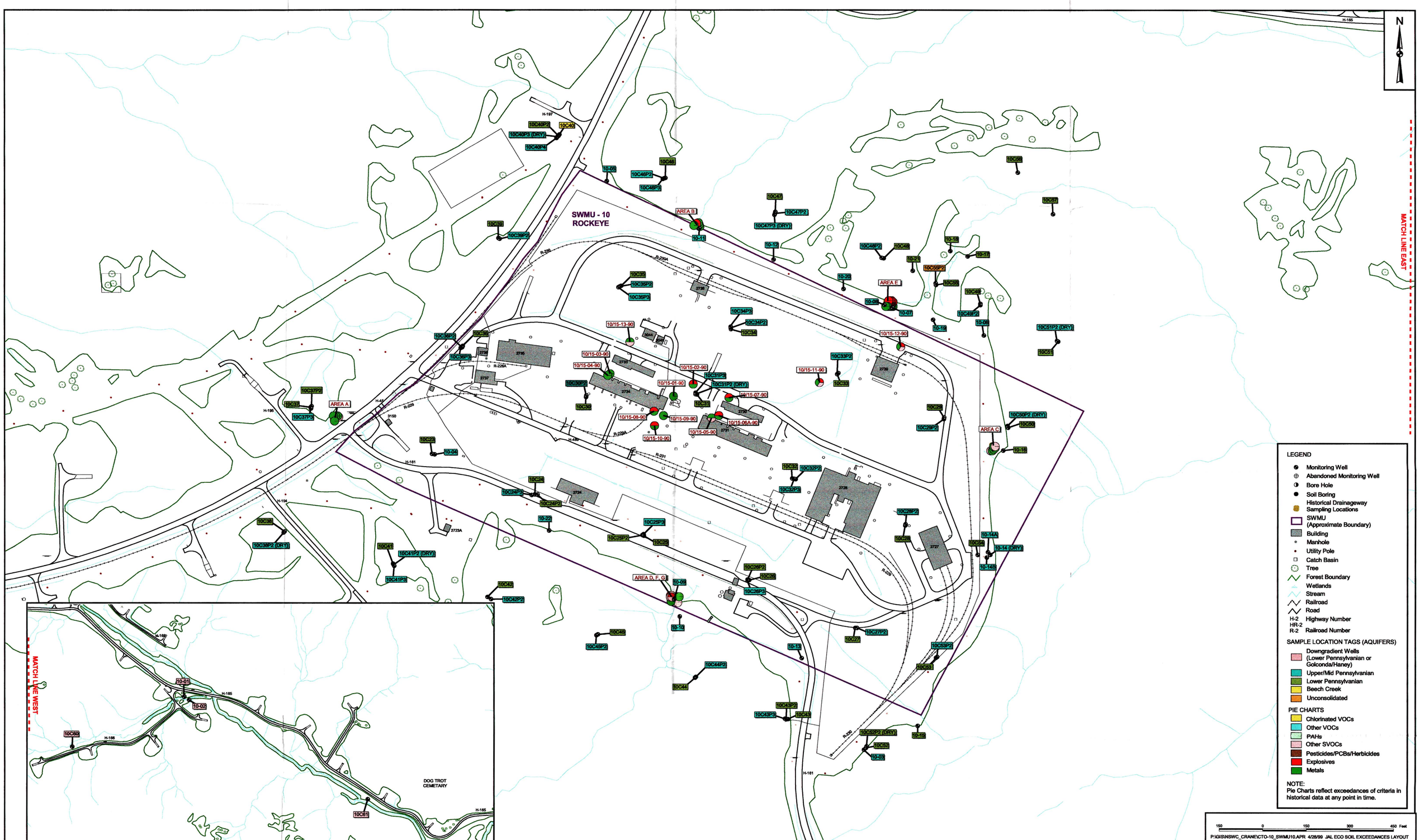
1 U.S. EPA, October 1996 and December 1998b.
2 U.S. EPA, Region 9, May 1998.
3 IDEM, October 1997.
4 U.S. EPA, December 1998a.
5 U.S. EPA, Region 5, April 1998 (Appendix C of guidance).
6 Total for all trihalomethanes (i.e., chloroform, bromodichloromethane, dibromochloromethane, and bromoform).
7 Based on organoleptic effects (i.e., which would make water and edible aquatic life unpalatable by not toxic to humans).
8 1,3-Dichloropropene.
9 o-, m-Xylene.
10 Chlordane.
11 Total for all Aroclor congeners.
12 Endosulfan.
13 Secondary MCL.

TABLE 8-8

SUMMARY OF HISTORICAL DATA - GROUND WATER, DOWNGRADIENT WELLS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
PAGE 6 OF 6

Chemical	Frequency of Detections	Range of Detections	Range of Nondetects	Location of Maximum Detection	Number of Results Exceeding Lowest Criteria	Ground Water			Surface Water	
						Federal MCL[1]	U.S. EPA Region 9 Tapwater[2]	IDEM Tier 1 Default Cleanup Level Residential Ground Water[3]	Federal AWQC Freshwater Chronic[4]	U.S. EPA Region 5 Surface Water EDQL[5]

14 Hexavalent chromium.
15 Action level.
16 Free cyanide.
17 Thallium carbonate.



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SCALE	
AS NOTED	

Tetra Tech NUS, Inc.

SOIL EXCEEDANCES - ECOLOGICAL
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO.	OWNER NO.
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APPROVED BY	DATE
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APPROVED BY	DATE
DRAWING NO.	REV.
FIGURE 8-4	

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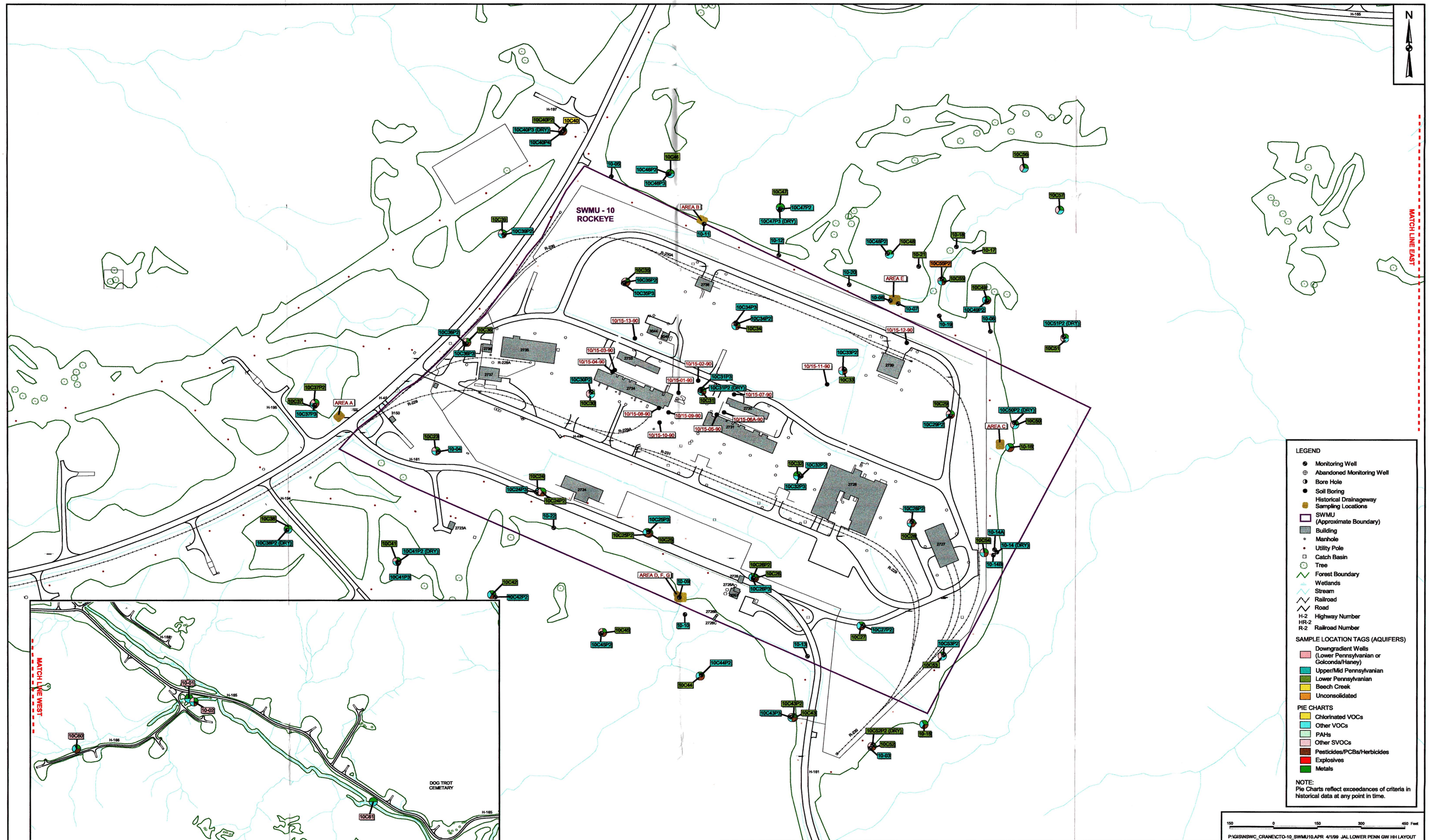

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COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

Tetra Tech NUS, Inc.

GROUND WATER EXCEEDANCES - HUMAN HEALTH
LOWER PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO.	OWNER NO.
7141	0010
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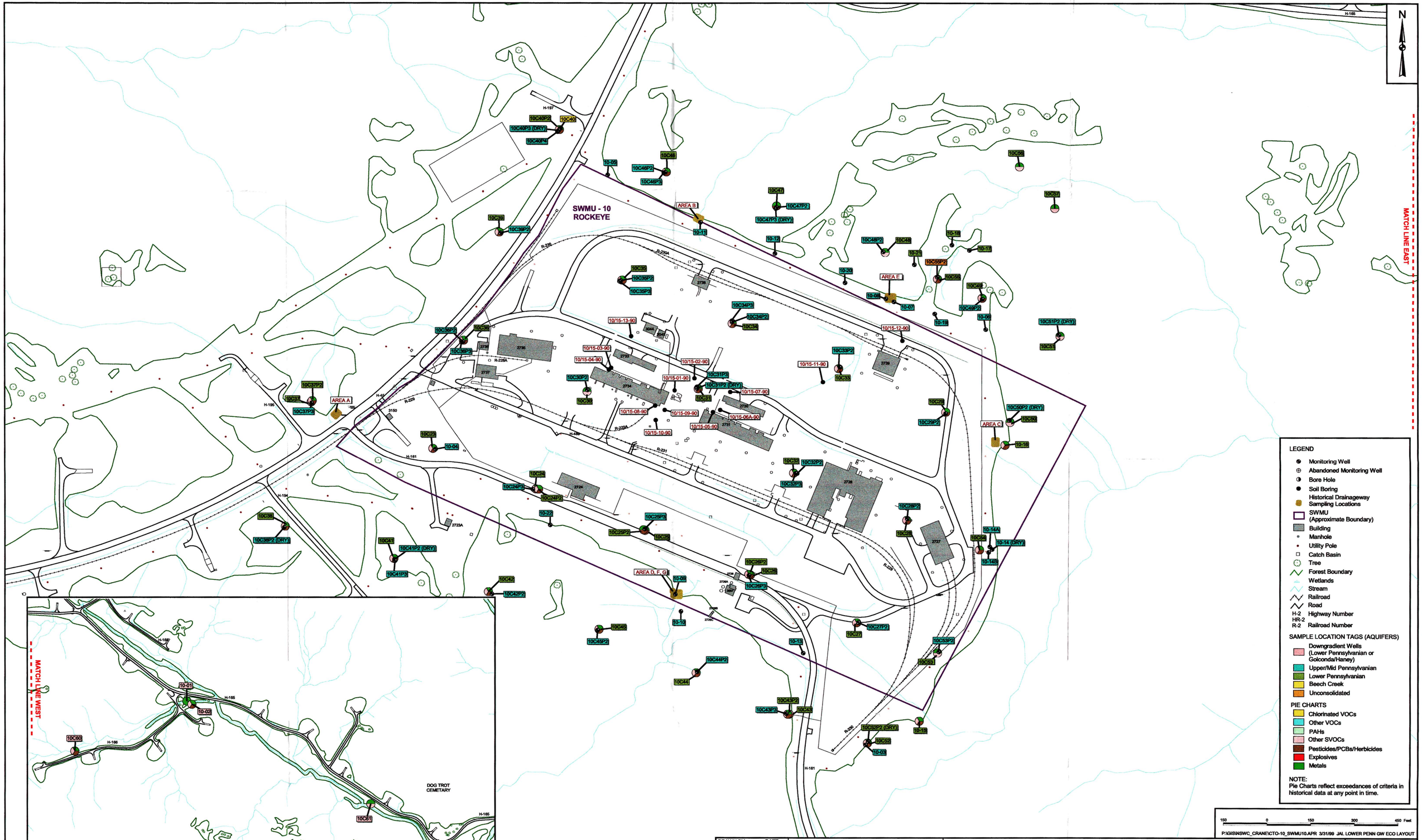
DRAWING NO.	REV.
FIGURE 8-5	—



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Tetra Tech NUS, Inc.

GROUND WATER EXCEEDANCES - ECOLOGICAL
LOWER PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO.	OWNER NO.
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APPROVED BY	DATE
K.M. Snedden	10/18/99
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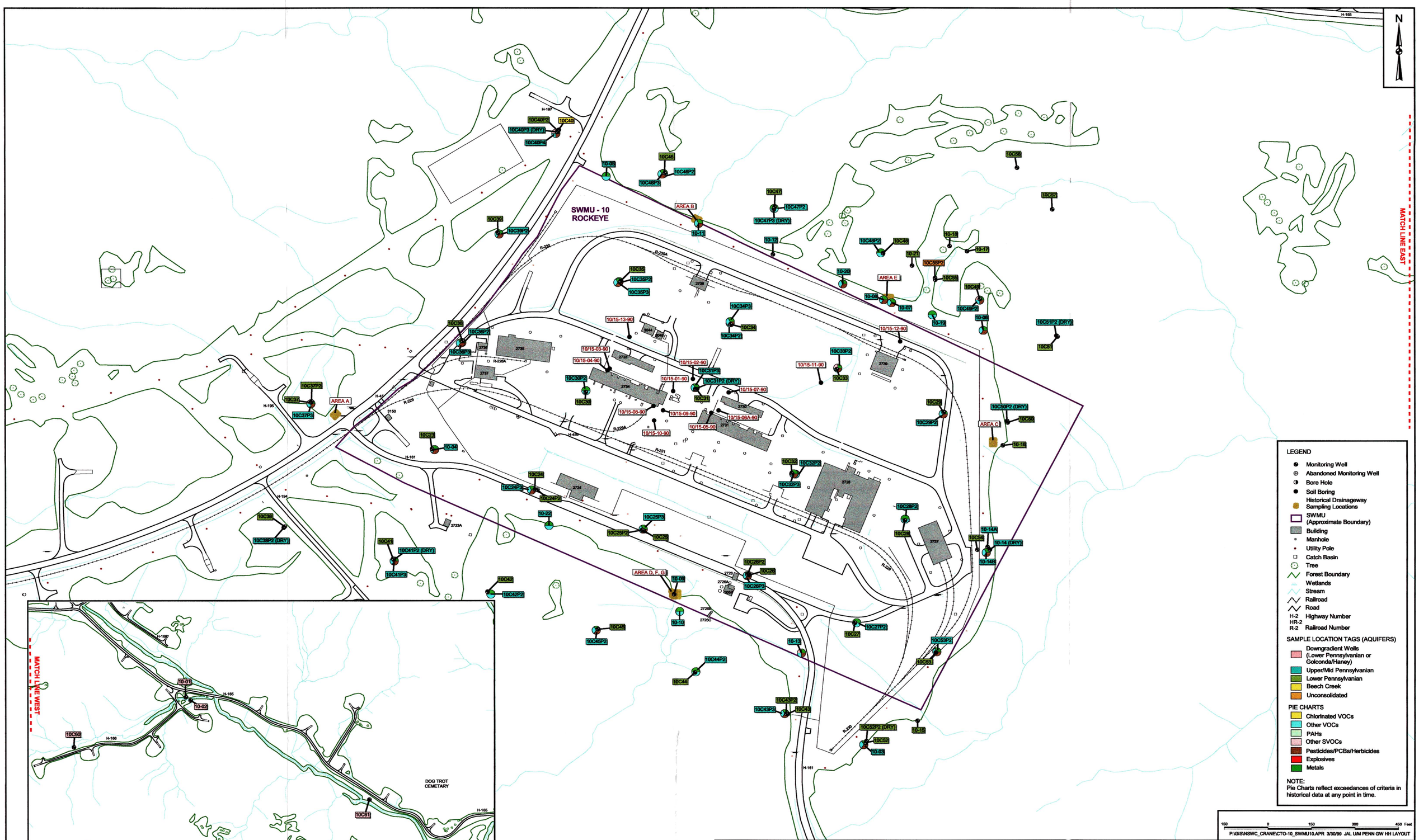
DRAWING NO.	REV.
FIGURE 8-6	



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SCALE	
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Tetra Tech NUS, Inc.

GROUND WATER EXCEEDANCES - HUMAN HEALTH
UPPER/MID PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO.	OWNER NO.
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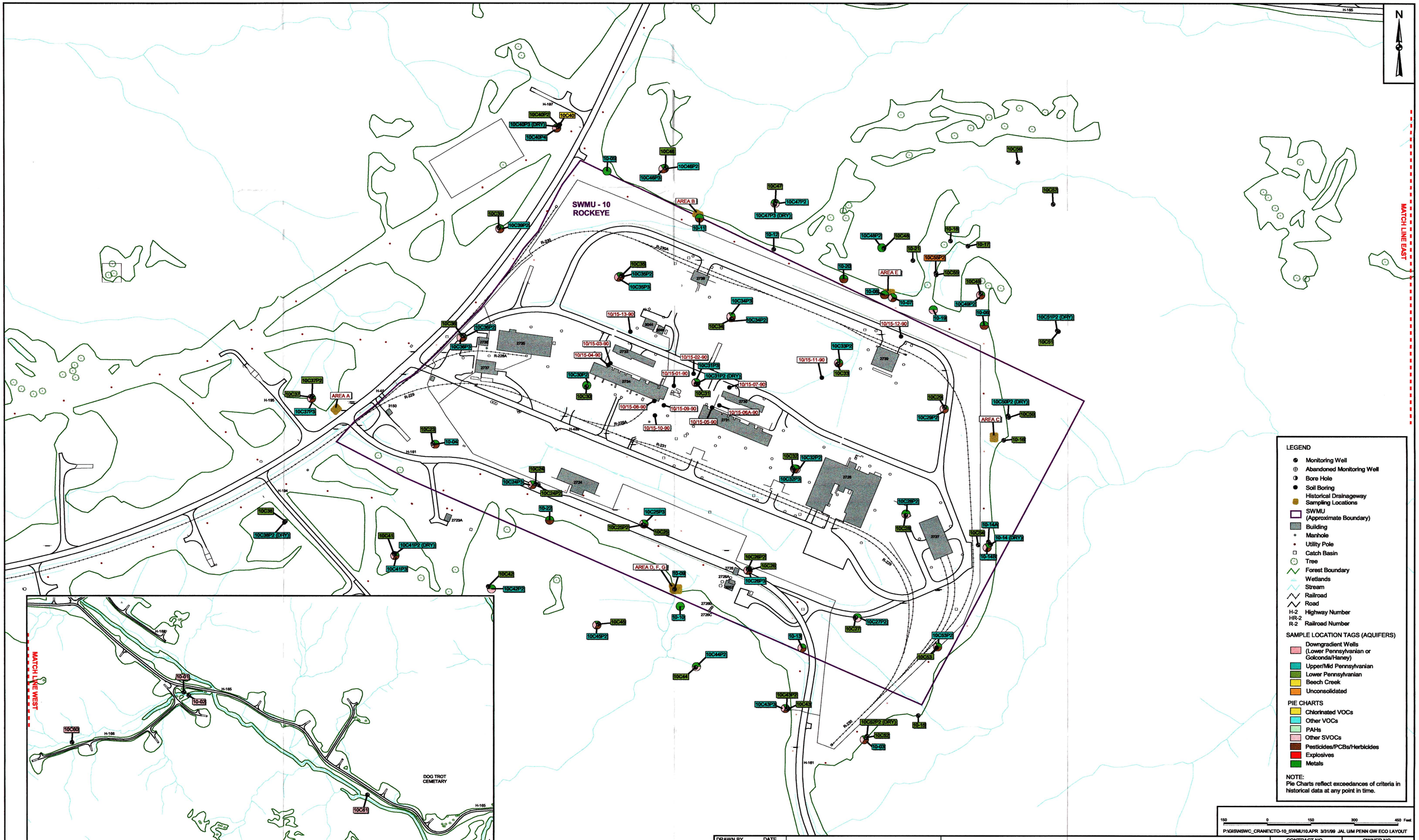
DRAWING NO.	REV.
FIGURE 8-7	



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J. LAMEY	3/31/99
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COST/SCHEDULE-AREA	
SCALE AS NOTED	

Tetra Tech NUS, Inc.

GROUND WATER EXCEEDANCES - ECOLOGICAL
UPPER/MID PENNSYLVANIAN AQUIFER
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO.	OWNER NO.
7141	0010
APPROVED BY	DATE
RC Tuckell	10-19-97
APPROVED BY	DATE
DRAWING NO.	REV.
FIGURE 8-8	

leading from the site. Subsurface soil samples also contained sporadic detectable concentrations of explosives. However, reported concentrations in these samples were relatively low (i.e., less than risk-based screening levels).

Explosives were detected in the unconsolidated aquifer and the two bedrock aquifers: Pennsylvanian (upper/middle and lower) and Golconda aquifers. The highest concentrations of explosives were found in the lower Pennsylvanian aquifer. The presence of explosives in ground water was confirmed during quarterly and semi-annual monitoring efforts. Explosives were predominantly found in the ground water samples collected from onsite and offsite monitoring wells located in the northeastern portion of the site. These wells are downgradient of what is the presently active area of Rockeye (i.e., the production facility).

Semivolatile organic compounds, primarily PAHs, were detected in the soil sample collected from one area of the site. This area is referred to as Area H (see Figure 8-2), where a sample was obtained near the air discharge vent from Building 2734. Although reported concentrations of a few semivolatiles exceeded risk-based concentrations, these chemicals are isolated to areas near the discharge and not found throughout the entire site. Semivolatiles were not detected in the ground water at the site, supporting the interpretation that these chemicals are not significant detected parameters of interest.

Acetone, 2-butanone, chloroform, methylene chloride, and several phthalates were detected in the soil and/or ground water samples collected at the SWMU 10. Several reported concentrations of these chemicals exceeded risk-based criteria, as illustrated on Figures 8-3 through 8-8. These chemicals were detected in the laboratory and field QC blanks associated with the site samples. Therefore, they are not considered to be site-related constituents and were eliminated as parameters of interest for Rockeye. These chemicals were also reported at similar concentrations in environmental samples collected at SWMUs 4, 5, and 9, supporting the conclusion that the presence of these chemicals are attributable to contamination introduced through sampling (decontamination or ambient conditions) or laboratory analysis.

Benzene, Aroclor-1254, a few miscellaneous volatile organics (such as 1,1,1-trichloroethane and xylenes), and various herbicides and pesticides were found in the soil and/or ground water samples at the site these chemicals were detected in ground water samples collected from all aquifers and in various locations (wells) throughout the site. These constituents, which were only sporadically detected in the site soils, were most consistently found in the ground water samples collected during the 1991 and 1992 sampling event. Considering the historical site operations, it is unlikely that these constituents are present as a result of previous site activities. These chemicals were typically present at low levels (i.e., less than 5 µg/L) in the site media and are considered to be a result of historical Basewide management

practices. Historically, it was common practice to treat areas alongside roadways with a mixture of herbicides and waste fuel oils. Given that Rockeye is an active facility, additional landspreading of fuel oil treated with pesticides and herbicides is likely to have occurred. Aroclor-1254, herbicides, and pesticides have been detected in the ground water at SWMUs 4, 5, and 9, which indicates that these chemicals are not present due to specific activities performed at SWMU 10. Their presence is attributed to Basewide practices as described above.

8.4.2 Inorganic Constituents

A variety of inorganics was found in the soil and ground water at Rockeye. Those inorganics detected at concentrations in excess of the lowest screening criteria are, as follows:

- Soil: Antimony, arsenic, barium, beryllium, cadmium, chromium (total), cobalt, copper, iron, lead, nickel, tin, and zinc

- Ground Water: Aluminum, antimony, arsenic, beryllium, cadmium, chromium (total), cobalt, copper, cyanide, iron, lead, manganese, mercury, nickel, selenium, thallium, vanadium, zinc, nitrate, nitrite, and sulfide.

Inorganics were detected at concentrations exceeding risk-based screening criteria in most wells in the various aquifers at the site. For conservative purposes and because of the uncertainty associated with the historical data, inorganics were identified as detected chemicals of interest for SWMU 10. However, based on statistical analyses performed during previous site investigations (U.S. ACE WES, 1993), the presence of inorganics in ground water may be attributable to background, rather than site operations. Naturally occurring acidic soil conditions (i.e., low soil pH) may enhance the leaching of inorganics in native soil to the ground water. In addition, inorganics detected in the soils at Rockeye are statistically similar to those concentrations detected in the background samples collected during previous investigations (U.S. ACE WES, 1998d).

8.4.3 Summary of Detected Chemicals of Interest

The following constituents are detected chemicals of interest for soil and ground water at SWMU 10, Rockeye (i.e., chemicals reported at concentrations in excess of risk-based screening criteria and determined to be site-related):

- Soil: 2,4-Dinitrotoluene, 2,6-dinitrotoluene, HMX, RDX, 2,4,6-trinitrotoluene, and various inorganics
- Ground Water: Amino-dinitrotoluenes, 2,4-dinitrotoluene, 2,6-dinitrotoluene, HMX, RDX, 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, and various inorganics

This list was used to develop appropriate chemical categories to be included in the analytical program for the proposed field investigation, which is presented in the following section.

8.5 PROPOSED INVESTIGATION

The proposed field investigation for SWMU 10, Rockeye, was developed based on a site-specific CSM. The general methodology used to develop the proposed investigation (and CSM) was presented in Section 4.0. This section of the work plan provides the rationale for the proposed site-specific investigation.

8.5.1 Conceptual Site Model

The CSM for the Rockeye site, which defines the contaminant source, transport mechanisms, exposure routes, and potential receptors for the site is presented in Figure 8-9. Based on a review of the existing data for the site, a release of hazardous constituents to the surrounding soil and drainageways has occurred as a result of historical site operations (i.e., bomb production). The historical data also indicates that contaminants have migrated to ground water via infiltration/percolation. Prior to installation of a wastewater treatment facility, sumps receiving production wastewater discharged directly to streams and/or tributaries of Furst, Sulphur, and Turkey Creek. Additional release mechanisms, which are also expected to contribute to the contaminant transport, include discharge of ground water to surface water/sediment, deposition via surface water runoff, and deposition of fugitive dust and volatile emissions to soils from production operation

Land use at Rockeye is not expected to change from its present use as a munitions production facility. Based on the general scenarios and receptor classes identified in Section 4.0, the following potential receptors may be exposed to contaminated media at the site:

- Trespassers (ages 6 to 17 years) – Likely receptor under future land use. This receptor may be exposed to potentially contaminated surface soil, air surface water, and sediment in tributaries of Furst, Sulphur, and Turkey Creeks. Because this site is active, it is unlikely that there would be current exposure for this receptor.

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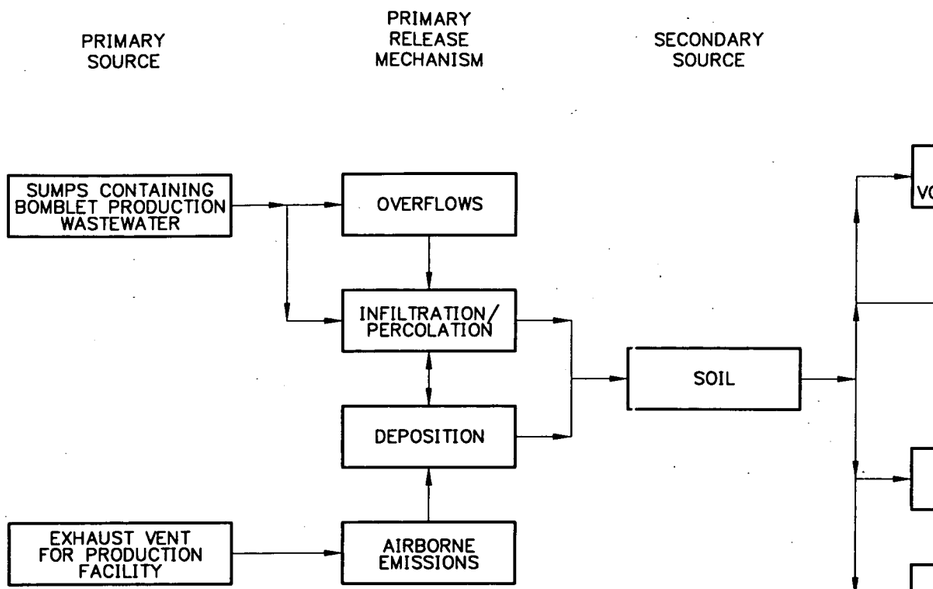
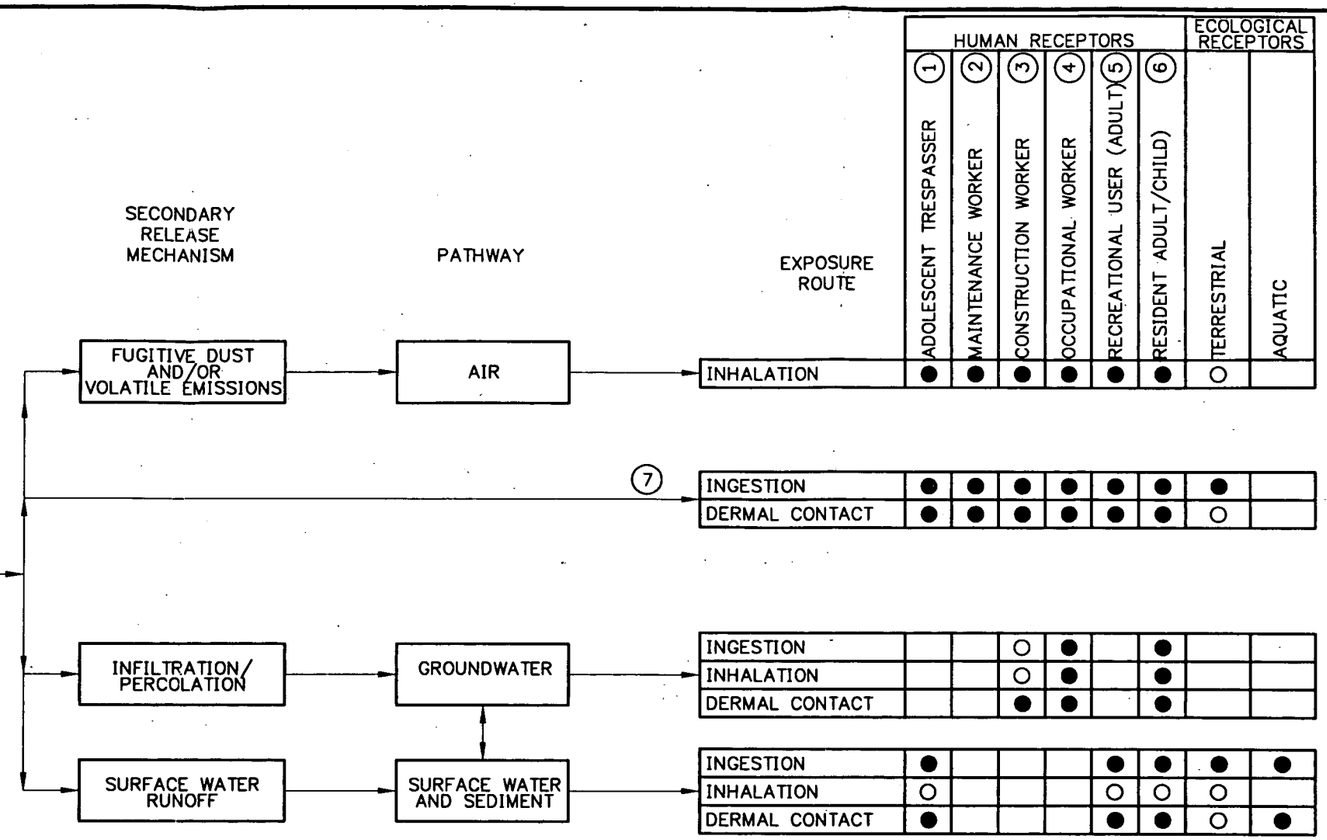




KEY

1. POTENTIAL RECEPTOR UNDER FUTURE USE. ACCESS TO THE SITE IS PHYSICALLY RESTRICTED BY A CHAIN-LINK FENCE.
2. POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. SITE IS CURRENTLY MAINTAINED.
3. POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. ADDITIONAL BUILDINGS COULD BE CONSTRUCTED AND UTILITY INSTALLATIONS COULD OCCUR.
4. POTENTIAL RECEPTOR UNDER CURRENT AND FUTURE LAND USE. THE SITE IS CURRENTLY USED FOR OCCUPATIONAL PURPOSES.
5. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. BASE COULD CLOSE AND BE TURNED INTO A STATE PARK.
6. POTENTIAL RECEPTOR UNDER FUTURE LAND USE. EVALUATED FOR DECISION-MAKING PURPOSES.
7. FOODCHAIN MODELING WILL BE CONDUCTED FOR ECOLOGICAL RECEPTORS.

● EXPOSURE PATHWAY TO BE EVALUATED IN THE RISK ASSESSMENT.

○ RELATIVELY INSIGNIFICANT POTENTIAL EXPOSURE PATHWAY COMPARED TO OTHER PATHWAYS EVALUATED IN THE RISK ASSESSMENT. RISKS NOT EVALUATED QUANTITATIVELY.

NO.	DATE	REVISIONS	BY	CHKD	APPD

REFERENCES

DRAWN BY MF DATE 3/3/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE NONE

CONCEPTUAL SITE MODEL
SWMU 10-ROCKEYE
NSWC CRANE, INDIANA

CONTRACT NO. 7141
APPROVED BY K.M. Spudic DATE 10/18/99
APPROVED BY DATE
DRAWING NO. FIGURE 8-9
REV. 0

FORM CADD NO. SDV_BH12.DGN - REV 0 - 1/20/98

- Maintenance Workers – Likely receptor under current and future land use. Rockeye is currently maintained and this receptor may be exposed to potentially contaminated surface soil and air. Exposure to ground water at the site and surface water and sediment in the creeks is not expected to occur.

- Construction Workers – Potential receptor under current and future land use. Very infrequently, upgrading to the bonding and grounding at Rockeye occurs. This process requires excavation. In the future, no construction activities are currently planned at the site. However, the site could be developed or a small, short-term construction project, such as a utility installation, could result in exposure to potentially contaminated media. This receptor may be exposed to surface and subsurface soil, air and ground water.

- Occupational Workers - Likely receptor under current and future landuse. Currently, the site is active and receptors may be exposed to surface soil and air. In the future scenario, the receptor may be exposed to surface soil, air and ground water. Exposure to surface water and sediment is not expected to occur.

- Recreational Users – Potential receptor under future land use. If the Facility were to close, the most likely scenario is that the property would be converted into a state park. This receptor may be exposed to potentially contaminated surface soil, air, surface water, and sediment in the creeks located near the site. However, it is highly unlikely that NSWC Crane would close because principal Base operations, the demilitarization of munitions, are critical to support the U.S. Naval Fleet.

- Residents – Potential receptor under future land use. The site could be developed for residential land use, if the Facility were to close. Future residents may be exposed to potentially contaminated surface soil, air, ground water, surface water, and sediment. Although this scenario is highly unlikely, a future residential scenario is typically evaluated in the risk assessment for decision-making purposes.

- Ecological Receptors – Under current and future land use, various ecological receptors, terrestrial and aquatic, are also likely to come in contact with site media. Terrestrial receptors may contact potentially contaminated surface soils, ingest contaminated prey items and/or surface water. Aquatic receptors may be exposed to potentially contaminated surface water, prey, and sediment.

Details regarding the assumed receptor characteristics (intake rate, frequency and duration of exposure, body weight, etc.) are defined in Sections 10.0 and 11.0 of this Work Plan, which present the methodologies for the human health and ecological risk assessments.

8.5.2 Proposed Sampling and Analysis

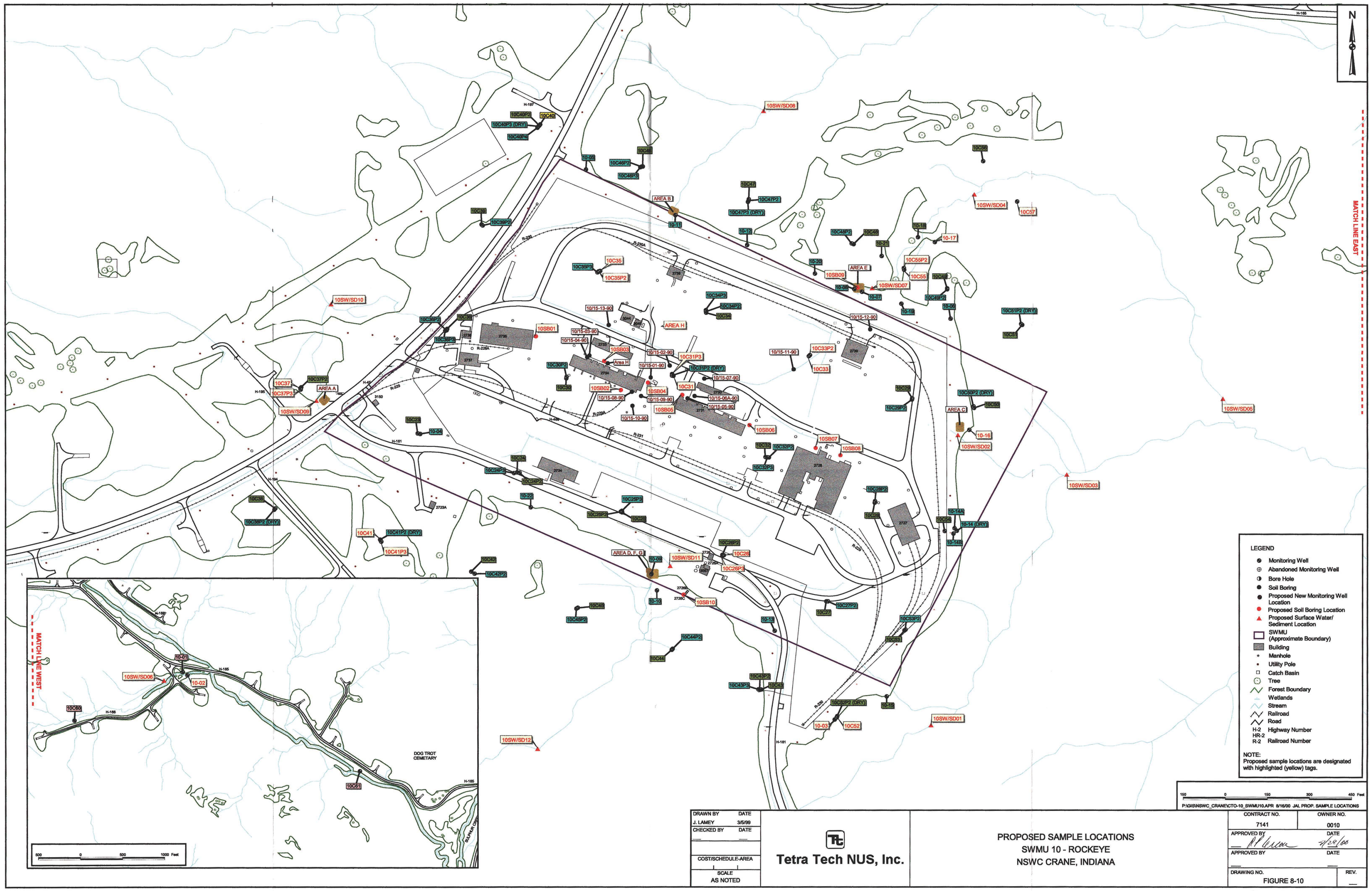
The primary objective of the proposed field investigation is to collect field and laboratory data needed to evaluate the potential risks for human and ecological receptors identified in the CSM. Figure 8-10, identifies the proposed sample locations. Table 8-9 summarizes the proposed sampling and analysis for SWMU 10, Rockeye, including overall objectives and purposes for the selection of a particular sampling point. The remainder of this section provides the rationale for the proposed sampling and analysis program.

As depicted on Table 8-9, environmental samples collected from the site will be analyzed for a various field and laboratory parameters. Field parameters will be collected for ground water and surface water samples. Typical water quality indicator parameters, such as turbidity, pH, dissolved oxygen, specific conductance, oxidation reduction potential and temperature, will be collected for these samples. Soil samples collected at the site will be screened for VOCs using monitoring equipment (a PID) and visually observed for signs of staining or saturation.

Soil, sediment, surface water, and ground water samples at Rockeye will be collected and analyzed for the Appendix IX organic and inorganic constituents, explosives, miscellaneous metals, and nitrate/nitrite. Surface water samples also will be analyzed for total and dissolved inorganics, hardness, and TSS and sediment samples will be analyzed for TOC to assist in assessing the potential risks for ecological receptors. Additionally, soil characteristic parameters (CEC, pH, and TOC) will be collected to determine the likelihood of the potential fate and transport of contaminants at the site (and the potential for risks outside the site boundaries). Ground water samples will not be analyzed for dissolved organics since low flow sampling procedures will be used to eliminate turbidity concerns.

As noted previously, Figure 8-10 illustrates the proposed sampling locations for the field investigation at Rockeye. The rationale for the collection of these samples is, as follows:

- Surface/Subsurface Soils (Borings) (20): To assess the potential risks associated with residual soil contamination at SWMU 10, 10 soil borings will be installed at the site. Eight of the soil borings will focus on the sumps/discharge areas around the five main buildings of the facility. One boring will be placed in Area E to evaluate soil conditions in an area where "Pink Water" discharges pooled. A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10SW/SD11
10SW/SD12
10SB01
10SB02
10SB03
10SB04
10SB05
10SB06
10SB07
10SB08
10SB09
10SB10
DOG TROT CEMETARY
LEGEND
Monitoring Well
Abandoned Monitoring Well
Bore Hole
Soil Boring
Proposed New Monitoring Well Location
Proposed Soil Boring Location
Proposed Surface Water/ Sediment Location
SWMU (Approximate Boundary)
Building
Manhole
Utility Pole
Catch Basin
Tree
Forest Boundary
Wetlands
Stream
Railroad
Road
H-2 Highway Number
HR-2
R-2 Railroad Number
NOTE:
Proposed sample locations are designated with highlighted (yellow) tags.
150 0 150 300 450 Feet
P:\GIS\NSWC_CRANE\CTO-10_SWMU10.APR 8/16/00 JAL PROP. SAMPLE LOCATIONS
DRAWN BY J. LAMEY DATE 3/5/99
CHECKED BY
COST/SCHEDULE-AREA
SCALE AS NOTED
Tetra Tech NUS, Inc.
PROPOSED SAMPLE LOCATIONS
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA
CONTRACT NO. 7141
OWNER NO. 0010
APPROVED BY
DATE 8/28/00
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TABLE 8-9

SUMMARY OF OBJECTIVES/PROPOSED SAMPLING
SWMU 10 - ROCKEYE
NSWC CRANE, INDIANA

OVERALL OBJECTIVES FOR SAMPLING PROGRAM

TYPE OF PROGRAM / SAMPLING OBJECTIVE	PARAMETER TYPE	TARGET CONSTITUENTS[1]	OBJECTIVE FOR ANALYSIS	LIMIT OF DETECTION	EVALUATIONS TO BE PERFORMED
Type: RCRA Risk Assessment to fulfill requirements of RCRA Part B permit. Objectives: Determine human health and ecological risks for potential receptors exposed to site media under current and future land use. Determine if there has been a release of hazardous constituents to off-SWMU surface water and sediment	Field (Soil, Ground Water, and Surface Water)	Dissolved Oxygen Oxidation Reduction Potential pH Specific Conductivity Temperature Turbidity PID Reading[2]	Evaluate general water quality. Determine if well water is equivalent to formation water (i.e., stability). To determine the correct subsurface soil sample interval (PID reading only).	As per selected field instrumentation, instrumentation will be calibrated according to the manufacturer's manual.	Qualitatively used to evaluate general water quality.
	Laboratory (Soil, Ground Water, Surface Water, and Sediment)	Explosives Appendix IX VOCs Appendix IX SVOCs Appendix IX Inorganics (total and dissolved)[3] Nitrate/Nitrite Cyanide (total and dissolved[3]) Miscellaneous Inorganics[4] (total and dissolved[3])	To obtain a representative presentation of the nature and quantity of constituents that were released to media by past operational activities.	Reporting limit low enough to meet Federal/State ARARs/TBCs and evaluate adverse human health and environmental impacts.	Comparison of constituents found in site media to risk-based screening criteria to determine if these media were impacted by past operations. Comparison of inorganic site soil data to established Basewide background levels for similar soil types. Estimate human health risks, as outlined in Section 10.0, Figure 10-1. Estimate ecological risks, as outlined in Section 11.0, Figure 11-1.
		Hardness[5] TSS[5]	Evaluate surface water conditions.	As per chosen laboratory methods.	To be used to assess potential risks for ecological receptors.
		CEC[6] pH[6] TOC[6]	Evaluate soil conditions (e.g. migration potential, etc.)	As per chosen laboratory methods.	Evaluate the potential for contaminant migration from the site and the potential for risks outside the site boundaries. For sediments, to be used to assess potential risks to ecological receptors.

SPECIFIC OBJECTIVES FOR SAMPLING LOCATIONS

MEDIUM	SAMPLE COLLECTION TECHNIQUE	SAMPLING POINT[7]		
		SAMPLE LOCATION	COMMENT	OBJECTIVE OF LOCATION
Surface/Subsurface Soil	Grab surface soil sample; specific collection technique identified in FSP, Section 2.4.2.1. Grab subsurface soil sample; specific collection technique identified in FSP, Section 2.4.2.3.	10SB01 through 10SB08	These 8 borings will be located at the sumps/discharge areas throughout the active area of the SWMU. A sample will be collected at the ground surface (0 to 2 feet bgs) and at a discrete depths between 2 to 10 feet bgs (interval based on field screening). If the water table is encountered within the 2 to 10 ft interval, the sample at depth will be collected from a depth above the water table. Two samples from 8 borings for a total of 16 samples.	Evaluate contaminant concentrations at sumps/discharge areas throughout the site for site for surface and subsurface soil. The soil depths reflect the exposure pathways for the identified potential receptors.
		10SB09	Soil boring located in Area E. Pink Water discharges from Rockeye pooled and collected in this area. A sample will be collected at ground surface (0 to 2 feet bgs) and at discrete depths between the 2 to 10ft interval (interval based on field screening). If the water table is encountered within the 2 to 10 ft interval, the sample depth will be collected from a depth above the water table. Two samples from one boring for a total of two samples.	Evaluate surface and subsurface soil conditions at an area where Pink Water discharge collected.
		10SB10	Soil boring located in the southern portion of the site near Building 2726C. This is positioned where a solvent tank used to be located. A sample will be collected at ground surface (0 to 2 ft bgs) and at discrete depths between the 2 to 10 ft. interval (interval based on field screening). If water table is encountered within the 2 to 10 ft. interval, the sample depth will be collected from a depth above the water table. Two samples from one boring for a total of two samples.	Evaluate surface and subsurface soil conditions at a previously located solvent tank.
Ground Water	Grab sample; specific collection technique identified in FSP, Section 2.4.1.	10C37 and 10C37P3	Sample existing monitoring well on the western side of the side, west of Highway 45.	Evaluate ground water quality at a location immediately west of the site.
		10C31 and 10C31P3	Sample existing monitoring well located centrally in the active area of the site.	Evaluate ground water quality at a location impacted by site activities.
		10-16	Sample existing monitoring well east of the site.	Evaluate ground water quality at a location immediately east of the site.
		10C35, 10C35P2, 10C33, 10C33P2, 10C55, 10C55P2, 10-17, and 10C-57	Sample existing wells located in the north central and north west area of the site.	Evaluate ground water quality at a location impacted by site activities.
		10C52, 10-03, 10C41, 10C41P3	Sample existing wells located in the south end of site.	Evaluate ground water quality at an upgradient location is not impacted by site activities.
		10-2	Sample existing well locatad east of the site.	Evaluate ground water quality at a location east of the site that indicates a connection between ground water and surface water.
		10C26 and 10C26P3	Sample existing wells located in the south central end of site.	Evaluate ground water quality near historical solvent tank locations.
Surface Water/Sediment[8]	Grab sample; specific collection technique identified in FSP, Section 2.4.3 (surface water) and 2.4.4 (sediment).	10SW/SD01	Location is southeast of the site outside the site boundaries in a tributary.	Evaluate surface water/sediment quality at a location immediately downstream of the site.
		10SW/SD02, 10SW/SD03, 10SW/SD05, and 10SW/SD06	Locations are east of the site near an area where wash water from munition production was released. Locations at drainpipe and further downstream in the tributary.	Evaluate surface water/sediment quality at a location impacted by site activities and at a downstream locations.
		10SW/SD04	Location is northeast of the site near an area where wash water from munition production was released (drainpipe).	Evaluate surface water/sediment quality at a location impacted by site activities.
		10SW/SD08	Location is north of the site outside the site boundaries in a tributary.	Evaluate surface water/sediment quality at locations downstream of the site.
		10SW/SD09 and 10SW/SD10	Locations are west of the site near an area where wash water from munition production was released. Locations at drainpipe and further downstream in the tributary.	Evaluate surface water/sediment quality at a location impacted by site activities and at a downstream location.
		10SW/SD11 and 10SW/SD12	Locations are south of the site near an area where wash water from munition production was released. Locations at drainpipe and further downstream in the tributary.	Evaluate surface water/sediment quality at a location impacted by site activities and at a downstream location.
		10SW/SD07	Location is near Area E where at various times of Pink Water discharges, the water pooled and this area acted as a collection point.	Evaluate surface water/sediment quality at potential "Pink Water" discharge collection part.

ARARs Applicable, Relevant, and Appropriate Requirements
CEC Cation Exchange Capacity
FSP Field Sampling Plan
PID Photoionization Detector
QAPP Quality Assurance Project Plan
TAL Target Analyte List
TBCs To Be Considered Values
TOC Total Organic Carbon

1 The list of specific chemicals included as target constituents are identified in the QAPP, Section 1.0, Table 1-1. Constituents to be analyzed for all samples, all matrices collected, unless otherwise noted.
2 Soil samples only will be monitored with a PID. The other identified field parameters will be collected for ground water and surface water.
3 Total and dissolved inorganic analyses will be performed for surface water.
4 Miscellaneous inorganics include calcium, iron, magnesium, manganese, potassium, and sodium.
5 Analyses performed on surface water samples only.
6 Analyses to be performed on 30 percent of the soil samples collected.
7 Proposed sampling locations are identified on Figure 8-10.
8 Due to the intermittent flow, surface water may not be available at all sample locations.

boring will be placed near Building 2726C because it is historically documented that a chlorination tank for the now incapacitated sewage treatment plant was present in this area. One surface and one subsurface sample (for a total of 20) will be collected from each soil boring (10). Surface soil samples will be collected from a depth of 0 to 2 feet bgs. Subsurface intervals (2 to 10 feet bgs) will be screened and selected based on the presence of organic contamination (highest PID readings), staining, or saturation. Random subsurface intervals will be selected if screening indicators are absent. The soil sample taken near Area H will be analyzed for SVOCs. All soil samples will be analyzed for inorganics and explosives.

- Ground Water (20): Twenty ground water samples will be collected from existing single or cluster wells at the site to assess the potential risks associated with the migration of soil constituents to ground water. No new monitoring wells will be installed during this field effort. The list of monitoring wells to be sampled are included on Table 8-9. Ground water samples from four wells (10-03, 10C52, 10C41, 10C41P3) will be collected to evaluate water quality upgradient of Rockeye. These wells will be analyzed for VOCs, inorganics, and explosives. Two cohorts (10C31 and 10C31P3) of one well cluster will characterize ground water affected by the central active area of the production facility between Buildings 2734 and 2731. These four wells will be analyzed for VOCs, inorganics, and explosives. During the RFI studies, wells 10-17 and 10C55, which are downgradient of the active area of the site, consistently showed the highest concentrations of explosives. Impacts to ground water north (downgradient) of the site will be determined by sampling monitoring wells 10C33, 10C33P2, 10C55, 10C55P2, 10-17, and 10C57. Of these wells only 10C55 and 10C55P2 will be analyzed for VOCs. All wells will be analyzed for inorganics and explosives. The connection of ground water and surface water at Sulphur Creek will be evaluated by measuring the quality of ground water in well 10-02, which is located approximately 1500 feet east of the site. Samples will be collected from wells 10C35 and 10C35P2 to evaluate the ground water migration northwest of Rockeye. Two cohorts (10C37 and 10C37P3) of one well cluster will be sampled to assess ground water migration west of the site (near the Area A drainageway). One monitoring well, 10-16, will be used to assess ground water quality east of the site (near the Area C drainageway). Two wells (10C26 and 10C26P3) located in the south central area of the site near Building 2726C will be sampled. These samples will be analyzed for only VOCs to determine the impact on surface water quality from an historical solvent tank.

- Surface Water and Sediment (12 each): To determine the potential risks associated with migration (ground water discharge and surface runoff) of ground water and soil chemicals to surface water and sediment, collocated surface water and sediment samples will be collected from 12 offsite locations. Prior to 1978, explosive-contaminated wastewater collected in sumps on the north side of Buildings

2734 and 2731 and were released to several drainageways, which lead to various tributaries and/or creeks. Samples from six stations (10SW/SD01, 10SW/SD02, 10SW/SD03, 10SW/SD04, 10SW/SD05, 10SW/SD06) will be used to evaluate contributions of affected runoff from the northern (Area E) and eastern drainageways (Area C), which lead to a tributary of Sulphur Creek. 10SW/SD08 will assess impacts of runoff northwest of the site. West of the site, runoff from the Area A drainageway, which leads to a tributary of Furst Creek, will be assessed by the collection of samples at two stations (10SW/SD09 and 10SW/SD10). Contributions from the south side of the facility to Turkey Creek will be determined by collecting samples at two stations (10SW/SD11 and 10SW/SD12) near the Area D, F, and G and drainageways. Samples from 10SW/SD07 will be used to evaluate contributions of "Pink Water" discharge that pooled near Area E.

The associated FSP, presented in Appendix A, provides details on the field sampling procedures (installation of soil borings and monitoring wells and sampling) to be used at the site. The associated HASP is contained in Appendix B. The QAPP, located in Appendix C, provides details on the analytical methodologies to be used for the proposed field of investigation.

The data collected during the proposed field investigation will be used to assess potential risks for human and ecological receptors exposed to site media under current and/or future land use. A description of how the data obtained during the proposed field investigation will be managed prior to use in the risk assessment is presented in Section 9.0. General methodologies and techniques used to calculate potential risks for the site are provided in Sections 10.0 (human health) and 11.0 (ecological).

9.0 DATA MANAGEMENT

All environmental and physical data collected for the SWMUs will be incorporated into a Basewide relational database and Environmental Geographic Information System (EGIS). TtNUS has the responsibility of managing the data obtained during the proposed field investigations, in addition to the existing data collected during previous site investigations. The general procedures to be used to manage the data collected to support risk assessment activities at SWMUs 4, 5, 9, and 10 are presented in this section. Data management activities specific to the reduction, validation, and reporting of the field and laboratory data are presented in Section 9.0 of the associated QAPP.

9.1 PROJECT PLANNING

To ensure that the data collected meet the needs of the project, several project planning procedures will be implemented prior to the conductance of the proposed field investigations for SWMUs 4, 5, 9, and 10. These planning procedures are discussed below.

9.1.1 Kick-off Meeting

Prior to conducting the proposed field investigations, an internal TtNUS kick-off meeting will be conducted to outline the data needs of the task order. Attendees to the kick-off meeting will include the TOM, the human health risk assessment lead, the ecological risk assessment lead, the FOL, the project chemist, the data management lead, and the EGIS lead. The data management lead will distribute a copy of the data management checklist (Appendix E) and will lead the project team through its contents. A review of the data management checklist will allow the project team to better understand how the data will be managed and manipulated to achieve the project needs and objectives. A completed copy of the data management checklist will be maintained in the TtNUS project central file and distributed to all project team members within 7 days of the kick-off meeting.

9.1.2 Sample Nomenclature and Survey Data Requirements

Sample nomenclature for the project is addressed in Section 2.6 of the attendant FSP (CTO 10 SOP 10). It is the responsibility of the FOL to comply with the sample and location nomenclature. It is also the responsibility of the FOL to coordinate with the EGIS lead to ensure that all survey technical specifications require the proper coordinate system, which is Indiana State Planar - North American Datum 1983 for the horizontal coordinates and National Geodetic Vertical Datum 1988 for the vertical coordinates.

9.1.3 Sample Tracking

A sample tracking system will be used to monitor and ensure that all samples identified in the proposed field investigations are collected. Prior to field mobilization, the FOL will coordinate with the Sample Management Coordinator (SMC) to initiate a sample tracking process. It is the responsibility of the TOM to ensure that a sampling tracking procedure is implemented. In the event that a field change has taken place, the FOL will be required to complete the Field Change Notification Form to document deviations from the proposed sampling.

9.1.4 Laboratory Electronic Deliverables

According to all laboratory technical specifications for NSWC Crane, the analytical laboratories will be contractually required to deliver the analytical data in the standard Electronic Data Deliverable (EDD) format provided in Appendix F. Particular attention will be paid to the EDD requirements for validated vs. non-validated data. Once all samples and analyses are accounted for, the SMC will forward the analytical data to TtNUS for incorporation into the NSWC Crane database.

9.2 DATABASE

The contents of the database to be maintained by TtNUS for SWMUs 4, 5, 9, and 10 is outlined in the Database Structure, provided in Appendix G. The Database Structure will outline what data are contained within the database (by investigation, media, etc.), the generator of the data (TtNUS, Corps of Engineers, etc.), and the level of quality of the data, where applicable.

It is the responsibility of the TtNUS data manager to coordinate with the NSWC Crane project team to keep the Database Structure current and make available the most recent version to all team members. A copy of the Database Structure shall be maintained in the project central file at TtNUS's Pittsburgh, Pennsylvania office.

9.3 THE ENVIRONMENTAL GEOGRAPHIC INFORMATION SYSTEM

All environmental data collected in support of the NSWC Crane project will be incorporated into the EGIS. The themes, layers, and database information contained in the EGIS are outlined in the GIS Structure (Appendix H). The NSWC Crane EGIS shall be made available to all members of the project team (SOUTHDIV, NSWC CRANE, USEPA, and IDEM). CD-ROM EGIS deliverables shall be made available on request from SOUTHDIV.

9.4 MAPPING AND GRAPHICS

CADD mapping is generally provided by the NSWC Crane. TtNUS will not use metadata to track changes to the mapping. In addition, Tri-Service Spatial Data Standards (TSSDS) will not be used, unless the mapping from the Facility already incorporates the standards. TSSDS also will not used in the final EGIS, based on the view that limited utility is gained from the substantial time required to incorporate the standards.

In addition to CADD mapping, Digital Ortho Quarter Quads (DOQ), aerial photography, and U.S. Geological Survey (USGS) 7.5 minute Quads will be obtained. The Quads will be obtained from either the USGS or other suppliers, while the aerial photography will be provided by the Facility. As necessary, the images are warped to the predetermined coordinate system using Microstation. Again, metadata are not used to track the changes.

From the survey data collected for the proposed investigations, sampling locations will be organized, and then a sample-vs-location table will be built so that the data can be loaded into the sample_data.dbf table (Appendix G).

9.5 SOFTWARE

TtNUS will standardize on the following software packages when managing and manipulating data for the NSWC Crane project:

- Data Management - Microsoft Visual FoxPro 6.0
- EGIS - ArcView 3.1
- 3-D Visualization - EVS Pro 3.0
- Statistical Analysis - Statistica 5.1
- Terrain Analysis - TerraModel 9.4.1

9.6 STORAGE OF DATA

TtNUS uses NT for Networks as its Information Management System (IMS). The NT IMS has a storage capacity of 2 Gigabytes and currently serves more than 110 desktop computers. The NT IMS automatically backs-up the system on a daily basis, thereby disallowing more than 1 day of work being lost should the network crash or malfunction. The database management and EGIS groups have been

allocated distinct drives on the Local Area Network (LAN). All environmental data for NSWC Crane will be stored on \\nusrpitbdc1\sdiv\NSWC_Crane subfolder of this drive on the NT Server. All tables, queries, programs and reports will be saved in the NSWC_Crane.pjx file in Microsoft Visual FoxPro. The NSWC Crane EGIS will be stored on \\nusrpitbdc1\gis\NSWC_Crane on the NT Server. All ArcView project files (*.apr) will be documented in a text file called readme_project.txt. This text file will also be stored on \\nusrpitbdc1\gis\NSWC_Crane.

10.0 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

This section of the Work Plan outlines the general methodologies and procedures that will be used to conduct Baseline Human Health Risk Assessments for SWMUs 4, 5, 9, and 10 at NSWC Crane. The objective of the risk assessments is to determine whether detected concentrations of chemicals at the sites pose a significant threat to potential human receptors under current and/or future land use. The potential risks to human receptors will be estimated based on the assumption that no actions are taken to control contaminant releases.

The following current U.S. EPA and IDEM risk assessment guidance were used to develop the framework for the Baseline Human Health Risk Assessments:

- U.S. EPA, December 1989. Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA 540/1-89/002.

- U.S. EPA, March 25, 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Washington, D.C. OSWER Directive 9285.6-03.

- U.S. EPA, January 1992. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Research and Development, Washington, D.C. EPA/600/8-91/011B.

- U.S. EPA, May 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. OSWER Publication No. 9285.7-081.

- U.S. EPA, May 1993. Distribution of Preliminary Review Draft: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Office of Solid Waste and Emergency Response, Washington, D.C.

- U.S. EPA, May 1996. Soil Screening Guidance: Technical Background Document. Office of Solid Waste and Emergency Response, Washington, D.C. EPA/540/R-95/128.

- U.S. EPA, August 1997. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/P-95/002Fa.

- U.S. EPA, November 1998. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment, Interim Guidance.

- IDEM, October 1997. RISC (Risk-Integrated System of Cleanups). Indiana Department of Environmental Management, Office of Environmental Response.

A Baseline Human Health Risk Assessment consists of five components: (1) Data Evaluation; (2) Exposure Assessment; (3) Toxicity Assessment; (4) Risk Characterization; and (5) Uncertainty Analysis. Sections 10.1 through 10.5 of the Work Plan contain detailed discussions of the methodologies to be followed for the five components of the risk assessment. A schematic diagram of the general risk assessment process is provided as Figure 10-1.

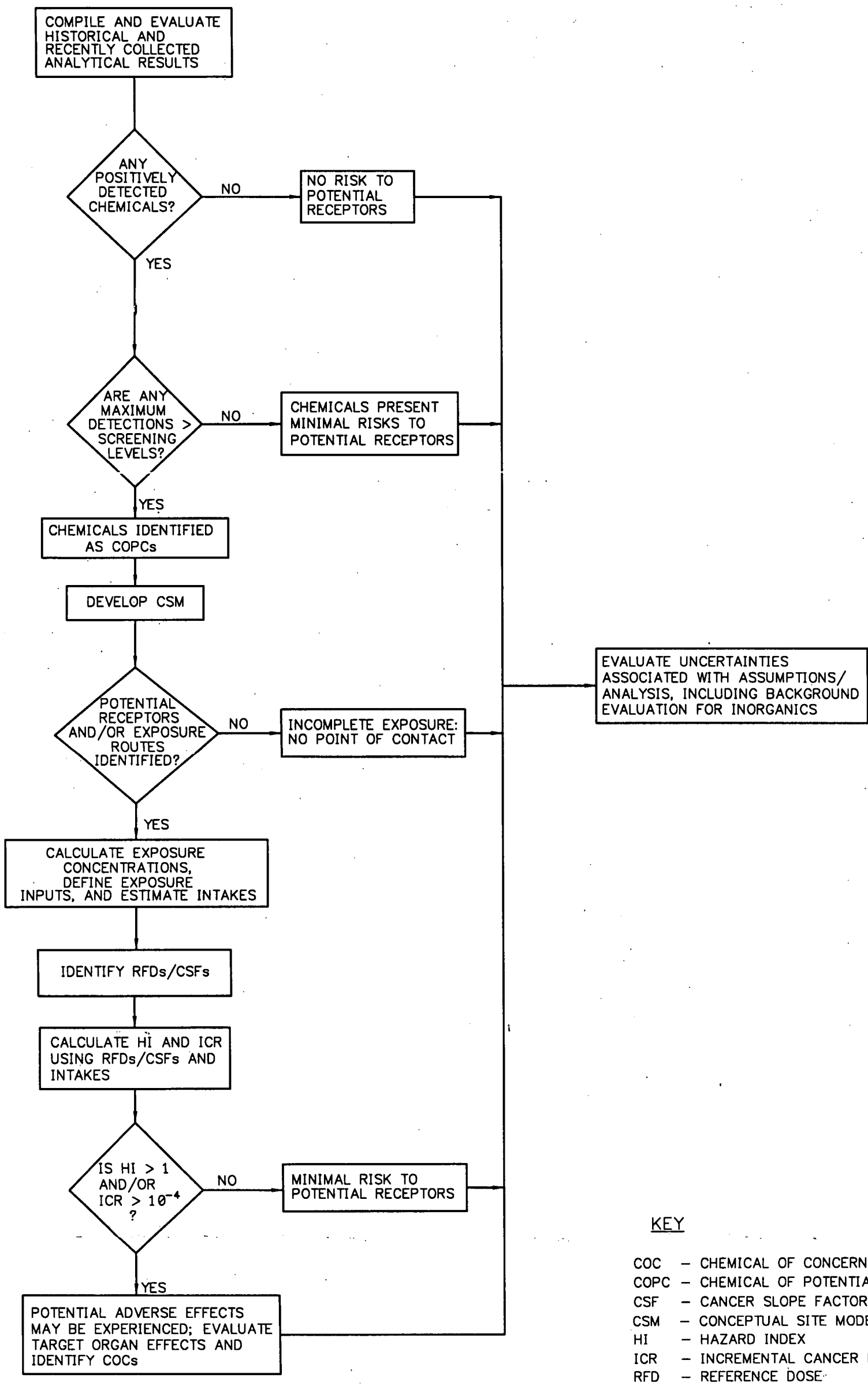
Three major aspects of chemical contamination and environmental fate and transport must be considered to evaluate potential risks: (1) contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; (2) potential exposure points must exist; and (3) human receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure. If any one of the factors listed above is absent for a site, the exposure route is regarded as incomplete, and no potential risks will be considered to exist for human receptors.

10.1 DATA EVALUATION

Data evaluation, the first component of a Baseline Human Health Risk Assessment, is a media-specific task involving the compilation and evaluation of analytical data. The main objective of the data evaluation is to develop a media-specific list of Chemicals of Potential Concern (COPCs), which will be used to quantitatively determine potential human health risks for site media.

10.1.1 Data Usability

Data collected for the proposed field investigations, which were described in Sections 5.5 (SWMU 4 – McComish Gorge), 6.5 (SWMU 5 – Old Burn Pit), 7.5 (SWMU 9 – Pesticide Control/R-150 Tank Area), and 8.5 (SWMU 10 – Rockeye) of this Work Plan, will be used to assess risks to potential human receptors. All analytical data used in the quantitative estimation of potential risks will be subjected to data validation. A discussion of data validation protocol to be followed is provided in the Section 9.0 of the



KEY

COC – CHEMICAL OF CONCERN
COPC – CHEMICAL OF POTENTIAL CONCERN
CSF – CANCER SLOPE FACTOR
CSM – CONCEPTUAL SITE MODEL
HI – HAZARD INDEX
ICR – INCREMENTAL CANCER RISK
RFD – REFERENCE DOSE

DRAWN BY KW DATE 4/20/99	SUMMARY OF HUMAN HEALTH RISK ASSESSMENT PROCESS NSWC CRANE, INDIANA	CONTRACT NO. 7141	
CHECKED BY DATE		APPROVED BY R.M. Snedu DATE 10/18/99	
COST/SCHED-AREA		APPROVED BY DATE	
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associated QAPP. A Data Quality Report will be generated for the proposed field investigation data. This report will provide information on precision, accuracy, representativeness, completeness, and comparability. A brief summary of the results of the data validation also will be included.

Fixed-based analytical results only from the target analyte lists for the proposed field investigations will be used in the quantitative risk evaluation. Typically, unfiltered results for ground water and surface water are used to assess risks associated with these media. Filtered results will be used for the risk assessment if the associated unfiltered samples are found to be turbid. Field measurements, data regarded as unreliable (i.e., qualified as "R" during the data validation process), and results of Tentatively Identified Compound (TIC) analyses will not be used in the quantitative risk assessment. However, these data may be used to substantiate the conclusions of the quantitative risk analysis.

Because of uncertainties associated with data quality, historical data collected during previous RFIs will not be used to quantitatively assess potential risks at SWMUs 4, 5, 9, and 10. The quality associated with the historical data has not been adequately documented, and the data do not seem to have been validated. The data packages (including the raw data) cannot be obtained to ascertain the level of quality associated with the data or to independently validate the data. However, these data may be used in a qualitative fashion to support the conclusions of the quantitative risk analysis. The proposed field investigations were developed to be comprehensive (i.e., locations sampled historically, as well as data gap locations, were included), thus, the uncertainty associated with the elimination of the historical data from the quantitative risk assessment will not be significant.

10.1.2 Selection of Chemicals of Potential Concern

The selection of COPCs is a qualitative screening process used to limit the number of chemicals and exposure routes quantitatively evaluated in the Baseline Human Health Risk Assessment to those site-related constituents that dominate overall potential risks. Screening by risk-based concentrations and Basewide background levels will be used to focus the risk assessment on meaningful chemicals and exposure routes.

In general, a chemical will be selected as a COPC and retained for further quantitative risk evaluation if: 1) the maximum detection in a sampled medium exceeds the lowest risk-based concentration and 2) the chemical is determined to be present at concentrations exceeding background. Note that this second condition applies only to those chemicals for which background comparison is appropriate, e.g., metals. Chemicals eliminated from further evaluation at this time are assumed to present minimal risks to potential human receptors.

10.1.2.1 COPC Screening Levels

Several types of screening levels will be used to identify COPCs for SWMUs 4, 5, 9, and 10. Screening concentrations based on U.S. EPA Region IX Preliminary Remedial Goals (PRGs) (U.S. EPA, Region IX, October 2000) will be used, as well as other IDEM and U.S. EPA criteria. The risk-based screening concentrations will correspond to a systemic hazard quotient of 0.1 (for noncarcinogens) or a lifetime cancer risk of 1E-6 (for carcinogens). Note that the Region IX PRGs are based on a hazard quotient of 1.0 while the screening concentrations are based on a hazard quotient of 0.1. The screening concentrations are based on a hazard quotient of 0.1 to insure that additive noncarcinogenic risks for all chemicals do not exceed 1.0. The screening levels to be used for each media in the risk assessment are briefly discussed below.

Soil/Sediment

The following criteria will be used to select COPC for soil (surface and subsurface soil):

- U.S. EPA Region IX PRGs for Residential Soil (U.S. EPA Region IX, May 1998);
- U.S. EPA Generic SSLs for Migration to Ground Water (U.S. EPA, May 1996);
- U.S. EPA Generic SSLs for Transfers from Soil to Air (U.S. EPA, May 1996);
- IDEM Tier I Cleanup Levels for Surface Soil (IDEM, October 1997); and
- IDEM Tier I Cleanup Levels for Subsurface Soil (IDEM, October 1997).

If the maximum concentration of a constituent exceeds any of these criteria (and the constituent is considered to be present at concentrations greater than Basewide background levels), the chemical will be selected as a COPC for soil and carried through to the quantitative risk assessment.

Because of the different exposure scenarios for potential human receptors, COPCs will be identified for surface and subsurface soil. Surface soil will be defined as soil collected from 0 to 2 feet bgs. Subsurface soil will be defined as soil collected from depths greater than 2 feet bgs.

The comparison of site soil data to U.S. EPA Generic SSLs for transfers from soil to air will be used to identify whether a quantitative analysis of this exposure pathway is warranted. If the maximum soil concentration of a chemical exceeds the SSL, a quantitative evaluation of potential risks from inhalation will be performed, as described in Section 10.2.4. Otherwise, the risks associated with the inhalation pathway will be considered insignificant, and the exposure pathway will be eliminated from further evaluation.

No specific screening levels exist for human exposure to sediment. COPCs will be selected for sediment by comparing detected site concentrations to the following:

- U.S. EPA Region IX PRGs for Residential Soil (U.S. EPA Region IX, May 1998) and
- IDEM Tier I Cleanup Levels for Surface Soil (IDEM, October 1997).

U.S. EPA Generic SSLs for transfers from soil to air and for migration to ground water are not considered to be appropriate for sediment screening because of high moisture content associated with sediment matrices. The use of soil screening levels for sediment COPC identification is regarded as a conservative approach because anticipated exposure to sediment is less than anticipated exposure to soil.

Ground Water/Surface Water

The same screening levels will be used to select COPCs for ground water and surface water. The following criteria will be used:

- U.S. EPA Region IX PRGs for Tap Water (U.S. EPA, Region IX, May 1998);
- IDEM Tier I Cleanup Levels for Residential Ground Water (IDEM, October 1997); and
- U.S. EPA Maximum Contaminant Levels (MCLs) (U.S. EPA, October 1996).

If the maximum concentration of a constituent exceeds any of these criteria (and the constituent is considered to be present at concentrations greater than Basewide background levels), the chemical will be selected as a COPC and carried through to the quantitative risk assessment..

Risk-based COPC screening levels for tap water ingestion, which are based on daily, residential exposure assumptions, will be used to select COPCs for ground water and surface water. In general, the use of tap water screening levels is regarded as a highly conservative approach to COPC selection at SWMUs 4, 5, 9, and 10 because ground water at the sites is not used as a potable drinking water source. Currently, there is no direct exposure to ground water at the four SWMUs. In addition, potential human exposure to surface water at SWMUs 4, 5, 9, and 10 is expected to be limited to incidental exposures (such as that which occurs during trespassing), which is significantly less than the daily exposure assumed during the development of the aforementioned ground water screening criteria.

Federal Ambient Water Quality Criteria (AWQC) will not be used to select COPCs for surface water. AWQC applicable to the protection of human health will not be used since surface water present at SWMUs 4, 5, 9, and 10 is not currently used and will not be used in the future as a potable drinking water source. In addition, the surface water bodies present at the sites do not support game fish populations because of their size and intermittent nature. Lake Greenwood is used as a drinking water supply for the Facility. Ground water at the four SWMUs does discharge to nearby surface water bodies. However, none of the surface water bodies (streams, creeks, tributaries, etc.) at the sites affect Lake Greenwood.

10.1.2.2 Lead as a COPC

Limited criteria are available to evaluate the potential risks associated with lead. There are no risk-based concentrations for this chemical since the U.S. EPA has not derived toxicity values for lead. However, recommended screening levels are available for lead in soil which are used to indicate the need for response activities. Guidance from both the Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and the Office of Solid Waste and Emergency Response (OSWER) recommend 400 mg/kg as the lowest screening level for lead-contaminated soil in a residential setting, where children are frequently present (U.S. EPA, July 14, 1994). OPPTS identifies 2,000 to 5,000 mg/kg as an appropriate range for areas where contact with soil by children in a residential setting is less frequent.

At this time, no screening level is available for non-residential areas involving adult and adolescent exposure only. A value of 400 mg/kg will be used as a screening level for soil and sediment. The Safe Drinking Water Act Action Level of 15 µg/L will used as the screening level for lead in ground water and surface water.

10.1.2.3 Essential Nutrients and Chemicals without Toxicity Criteria

The essential nutrients calcium, magnesium, potassium, and sodium will not be identified as COPCs for SWMUs 4, 5, 9, and 10. These inorganic chemicals are naturally abundant in environmental matrices and are only toxic at high doses. In addition, because of the lack of toxicity criteria, risk-based COPC screening levels are not available for some chemicals (i.e., hexanone, benzo(g,h,i)perylene, phenanthrene). These chemicals will not be selected as COPCs as they can not be addressed during the quantitative risk assessment. However, these chemicals will be mentioned in the data evaluation section, after the identification of COPCs, and qualitatively addressed in the uncertainty section of the risk assessment.

10.1.2.4 Determination of Site-Related Chemicals

Chemicals found at concentrations indicative of background levels are not considered to be site-related contaminants and will not be retained as COPCs for the quantitative risk assessment. The use of Basewide background soil data will determine if detected chemicals are present at naturally occurring levels. Conventional statistical methods (e.g., Bartlett's T-test, etc.) will be employed to compare site concentrations for SWMUs 4, 5, 9, and 10 to background concentrations.

The elimination of detected chemicals based on background data for soil will be limited to inorganics only. Although some organic compounds (primarily PAHs, pesticides, and PCBs) can be a result of anthropogenic sources, organics are not considered to represent "true" background levels. All detected organic compounds will be regarded as site-related for purposes of COPC selection. However, historical information for a site will be reviewed to determine if the presence of organics are attributable to site-related activities or anthropogenic sources.

10.1.3 COPC Summary Screening Tables

Media-specific tables summarizing the selection of COPCs will be included in the SWMU-specific risk assessments. At a minimum, the following information will be included in the summary tables: 1) maximum concentration in a single sample of all detected chemicals; 2) frequency of detection; 3) location of maximum concentration; 4) COPC screening levels; and 5) results of COPC screening process. An example format of a typical COPC summary screening table is provided as Table 10-1.

10.2 EXPOSURE ASSESSMENT

This portion of the risk assessment defines and evaluates, quantitatively or qualitatively, the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, identify potentially exposed populations and applicable exposure pathways, calculate concentrations of COPCs to which receptors might be exposed, and estimate chemical intakes under the identified exposure scenarios.

Actual or potential exposures at SWMUs 4, 5, 9, and 10 at NSWC Crane will be determined based on the most likely pathways of contaminant release and transport, as well as human activity patterns. A complete exposure pathway has three components: (1) a source of chemicals that can be released to the

TABLE 10-1

FORMAT OF COPC SELECTION SUMMARY TABLE
SWMUs 4, 5, 9, AND 10
NSWC CRANE, INDIANA

Chemical	Frequency of Detection	Range of Detection	Location of Maximum Detection	Risk-Based COC Screening Level	Other Health-Based Criteria	Attributable to Background?	Selected as COC?	Rationale
All positively detected chemicals presented.	Presented as the number of positive detections divided by the total number of sample results. Sample results qualified as rejected during data validation are not included in the total sample count. Sample and duplicate results counted as separate samples.	Positive results qualified as rejected during data validation are not presented. Sample results qualified as rejected during data validation are not included in the range. Sample and duplicate results counted as separate samples.	The sampling date associated with the maximum detection may be appended if an extensive amount of historical data is available.	Direct exposure criteria developed using current USEPA Region IX PRG guidance.	Soil and tap water ingestion, SSLs for transfers from soil to air, and SSLs for transfers from soil to groundwater will be used, in addition to Federal drinking water standards.	Yes or No identification.	Yes or No identification.	Indicates decision process. Will typically be presented as references, such as "ASL" above screening level, "BSL" below screening level, etc.

environment; (2) a route of contaminant transport through an environmental medium; and (3) an exposure or contact point for a human receptor.

10.2.1 Conceptual Site Model

The development of a CSM is an essential component of the exposure assessment. The CSM will integrate information regarding the physical characteristics of the site, exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify potential exposure routes and receptors to be evaluated in the risk assessment. A well defined CSM will allow for a better understanding of the risks at a site and will aid the risk managers in the identification of the potential need for remediation. A general discussion of CSMs was provided in Section 4.0 of this Work Plan.

Site-specific CSMs for SWMUs 4, 5, 9, and 10 were presented in Sections 5.0 through 8.0 of this Work Plan and illustrated in Figures 5-7, 6-7, 7-7, and 8-9. The models were used to develop the proposed field investigations to ensure that the data collected meet the needs of the risk assessments. Sources of contamination, contaminant release mechanisms, transport/migration pathways, exposure routes, and potential receptors are defined for each SWMU. These CSMs will be refined during the risk assessment process using the data and information collected as part of the proposed field investigations.

Table 4-1 provided a site-specific summary of the potential receptors to be evaluated for SWMUs 4, 5, 9, and 10. A summary of the exposure routes that will be addressed quantitatively for each human receptor is provided in Table 10-2.

10.2.2 Central Tendency Exposure vs. Reasonable Maximum Exposure

Traditionally, exposures evaluated in the human health risk assessment were based on the concept of a Reasonable Maximum Exposure (RME) only, which is defined as "the maximum exposure that is reasonably expected to occur at a site" (U.S. EPA, December 1989). However, recent risk assessment guidance (U.S. EPA, February, 1992) indicates the need to address an average case or Central Tendency Exposure (CTE).

To provide a full characterization of potential exposure, both RME and CTE will be evaluated in the site-specific risk assessments for SWMUs 4, 5, 9, and 10 at NSWC Crane. The available guidance (U.S. EPA, May 1993) concerning the evaluation of CTE is limited and at times vague. Therefore, professional judgment may be exercised when defining CTE conditions for a particular receptor at a site.

TABLE 10-2

EXPOSURE ROUTES FOR QUANTITATIVE EVALUATION
SWMUs 4, 5, 9, AND 10
NSWC CRANE, INDIANA

Receptors	Exposure Routes
Adolescent Trespassers (6 to 17 Years)	• Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface) • Surface Water/Sediment Dermal Contact • Surface Water/Sediment Ingestion
Maintenance/Occupational Workers	• Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface)
Construction Workers	• Soil Dermal Contact (surface and subsurface) • Soil Ingestion (surface and subsurface) • Inhalation of Air/Dust/Emissions (surface and subsurface) • Ground Water Dermal Contact (during excavation)
Adult Recreational Users	• Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface) • Surface Water/Sediment Dermal Contact • Surface Water/Sediment Ingestion
Residents (Adult/Children)	• Soil Dermal Contact (surface) • Soil Ingestion (surface) • Inhalation of Air/Dust/Emissions (surface) • Direct Ingestion of Ground Water • Ground Water Dermal Contact (showering/bathing) • Inhalation of Volatiles in Ground Water (showering/bathing) • Surface Water/Sediment Dermal Contact • Surface Water/Sediment Ingestion

10.2.3 Exposure Concentrations

The exposure concentration, which is calculated for COPCs only, is a reasonable maximum estimate of the chemical concentration that is likely to be contacted over time by a receptor and is used to calculate estimated exposure intakes. The 95 percent upper confidence limit (UCL), which is based on the distribution of a data set, is considered to be the best estimate of the exposure concentration for data sets with 10 or more samples (U.S. EPA, May 1992). The 95 percent UCL will be used as the exposure concentration to assess RME and CTE risks (U.S. EPA, May 1993). For data sets with less than 10 samples, the UCL is considered to be a poor estimate of the mean, and the exposure concentration will be defined as the maximum detection.

Conventional statistical methods (i.e., the Shapiro-Wilk W-Test) will be used to determine the distribution and UCL of a particular data set (Gilbert, 1987; U.S. EPA, May 1992). Detailed sample calculations, as well as general methodology for the statistical evaluation, will be presented in the site-specific risk assessments. Sample and duplicate analytical results will be averaged for statistical use. Nondetected data points will be utilized; in general, one-half the sample-specific detection limit will be employed for these analytical results. If the calculated 95 percent UCL exceeds the maximum detected concentration, the maximum will be used as exposure concentration in place of the UCL.

10.2.4 Chemical Intake Estimation

The methodologies and techniques used to estimate exposure intakes are presented in this section of the Work Plan. Intakes for the identified potential receptor groups will be calculated using current U.S. EPA risk assessment guidance (U.S. EPA, December 1989 and January 1992) and presented in the risk assessment spreadsheets. Risk assessment spreadsheets will be appended to the site-specific risk assessments as support documentation.

Noncarcinogenic intakes will be estimated using the concept of an average daily exposure. Carcinogenic intakes will be calculated as an incremental lifetime average daily exposure, which will assume a life expectancy of 70 years. Equations used to calculate estimated intakes are provided below. Assumptions regarding exposure are presented in Table 10-3.

TABLE 10-3

SUMMARY OF EXPOSURE ASSUMPTIONS
SWMUs 4, 5, 9, AND 10
NSWC CRANE, INDIANA
PAGE 1 OF 4

Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Adolescent Trespasser (6 to 17 Years)	EF (days/yr)	26	13	Professional judgement; 1 day/week for the RME and 1 day/every other week for the CTE.
	ED (yrs)	11	11	Adolescents from age 6 to 17 evaluated.
	ET (hours/day) and t_{event} (hr/event)	4	2	Professional judgment.
	BW (kg)	43	43	Average age-specific value (USEPA, May 1989).
	SA (cm^2/day) and A (cm^2)	3,820	3,100	25 percent of the total body surface area will be assumed to be available for soil, sediment, and surface water contact. CTE and RME areas represent the mean of 50th and 95th percentile values for ages 6 to 17, respectively, as provided in Table 6-6 of the Exposure Factors Handbook (USEPA, August 1997).
	IR_S (mg/day)	100	50	Assumed similar to adult exposure (USEPA, May 1993).
	IR_a (m^3/hour)	1.9	1.9	Recommended short-term heavy activities rate for children (USEPA, August 1997; Table 5-23).
	EV (events/day)	1	1	Professional judgement.
	CR (L/hr)	0.05(1) 0.01(2)	0.05(1) 0.01(2)	Intake rates for exposure to surface water during wading (USEPA, November 1995).
Maintenance/ Occupational Worker	EF (days/yr)	24 (maintenance) 250 (occupational)	12 (maintenance) 240 (occupational)	Professional judgement for maintenance worker; 2 days/month for the RME and 1 day/month for the CTE. Convention for the occupational worker (USEPA, May 1993).
	ED (yrs)	25	9	Convention for RME (USEPA, March 1991); 50th percentile time at one residence for CTE (USEPA, May 1989).
	ET (hours)	8 (air)	8 (air)	Standard default (USEPA, March 1991).
	BW (kg)	70	70	USEPA, May 1993.

TABLE 10-3

SUMMARY OF EXPOSURE ASSUMPTIONS
SWMUs 4, 5, 9, AND 10
NSWC CRANE, INDIANA
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Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Maintenance/ Occupational Worker (Continued)	SA (cm^2/day)	3,300	3,300	Surface area of the head, hands, and forearms measured in men assumed to be available for soil contact . The RME and CTE values represent 50th percentile areas of the head, hands, and forearms (USEPA, August 1997, Table 6-2).
	IR_S (mg/day)	100	50	USEPA, May 1993.
	IR_a (m^3/hour)	2.5 (maintenance) 0.6 (occupational)	2.5 (maintenance) 0.6 (occupational)	For maintenance workers, recommended short-term heavy activities rate for outdoor workers (USEPA, August 1997; Table 5-23). For occupational workers, adult daily inhalation rate (USEPA, December 1989).
Construction Worker	EF (days/yr)	150	150	Professional judgement. Ground assumed to be frozen or snow covered for 22 weeks/yr.
	ED (yrs)	1	1	Estimated length of construction project (professional judgement).
	ET (hours)	8 (air) 2 (ground water)	8 (air) 1.5 (ground water)	For air, standard default (USEPA, March 1991). Professional judgement for dermal exposure to ground water.
	BW (kg)	70	70	USEPA, May 1993.
	SA (cm^2/day)	5,800	5,000	Recommended values for adult skin surface area assumed to be available for soil contact (USEPA, August 1997; Table 6-16).
	IR_S (mg/day)	480	240	Convention for the RME (USEPA, March 1991). CTE is assumed to be one-half the RME value.
	IR_a (m^3/hour)	2.5	2.5	Recommended short-term heavy activities rate for outdoor workers (USEPA, August 1997; Table 5-23).
	EV (events/day)	1	1	Professional judgement.

TABLE 10-3

SUMMARY OF EXPOSURE ASSUMPTIONS
SWMUs 4, 5, 9, AND 10
NSWC CRANE, INDIANA
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Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Adult Recreational User	EF (days/yr)	52	26	Professional judgement; 1 day/week for the RME and 1 day/every other week for the CTE.
	ED (yrs)	30	9	USEPA, May 1993. Assumed length of residence for an adult living near the facility.
	ET (hours/day) and t_{event} (hr/event)	4	2	Professional judgement.
Adult Recreational User (Continued)	BW (kg)	70	70	USEPA, May 1993.
	SA (cm^2/day)	9,070	9,070	Feet, lower legs, hands, head, and arms of adult male assumed to be available for sediment contact. The RME and CTE values represent the 50th percentile areas of the feet, lower legs, hands and arms (USEPA, August 1997, Table 6-2).
	IR_S (mg/day)	100	50	Based on USEPA, May 1993.
	IR_a (m^3/hour)	1.6	1.6	Recommended short-term moderate activities rate for adults (USEPA, August 1997; Table 5-23).
	EV (events/day)	1	1	Professional judgment.
	CR (L/hr)	0.05(1) 0.01(2)	0.05(1) 0.01(2)	Intake rates for exposure to surface water during wading (USEPA, November 1995).

TABLE 10-3

SUMMARY OF EXPOSURE ASSUMPTIONS
SWMUs 4, 5, 9, AND 10
NSWC CRANE, INDIANA
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Receptor	Exposure Assumptions			Rationale/Reference
	Input Parameter	RME	CTE	
Resident (Adult/Child)	EF (days/yr or showers/yr)	350	234	USEPA, May 1993. One shower assumed to be taken per day.
	ED (yrs)	24(1) 6(2)	7(1) 2(2)	USEPA, May 1993.
	t_{event} (hr/event)	0.25	0.167	15 min/event for RME and 10 min/event for CTE (USEPA, January 1992).
	BW (kg)	70(1) 15(2)	70(1) 15(2)	USEPA, May 1993.
	SA (cm^2/day)	5,800(1) 2,000(2)	5,000(1) 1,745(2)	Recommended values for adult skin surface area assumed to be available for soil contact (USEPA, August 1997). Child CTE and RME areas represent 25% of the total body area, as provided in Table 6-6 of the Exposure Factors Handbook (USEPA, August 1997).
	IR_S (mg/day)	100(1) 200(2)	50(1) 100(2)	USEPA, May 1993.
	IR_a (m^3/day) (transfers from soil to air)	20(1) 8.3(2)	20(1) 8.3(2)	Adult daily inhalation rate (USEPA, December 1989) Child daily inhalation rate – Recommended long-term rate for children, 3-5 years of age (USEPA, August 1997; Table 5-23).
	IR_a (m^3/hr) (showering)	0.6	0.6	For all age groups while showering (USEPA, December 1989).
	IR_w (L/day)	2(1) 1.5(2)	1.4(1) 0.66(2)	USEPA, May 1993 for adult exposure. USEPA, August 1997, Table 3-30 for child exposure.
	EV (events/day)	1	1	Professional judgement

EF = Exposure Frequency
ED = Exposure Duration
ET = Exposure Time
BW = Body Weight
SA = Body Surface Area Exposed
IRs = Ingestion Rate - Soil
IRa = Inhalation Rate
EV = Exposure Events
CR = Contact Rate - Surface Water
Irw = Ingestion Rate - Groundwater

1 Exposure assumption for adult receptor.
2 Exposure assumption for adolescent receptor.

10.2.4.1 Inhalation of Air and Fugitive Dust/Volatile Emissions

The amount of a chemical a receptor takes in as a result of respiration is determined using the concentration of the contaminant in air. Intakes of both particulates and vapors/gases from soil will be calculated using the same equation, as follows (U.S. EPA, December 1989):

$$Intake_{ai} = (C_{ai})(IR_a)(ET)(EF)(ED) / (BW)(AT)$$

where: $Intake_{ai}$	=	intake of chemical "i" from air via inhalation (mg/kg/day)
C_{ai}	=	concentration of chemical "i" in air (mg/m^3)
IR_a	=	inhalation rate (m^3/hr)
ET	=	exposure time (hours/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yrs x 365 days/yr

The concentration of a chemical in air will be developed using modeling techniques, measured soil concentrations, and additional site-specific information.

As mentioned previously in Section 10.1.2.1, a qualitative evaluation of exposure (i.e., comparison of maximum site soil concentrations to U.S. EPA Generic SSLs for transfers from soil to air) will be used to identify whether a quantitative analysis of this exposure pathway is warranted. If it is determined that a quantitative evaluation is not required, the potential risks associated with the inhalation pathway will be regarded as minimal and no further evaluation will be performed.

10.2.4.2 Dermal Contact with Soil/Sediment

Direct physical contact with soil (and sediment) may result in the dermal absorption of chemicals. Exposures associated with the dermal route are estimated in the following manner (U.S. EPA, December 1989 and January 1992):

$$Intake_{si} = (C_{si})(SA)(AF)(ABS)(CF)(EF)(ED) / (BW)(AT)$$

where: $Intake_{si}$ = amount of chemical "i" absorbed during contact with soil/sediment (mg/kg/day)

C_{si} = concentration of chemical "i" in soil/sediment (mg/kg)

SA = skin surface area available for contact (cm^2/day)

AF = skin adherence factor (mg/cm^2)

ABS = absorption factor (dimensionless)

CF = conversion factor (1E-6 kg/mg)

EF = exposure frequency (days/yr)

ED = exposure duration (yr)

BW = body weight (kg)

AT = averaging time (days);
for noncarcinogens, AT = ED x 365 days/yr;
for carcinogens, AT = 70 yrs x 365 days/yr

Exposed surface areas of body available for dermal contact are determined on a receptor-specific basis since they correspond with assumed human activities and clothing worn during exposure events. Current guidance (U.S. EPA, January 1992; U.S. EPA, August 1997) were used to develop the default assumptions concerning the amount of skin surface area available for contact for a receptor. To maintain consistency from project to project, input parameters previously used for other NSWC Crane risk assessments (B&R Environmental, 1997) were also reviewed when developing the exposed surface areas. The rationales used to select the skin areas are as follows:

- For maintenance and occupational workers exposed to surface soil, the surface area available for soil contact is assumed to be the hands and forearms of an adult male. The skin surface area is 3,300 cm^2 for the CTE and the RME. These values represent the 50th percentile areas for the head, hands, and forearms (U.S. EPA, August 1997).

- For construction workers exposed to surface and subsurface soil, the surface areas for the RME (5,800 cm^2) and CTE (5,000 cm^2) are the values recommended for soil contact by the U.S. EPA in the Exposure Factors Handbook (U.S. EPA, August 1997). These values represent 25 percent of the total body surface area of an adult male.

- For adolescent trespassers, 25 percent of the total body surface area for an adolescent (aged 6 to 16) will be assumed to be available for surface soil and/or sediment contact. The RME value (3,820 cm^2) will be derived from the 95th percentile surface area data and the CTE value (3,100 cm^2) will be derived from the 50th percentile data, as provided in Table 6-6 of the Exposure Factors Handbook (U.S. EPA, August 1997).

- For adult recreational users assumed to be exposed to surface soil and sediment, the exposed surface area available for contact will be the sum of the feet, lower, legs, hands, and arms of an adult male. This skin surface area is 9,070 cm^2 for the CTE and for the RME. These values represent the 50th percentile areas for the head, feet, lower legs, hands, and forearms (U.S. EPA, August 1997).

- For adult residents exposed to surface soil, the exposed surface areas available for contact will be the U.S. EPA recommended values for adult skin surface area for exposure to soil (Table 6-14, U.S. EPA, August 1997). For child residents assumed to be exposed to surface soil, the CTE and RME areas will represent 25 percent of the 50th and 95th percentile total body area of children ages 2 to 6, respectively, as provided in Table 6-6 of the Exposure Factors Handbook (U.S. EPA, August 1997).

The published range for the soil adherence factor is 0.2 to 1.0 mg/cm^2 (U.S. EPA, January 1992). Soil adherence factors of 1.0 and 0.2 will be used to evaluate RME and CTE, respectively. Current U.S. EPA guidance (U.S. EPA, November 1998) will be used to determine chemical-specific dermal absorption factors.

10.2.4.3 Incidental Ingestion of Soil/Sediment

Incidental ingestion of soil (and sediment) by potential receptors coincides with dermal exposure. Exposures associated with incidental ingestion are estimated in the following manner (U.S. EPA, December 1989):

$$Intake_{si} = (C_{si})(IR_s)(FI)(EF)(ED)(CF)\ /(BW)(AT)$$

where: $Intake_{si}$ = intake of contaminant "i" from soil or sediment (mg/kg/day)
C_{si} = concentration of contaminant "i" in soil or sediment (mg/kg)

IR_s	=	ingestion rate (mg/day)
FI	=	fraction ingested from contaminated source (dimensionless)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
CF	=	conversion factor (1E-6 kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yrs x 365 days/yr

The same exposure frequencies and durations used in the estimation of dermal intakes will be used to estimate exposure via incidental ingestion. The default value of 1.0 will be used for the fraction of soil ingested from the source for the RME and CTE exposure scenarios.

10.2.4.4 Dermal Contact with Ground Water/Surface Water

The same equation is used to estimate intakes for dermal contact with ground water and surface water. Direct contact with ground water at SWMUs 4, 5, 9, and 10 is limited to exposure that would occur under a residential and construction scenario. Residential receptors are assumed to use ground water for domestic purposes (i.e., bathing, showering, washing dishes), which can result in a dermal exposure. Short-term dermal exposure is assumed to occur for the construction worker. Dermal contact with surface water may also occur while receptors are involved in certain activities, such as trespassing or recreational sport (hiking, biking, etc.).

The following equation will be used to assess exposures resulting from dermal contact with water (U.S. EPA, January 1992):

$$DAD_{wi} = (DA_{event})(EV)(ED)(EF)(A) / (BW)(AT)$$

where:	DAD_{wi}	=	dermally absorbed dose of chemical "i" from water (mg/kg/day)
	DA_{event}	=	absorbed dose per event (mg/cm^2-event)
	EV	=	event frequency (events/day)
	ED	=	exposure duration (yr)
	EF	=	exposure frequency (days/yr)

A	=	skin surface area available for contact (cm^2)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yrs x 365 days/yr

Ground water exposure for residential receptors is assumed to occur on a daily basis. Exposure to ground water for construction workers and exposure to surface water for residents, trespassers, and recreational users will be limited to infrequent exposure events. Dermal intakes for residents will assume total body exposure. For construction workers, trespassers, and recreational users, the exposed surface area of the body available for contact will be determined based on assumed activities and will be similar to the assumptions outlined for dermal contact with soil and sediment.

The absorbed dose per event (DA_{event}) will be estimated using a nonsteady-state approach for organic compounds and a traditional steady-state approach for inorganics. For organics, the following equations apply:

$$\text{If } t_{event} < t^*, \text{ then: } DA_{event} = (2\,K_p)(C_{wi})(CF)\left[\frac{\sqrt{6\,T\,t_{event}}}{\pi}\right]$$

$$\text{If } t_{event} > t^*, \text{ then: } DA_{event} = (K_p)(C_{wi})(CF)\left[\frac{t_{event}}{1+B} + 2\,T\left[\frac{1+3\,B}{1+B}\right]\right]$$

where:	t_{event}	=	duration of event (hr/event)
	t^*	=	time it takes to reach steady-state conditions (hr)
	K_p	=	permeability coefficient from water through skin (cm/hr)
	C_{wi}	=	concentration of chemical "i" in water (mg/L)
	T	=	lag time (hr)
	π	=	constant (dimensionless; equal to 3.141592654)
	CF	=	conversion factor (1E-3 L/cm^3)
	B	=	partitioning constant derived by Bunge Model (dimensionless)

Values for the chemical-specific parameters (t_{event}, t^*, K_p, T, and B) will be obtained from the current dermal guidance (U.S. EPA, January 1992, Table 5-8). If no published values are available for a particular compound, they will be calculated using equations provided in the cited guidance.

The following nonsteady-state equation will be used to estimate DA_{event} for inorganics:

$$DA_{event} = (K_p)\,(C_{wi})\,(t_{event})$$

In general, the recommended default value of 1E-3 will be used for the dermal permeability of inorganic constituents.

10.2.4.5 Incidental/Direct Ingestion of Ground Water/Surface Water

Residents may be exposed to ground water via direct ingestion. Direct contact with surface waters while swimming or exploring could also result in the inadvertent ingestion of small amounts of water. Intakes associated with ingestion of water will be evaluated using the following equations (U.S. EPA, December 1989):

$$Intake_{wi} = (C_{wi})(IR_w)(EF)(ED)\,/(BW)(AT) \quad \textit{for groundwater}$$

$$Intake_{wi} = (C_{wi})(CR)(ET)(EF)(ED)\,/(BW)(AT) \quad \textit{for surface water}$$

where:

$Intake_{wi}$	=	intake of chemical "i" from water (mg/kg/day)
C_{wi}	=	concentration of chemical "i" in water (mg/L)
IR_w	=	ingestion rate for ground water (L/day)
CR	=	contact rate for surface water (L/hr)
ET	=	exposure time for surface water (hr/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days);
		for noncarcinogens, AT = ED x 365 days/yr;
		for carcinogens, AT = 70 yrs x 365 days/yr

The same exposure times, frequencies, and durations used to assess dermal exposure to water will be used to estimate intakes for ingestion of water.

10.2.4.6 Inhalation of Volatiles in Ground Water

Ground water exposure may also result in an inhalation exposure. This exposure route will be evaluated for residential receptors only who may be exposed while showering, bathing, washing dishes, etc. Inhalation exposures will be estimated using a mass transfer model, developed specifically for this exposure route, in combination with an air intake estimation model. The mass transfer model accounts for inhalation that occurs during a shower and after a shower while the receptor remains in the closed bathroom. The method employed is as follows (U.S. EPA, December 1989; Foster and Chrostowski, 1987):

$$Intake_{si} = (S)(IR_{sh})(K)(EF)(ED) / (BW)(AT)(R_a)(CF)$$

$$K = D_s + \frac{\exp(R_a \times D_t)}{R_a} - \frac{\exp R_a \times (D_s - D_t)}{R_a}$$

where:

$Intake_{wi}$	=	intake of chemical "i" from water via inhalation (mg/kg/day)
S	=	volatile chemical generation rate (µg/m^3-min-shower)
IR_{sh}	=	inhalation rate (L/min)
EF	=	exposure frequency (showers/yr)
ED	=	exposure duration (yrs)
BW	=	body weight (kg)
AT	=	averaging time or period of exposure (days)
R_a	=	air exchange rate (min^{-1})
K	=	mass transfer coefficient (min)
D_s	=	shower duration (min)
D_t	=	total time in bathroom (min)
CF	=	conversion factor (1E+6 µg-L/mg-m^3)

The volatile chemical generation rate will be estimated using the Foster and Chrostowski mass transfer model, which is based on two-phase film theory. The model employs contaminant-specific mass transfer coefficients, Henry's Law constants, droplet diameter, drop time, viscosity, temperature, etc. Calculations of the shower model will be provided in the appendices to the site-specific risk assessments.

10.2.4.7 Summary of Exposure Parameters

A summary of the exposure input parameters for all exposure pathways are presented in Table 10-3 for the identified potential receptor groups at SWMUs 4, 5, 9, and 10. In general, standard default parameters (U.S. EPA, March 1991), which combine mid-range and upper-end exposure factors, will be used to assess RME conditions. CTE will be assessed primarily by the use of mid-range exposure factors presented in current risk assessment guidance (U.S. EPA, May 1989 and May 1993). These input parameters may be updated according to new risk assessment guidance, as it becomes available.

10.2.5 Exposure to Lead

The equations and methodology presented in the previous section cannot be used to evaluate exposure to lead because of the absence of published dose-response parameters. Exposure to lead will be assessed using the latest version of the U.S. EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead (U.S. EPA, February 1994). This model is designed to estimate blood levels of lead in children (under 7 years of age) based on either default or site-specific input values for air, drinking water, diet, dust, and soil exposure.

Studies indicate that infants and young children are extremely susceptible to adverse effects from exposure to lead. Considerable behavioral and developmental impairments have been noted in children with elevated blood lead levels. The threshold for toxic effects from this chemical is believed to be in the range of 10 µg/dL to 15 µg/dL. Blood lead levels greater than 10 µg/dL are considered to be a "concern".

For SWMUs 4, 5, 9, and 10, the IEUBK Model for lead will be used to address exposure to lead in children when detected ground water and surface water concentrations exceed the 15 µg/L Federal Action Level promulgated under the Safe Drinking Water Act and when detected soil and sediment concentrations exceed the OSWER soil screening level of 400 mg/kg for residential land use (U.S. EPA, July 1994a). Average chemical concentrations, as well as default parameters for some input parameters, will be employed. Estimated blood lead levels and probability density histograms will be presented as support documentation for this analysis and appended to the site-specific risk assessment.

Adult exposure to lead in soil will be quantified by the model provided by the U.S. EPA's Technical Review Workgroup for Lead (U.S. EPA, December 1996). In this model, adult exposure to lead in soil is addressed by an evaluation of the relationship between the site soil lead concentration and the blood lead concentration in the developing fetuses of adult women. The adult lead model will generate a spreadsheet for each exposure scenario evaluated (i.e., workers and adult residents). The spreadsheets will calculate a range of 95th percentile fetal blood lead concentrations from central estimates of blood lead concentrations in pregnant adult women. The spreadsheets also calculate 95th percentile blood lead concentrations in fetuses born to women exposed to lead in soil.

No models are currently available to evaluate the periodic exposure of adolescent trespassers to lead. Therefore, the results of the IEUBK Model for children will be used to qualitatively assess exposure of this receptor. Essentially, the qualitative discussion will cite that potential adverse effects from exposure to lead are expected to be of a lesser magnitude for adolescent trespassers than for children.

10.2.6 Exposure to Total Petroleum Hydrocarbons

Total petroleum hydrocarbons (TPH) will be qualitatively evaluated by comparing maximum concentrations in soil and sediment to the 100 mg/kg soil notification level specified in the State of Indiana's Underground Storage Tank (UST) program (http://www.state.in.us/idem/oer/ustclosure.html). The notification level is typically used to signify potential releases to soil from fuel tanks and is used to identify the need for contaminant-specific analyses, which will be performed for the site.

10.3 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to identify the potential health hazards and adverse effects in exposed populations. Quantitative estimates of the relationship between the magnitude and type of exposures and the severity or probability of human health effects will be defined for the identified COPCs. Quantitative toxicity values determined during this component of the risk assessment will be integrated with outputs of the exposure assessment to characterize the potential for the occurrence of adverse health effects for each receptor group.

The toxicity value used to evaluate noncarcinogenic health effects is the Reference Dose (RfD). Carcinogenic effects are quantified using the Cancer Slope Factor (CSF).

10.3.1 Toxicity Criteria

Oral and inhalation RfDs and CSFs to be used in the site-specific risk assessments for SWMUs 4, 5, 9, and 10 will be obtained from the following primary literature sources:

- Integrated Risk Information System (IRIS)
- Annual Health Effects Assessment Summary Tables (HEAST)
- NCEA Superfund Health Risk Technical Support Center

Although RfDs and CSFs can be found in several toxicological sources, U.S. EPA's IRIS on-line database is the preferred source of toxicity values. This database is continuously updated and values presented have been verified by U.S. EPA RfD and Carcinogenic Risk Assessment Verification Endeavor (CRAVE) work groups. The U.S. EPA Region IX PRG Tables and Region III RBC Tables will also be used as a source of toxicity criteria.

10.3.1.1 Toxicity Criteria for Dermal Exposure

RfDs and CSFs found in literature may be expressed as administered doses; therefore, these values are considered to be inappropriate for estimating the risks associated with dermal routes of exposure. Oral dose-response parameters based on administered doses must be adjusted to absorbed doses before the comparison to estimated dermal exposure intakes is made. Because this information is not always readily available, all oral dose-response parameters will be adjusted.

The adjustment to an absorbed dose will be made using chemical-specific absorption efficiencies published in available guidance (i.e., IRIS, Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profiles, etc.) and the following equations:

$$RfD_{dermal} = (RfD_{oral})(ABS_{GI})$$

$$CSF_{dermal} = (CSF_{oral}) / (ABS_{GI})$$

where: ABS_{GI} = absorption efficiency in the gastrointestinal tract

Absorption efficiencies used in the risk assessments will reflect the U.S. EPA's current dermal assessment guidance (U.S. EPA, November 1998).

10.3.1.2 Toxicity Criteria for Carcinogenic Effects of PAHs

Limited toxicity values are available to evaluate the carcinogenic effects from exposure to PAHs. The most extensively studied PAH is benzo(a)pyrene, which is classified by the U.S. EPA as a known human carcinogen. Although CSFs are available for benzo(a)pyrene, insufficient data are available to calculate CSFs for other carcinogenic PAHs. Toxic effects for these chemicals will be evaluated using the concept of estimated orders of potential potency, as presented in current U.S. EPA guidance (U.S. EPA, July 1993). These parameters are based on the carcinogenicity of benzo(a)pyrene and are available for select carcinogenic PAHs. The equivalent oral and inhalation CSF for these chemicals is derived by multiplying the CSF for benzo(a)pyrene by the order of potential potency.

10.3.1.3 Toxicity Criteria for Carcinogenic Effects of Dioxins/Furans

Similar to the concept of estimated orders of potential potency for PAHs, chlorinated dibenzo-p-dioxins (CDDs) and -dibenzofurans (CDFs) will be evaluated using Toxicity Equivalence Factors (TEFs) relative to the toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (U.S. EPA, March 1989). Based on a variety of approaches that generate toxicities relative to 2,3,7,8-TCDD, the U.S. EPA developed TEFs for other dioxins/furans from structure-activity relationships and the available toxicological information. The equivalent oral CSF for these chemicals is derived by multiplying the CSF for 2,3,7,8-TCDD by the TEF.

10.3.1.4 Toxicity Criteria for Chromium

Toxicity criteria are available for different forms of chromium, which is considered to be more toxic in the hexavalent state. Because there is no evidence to support the conclusion that hexavalent chromium is present at the sites, speciation analyses will not be completed for SWMUs 4, 5, 9, and 10. Risks associated with this chemical will be assessed by assuming that 10 percent of the reported total chromium result is attributable to hexavalent chromium, while 90 percent of the total chromium result is comprised of trivalent chromium. This assumption is based on published toxicological information (ATSDR, October 1991).

10.3.2 Toxicity Profiles

Toxicological profiles for each COPC will be presented as an appendix to the risk assessment. These brief profiles present a summary of the current available literature on the carcinogenic and noncarcinogenic health effects associated with human exposure to COPCs.

10.4 RISK CHARACTERIZATION

Potential risks (noncarcinogenic and carcinogenic) for human receptors resulting from the exposures outlined in the exposure assessment are quantitatively determined during the risk characterization component of the Baseline Human Health Risk Assessment.

A summary and interpretive discussion of the quantitative risk estimates will be provided in the text of the site-specific risk assessments. During the interpretive risk discussion, COPCs which contribute significantly to elevated risks will be identified as "risk drivers" or Chemicals of Concern (COCs). All the numeric estimates of risk will be contained in the risk assessment spreadsheets, which will appended to the assessment as support documentation.

10.4.1 Quantitative Analysis

Quantitative estimates of risk will be calculated according to risk assessment methods outlined in U.S. EPA guidance (U.S. EPA, December 1989). Lifetime cancer risks will be expressed in the form of dimensionless probabilities, referred to as incremental cancer risks (ICRs), based on CSFs. Noncarcinogenic risk estimates will be presented in the form of Hazard Quotients (HQs) that are determined through a comparison of intakes with published RfDs.

ICR estimates are generated for each COPC using estimated exposure intakes and published CSFs, as follows:

$$ICR = (\text{Estimated Exposure Intake})(CSF)$$

If the above equation results in an ICR greater than 0.01, the following equation will be used:

$$ICR = 1-[\exp(-\text{Estimated Exposure Intake})(CSF)]$$

An ICR of 1E-6 indicates that the exposed receptor has a one-in-one-million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons.

As mentioned previously, noncarcinogenic risks will be assessed using the concept of HQs and Hazard Indices (HIs). The HQ for a COPC is the ratio of the estimated intake to the RfD, as follows:

$$HQ = (\text{Estimated Exposure Intake}) / (RfD)$$

An HI will be generated by summing the individual HQs for all COPCs. The HI is not a mathematical prediction of the severity of toxic effects and therefore is not a true "risk"; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

10.4.1.1 Comparison of Quantitative Risk Estimates to Benchmarks

To interpret the quantitative risks and to aid risk managers in determining the need for remediation at a site, quantitative risk estimates will be compared to typical benchmarks. Calculated ICRs will be interpreted using the U.S. EPA's "target range" (1E-4 to 1E-6), while HIs will be evaluated using a value of 1.0.

The U.S. EPA has defined the range of 1E-4 to 1E-6 as the ICR "target range" for most hazardous waste facilities addressed under RCRA. Individual or cumulative ICRs greater than 1E-4 will not be considered as protective of human health, while ICRs less than 1E-6 will be regarded as protective.

An HI exceeding unity (1.0) indicates that there may be potential noncarcinogenic health risks associated with exposure. If an HI exceeds unity, a segregation of target organs effects associated with exposure to COPCs will be performed. Only those chemicals which affect the same target organ(s) or exhibit similar critical effect(s) will be regarded as truly additive. Consequently, it may be possible for a cumulative HI to exceed 1.0, but no adverse health effects are anticipated if the COPCs do not affect the same target organ or exhibit the same critical effect.

10.4.2 Qualitative Analysis

As mentioned previously, a qualitative evaluation of risk will be made for several exposure situations.

- The soil inhalation pathway (Section 10.2.4) will be initially evaluated by a comparison of maximum site soil concentrations to U.S. EPA Generic SSLs for transfers from soil to air. If the maximum site concentration exceeds the SSL for a chemical, a quantitative analysis of this exposure pathway will be performed.

- Total petroleum hydrocarbons (Section 10.2.6) will be qualitatively evaluated by comparing maximum concentrations in soil and sediment to the 100 mg/kg soil notification level specified in the State of Indiana's UST program.

10.5 UNCERTAINTY ANALYSIS

The goal of the uncertainty analysis is to identify important uncertainties and limitations associated with the Baseline Human Health Risk Assessment. Uncertainties related to each component of the assessment (i.e., data evaluation, exposure assessment, toxicity assessment, and risk characterization) will be presented. In addition, the effect of a particular uncertainty on the outcome of the assessment (i.e., risk estimates) will also be indicated, where possible. The following subsections present an overview of uncertainties which may be addressed in the risk assessment uncertainty section.

10.5.1 Uncertainty in Data Evaluation

This section may discuss uncertainties in the risk assessment associated with the analytical data and data quality. This may also involve a discussion of uncertainty in the COPC selection process, the inclusion or exclusion of COPCs in the risk assessment on the basis of background concentrations, the uncertainty in COPC screening levels, and the omission of constituents for which health criteria are not available.

10.5.2 Uncertainty in the Exposure Assessment

This section will include a discussion of the following: assumptions related to current and future land use; the uncertainty in exposure point concentrations, for example, the use of maximum concentrations to estimate risks; uncertainty in the selection of potential receptors and exposure scenarios; and uncertainty

in the selection of exposure parameters (RME vs. CTE). If predictive models are used in the risk estimation, the uncertainty associated with the model and modeling parameters will be evaluated.

10.5.3 Uncertainty in the Toxicity Assessment

The uncertainties inherent in RfDs and CSFs and use of available criteria will be discussed. A discussion of the uncertainty in hazard assessment, which deals with characterizing the nature and strength of the evidence of causation, or the likelihood that a chemical that induces adverse effects in animals will also induce adverse effects in humans, will be provided. This section will also discuss uncertainty in the dose-response evaluations for the COPCs which relates to the determination of a CSF for the carcinogenic assessment and derivation of an RfD or RfC for the noncarcinogenic assessment. In addition, a discussion of the uncertainty in the toxicity of specific constituents, such as PAHs, arsenic, chromium, aluminum, iron, and copper, will be presented, if applicable.

10.5.4 Uncertainty in the Risk Characterization

This section will discuss the uncertainty in risk characterization which results primarily from assumptions made regarding additivity/synergism of effects from exposure to multiple COPCs affecting different target organs across various exposure routes. The risk assessment will discuss the uncertainty inherent in summing risks for several substances across different exposure pathways.

11.0 ECOLOGICAL RISK ASSESSMENT METHODOLOGY

The goal of the Screening-level Ecological Risk Assessment (SERA) will be to determine whether adverse ecological impacts are present as a result of exposure to chemicals released to the environment through past site operations at SWMUs 4, 5, 9, and 10 at NSWC Crane. This SERA will provide information to scientists and managers that will enable them to conclude either that ecological risks at the site are most likely negligible, or that further information is necessary to evaluate potential ecological risks at the site. The SERA methodology used at NSWC Crane will follow the guidance presented in the Department of Navy Environmental Policy Memorandum 97-04, Use of Ecological Risk Assessments (May 16, 1997), Chief of Naval Operations Letter 5090 SER N453E/9U 59 5335 (April 5, 1999), Navy Policy for Conducting Ecological Risk Assessment, the Final Guidelines for Ecological Risk Assessment (U.S. EPA, 1998a) and the Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (U.S. EPA, June 1997). A schematic diagram of the general risk assessment process is provided in Figure 11-1.

The risk assessor and risk manager will work together in the problem formulation phase to develop theories about possible relationships between undesirable ecological effects and observable stressors. The key role of the risk manager will be to identify the goals of the risk assessment and ensure the risk assessment provides decision-making information relevant to those goals. To that end, the risk manager will describe why the risk assessment is needed, what decisions it will support, and what information is required of the risk assessor. The risk assessor will interpret the goals identified by the risk manager into ecological values that can be evaluated in the risk assessment. The risk assessor will ensure that science is effectively used to address ecological concerns.

This SERA will consist of the first two (plus Step 3A) of eight steps required by the Environmental Protection Agency (EPA) guidance (EPA, 1997 and 1998) and the Navy Policy for Conducting Ecological Risk Assessments (Navy, 1999). Figure 9-1 present these steps in relation to the EPA process that will be used at NWSC Crane.

The first two steps are the screening-level assessment. Step 3A further refines the screening level risk assessment. Steps 3B through 7 are conducted if additional evaluations or investigations are necessary. Finally, Step 8, Risk Management, is incorporated throughout the ERA process, in cooperation with the Region 5 Biological Technical Assistance Group (BTAG).

11.1 PROBLEM FORMULATION

Problem formulation is the first step of an SERA. It results in three products (U.S. EPA, 1998a):

- Assessment endpoints that adequately reflect management goals and the ecosystems they represent;
- Conceptual models that describe the key relationships between a stressor and assessment endpoint or between several stressors and assessment endpoints; and
- An analysis plan.

Problem formulation includes identifying the following:

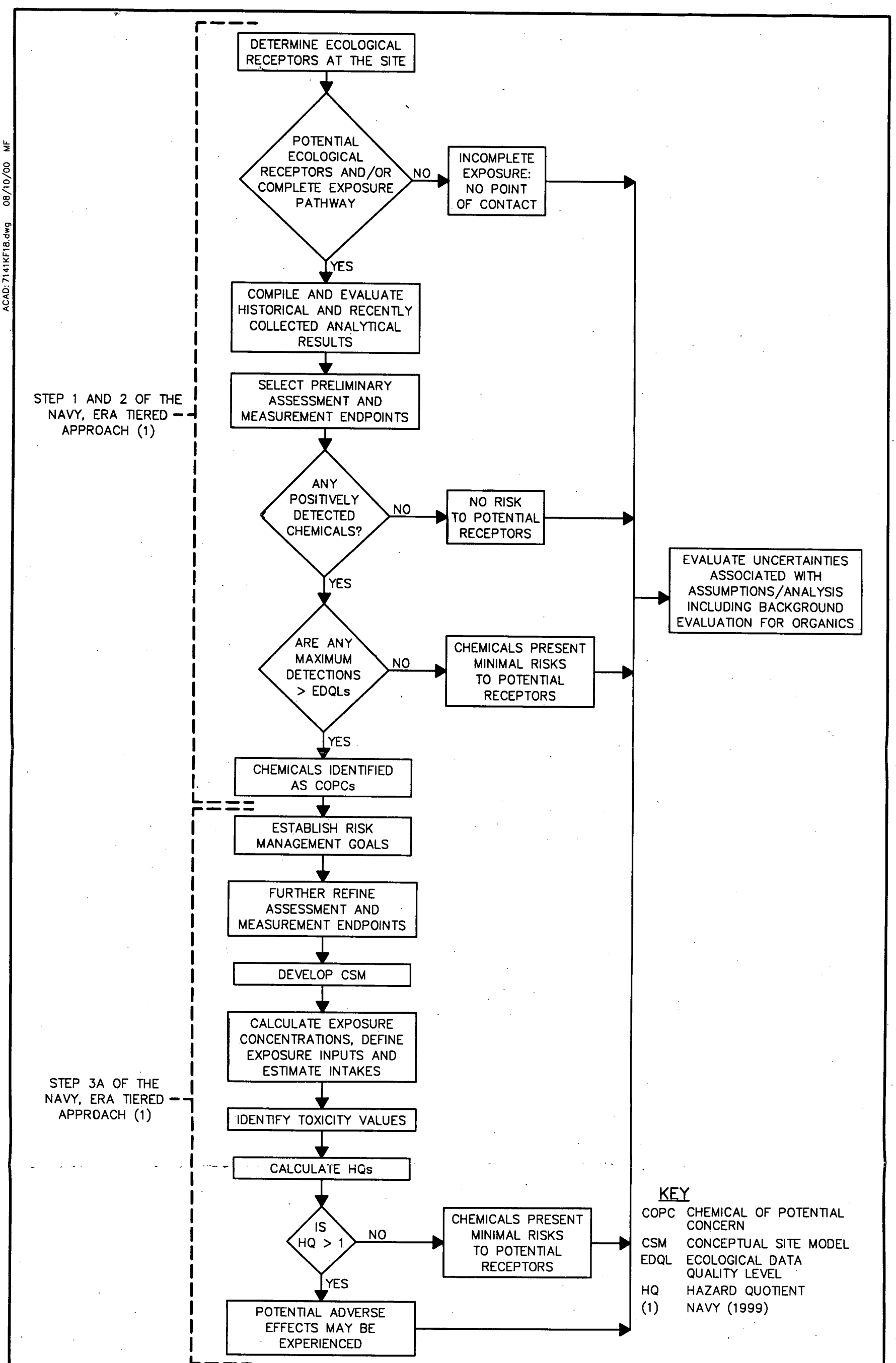
- Ecosystems potentially at risk;
- Source and stressor characteristics;
- Exposure characteristics; and
- Ecological effects.

The problem formulation process enables the risk assessor to identify the ecological resources to be protected (known as assessment endpoints); the measurements to be used to evaluate risks to those resources (known as measures of effects); and the chemicals, geographic areas, and environmental media relevant to the risk assessment.

11.1.1 Ecological Setting and Potential Ecological Receptors at NSWC Crane

Eighty percent of NSWC Crane's 63,000 acres is classified as Central Hardwoods Forest of the United States (NEESA, 1983). In addition, some agricultural fields are in various stages of succession. Openings on dry upland sites contain almost pure stands of grasses with some clumps of woody plants such as persimmon, sassafras, and sumac. Wetter sites have river birch, willow, sycamore, and cottonwood. Hillside communities have mostly hickory, white and black oak, red maple, sugar maple, tulip poplar, ash, and beech (NEESA, 1983).

The great variety of habitats at NSWC Crane (i.e., many stages of forest succession, streams, ponds, Lake Greenwood, grassy open spaces) lead to a high diversity of animal species (NEESA, 1983). Some of these species include (but are not limited to) mammals such as white-tailed deer, beaver, coyote,



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COST/SCHED-AREA		APPROVED BY / DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 11-1	REV. 0

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hawks, red fox, rabbits, raccoons, mice; birds such as ducks, geese, wild turkey, bobwhite quail, red-tailed hawks, and American robins; and various amphibians, reptiles, fish, and invertebrates.

The bird population includes a number of Threatened, Endangered, or Species of Special Concern that use the site as their home range. These species include the bald eagle, osprey, sharp-skinned hawk, red-shouldered hawk, broad-winged hawk, black and white warbler, hooded warbler, and the worm-eating warbler (B&R Environmental, 1997).

There are six main creeks that receive drainage in five separate drainage basins at NSWC Crane: Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, and Seed Tick Creek. There also are many smaller streams/creeks and drainage ditches located at the facility, along with several small man-made ponds and one large lake (Lake Greenwood). Lake Greenwood is the source of potable water for NSWC Crane. Surface water from the facility eventually discharges to the east fork of the White River, which is located south of the facility.

Because of the large numbers of ecological receptors present at the site, it is not feasible to evaluate potential risks to all of them. Therefore, surrogate species will be selected to represent various trophic levels and feeding preferences if it is necessary to conduct foodchain modeling. These surrogate species will be selected after the site visit and after discussions with State and Federal regulators.

11.1.2 Potential Sources of Contamination and Associated Exposure Pathways

For this work plan, four SWMUs were identified at NSWC Crane as areas potentially warranting investigation, possibly including environmental sampling. A wide variety of chemicals were potentially released at these areas including metals, volatile and semivolatile organic compounds, PCBs, and pesticides. Specific information for the SWMUs, including a site description and detected chemicals of interest, was provided in Sections 5.0 and 8.0 of this Work Plan.

The likelihood that ecological receptors could be exposed to potential contamination varies with the particular circumstances associated with each SWMU. The discussion immediately below presents the identification of exposure pathways to ecological receptors from the SWMUs in general terms. This is followed by a brief description of the exposure pathways to ecological receptors at each SWMU.

Several of the SWMUs involve potential releases of contaminants to surface soils through spills or as byproducts of routine operations. The ecological receptors using these areas could be exposed to released chemicals through direct contact, incidental ingestion, grooming activities, and consumption of

soil organisms and/or vegetation, which have taken up the chemicals. Chemicals released to surface soils could infiltrate to subsurface soils; however, it is unlikely that there would be significant contact between ecological receptors and contaminants in the subsurface soil. The avian receptors chosen for the sites (bobwhite quail and American woodcock) do not burrow in the subsurface soil. The small mammal receptors chosen for the sites (meadow vole and the short-tail shrew), may burrow in the soil but rarely exceed 50 cm, eliminating exposure through direct contact and grooming activities (USEPA, 1993a). Because most, if not all, of the food consumed by these birds and mammals (i.e., plants, soil invertebrates) will primarily be exposed to contaminants in the surface soil (0 to 2 feet), the receptors will not be exposed to chemicals in the subsurface soil through incidental ingestion or consumption of organisms and/or vegetation, which have taken up the chemicals. In addition, there is little toxicity data available for plants with roots that extend greater that 2 feet into the soil. Thus, subsurface soils will not be evaluated in the ecological risk assessment.

Chemicals released either to surface or subsurface soils could potentially migrate downward to the shallow aquifer. Although most ecological receptors would not directly contact the ground water while it is in the ground, they may contact contaminated ground water after it discharges to the surface (i.e., seeps, springs), or to a surface water body. Finally, contaminants in surface soil may become suspended or dissolved in surface water runoff and eventually reach aquatic habitats via overland flow or transport through storm sewers.

11.1.3 Ecological Effects

The results of the surface soil, surface water, and sediment sampling for each SWMU will be presented in the report. Physical and chemical characteristics of contaminants may affect their mobility, transport, and bioavailability in the environment. These characteristics include the organic carbon partition coefficient, octanol water partition coefficient, and vapor pressure. These characteristics will be summarized for the contaminants that are detected in the various media, as appropriate.

In addition to the above physical and chemical characteristics, the SERA specifically uses plant, invertebrate, and small mammal bioaccumulation factors to predict contaminant loading in plants, invertebrates, small mammals, and bioconcentration factors to predict concentrations in aquatic organisms. The following list presents the source of the bioaccumulation and bioconcentration factors that will be used in the SERA:

- Plant Bioaccumulation Factors - Organics: Toxicity and Chemical-Specific Factors Database (ORNL, 1998a)

- Plant Bioaccumulation Factors - Inorganics: Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants (ORNL, 1998b)

- Soil Invertebrate Bioaccumulation Factors - PCBs and Inorganics: Development and Validation of Bioaccumulation Models for Earthworms (Sample et al., 1998a)

- Sediment Invertebrate Bioaccumulation Factors - PCBs and Inorganics: Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation (ORNL, 1998c).

- Small Mammal Bioaccumulation Factors – Inorganics: Development and Validation of Bioaccumulation Models for Small Mammals (Sample et al., 1998b).

- Aquatic Bioconcentration Factors – Organics and Inorganics: Various Sources

Some of the BAFs presented in the documents listed previously estimate the tissue concentrations in dry weight. These values must be converted to wet weight for use in exposure estimation in the foodchain models by multiplying the BAF by the proportion of dry matter content of the organism (Sample, et al., 1997). The following table presents the proportion of dry matter that will be used to adjust the BAFs, if necessary (Sample et al., 1997).

Food Type	Percent Water Content	Percent Dry Weight
Aquatic Invertebrates (isopods, amphipods)	71-80	20-29
Terrestrial Invertebrates (earthworms)	84	16
Mammals (mice, voles, rabbits)	68	32
Terrestrial Plants (monocots-young grass)	70-88	12-30

Other plant, invertebrate, and small mammal bioaccumulation factors obtained from the literature also may be used for contaminants that are not listed in the above reference sources. Contaminants that do not have bioaccumulation factors will be assigned a default value of 1.

11.1.4 Assessment Endpoints

Assessment endpoints are explicit expressions of the environmental value that is to be protected (EPA 1997a). The selection of these endpoints is based on the habitats present, the migration pathways of probable contaminants, and the routes that contaminants may take to enter receptors.

The habitat at and adjacent to the sites consist of forested areas, open fields with grasses, and aquatic habitats. For this SERA, the assessment endpoints are for the protection of the following groups of receptors from adverse effects of contaminants on their growth, survival, and reproduction:

- Soil invertebrates
- Terrestrial Vegetation
- Herbivorous mammals
- Herbivorous birds
- Carnivorous birds
- Carnivorous mammals
- Omnivorous mammals
- Omnivorous birds
- Benthic invertebrates
- Fish

The above receptors will be selected for each site based on habitat. For example, sites that do not contain aquatic habitats will not be evaluated for benthic invertebrates and fish.

Many receptors in the soil and aquatic environments are adequately described in general categories such as soil invertebrates, vegetation, and sediment-dwelling (benthic) invertebrates. This is due to the nature of the threshold values, effects values, or water quality criteria that are typically used to characterize risk for such organisms. For vertebrate receptors, selection of particular species may be required so that intake through eating, drinking, and other routes can be estimated.

Receptor identification is influenced by the contaminants, their likely mode of transport, ultimate fate, and toxicity. For example, most metals (with notable exceptions of cadmium and mercury) typically do not bioaccumulate. For contaminants that bioaccumulate, such as mercury compounds and chlorinated pesticides, effects on upper trophic level receptors need to be assessed. For contaminants that do not bioaccumulate, organisms that are in direct contact with soil/sediment (i.e., sediment- and soil-dwelling organisms and plants) and animals that may incidentally ingest soil particles are selected as receptors for

metals if exposure pathways are complete. Sensitivity to particular contaminants is also considered. For example, birds and mammals may have different sensitivities to organic compounds, so each group, or the most sensitive group for a particular contaminant, is assessed.

As previously mentioned, for most receptor species, ingestion is the primary route of exposure. Indicator species are selected for their preferred habitat, body size, sensitivity, home range, abundance, commercial or sport utilization, legal status, and functional role (e.g., predators). For conservativeness, indicator species may be small and have small home ranges. Species known to be sensitive to particular contaminants may be selected or toxicity values for those species may be used. For example, mink are sensitive to PCBs for reproductive endpoints and therefore mink Terrestrial Reference Values (TRVs) would be selected for a scenario involving exposure to PCBs from an aquatic or sedimentary source. The availability of exposure parameters such as body mass, feeding rate, and drinking rate may also be a factor in selecting indicator species. The following indicator species will be used for the food chain modeling (discussed later):

- Herbivorous mammals: Meadow Vole
- Herbivorous birds: Bobwhite Quail
- Carnivorous birds: American Woodcock
- Carnivorous mammals: Short-Tail Shrew

11.1.5 Conceptual Model

A conceptual model in problem formulation is a written description and visual representation of predicted relationships between ecological entities and the stressors to which they may be exposed (U.S. EPA, 1998a). The conceptual model consists of two primary components: 1) predicted relationships among stressor, exposure, and assessment endpoint response; and 2) a diagram that illustrates the relationships (U.S. EPA, 1998a). The following risk hypotheses describe these relationships and are evaluated as part of this SERA:

- Contaminants in the surface soil at the site will not cause a decrease in survival to plants and earthworms/invertebrates;

- Contaminants in the surface soil at the site will not cause an increase in mortality, decrease in reproduction, and/or developmental effects in birds and mammals; and

- Contaminants in the surface water or sediment impacted by the site will not cause an increase in mortality to benthic macroinvertebrates, and fish, and an increase in mortality, decrease in reproduction, and/or developmental effects piscivorous wildlife.

The conceptual models for SWMUs 4, 5, 9, and 10 were presented in Sections 5.0 through 8.0 (Figures 5-7, 6-7, 7-7, and 8-9).

The primary source of the contamination at a SWMU was identified based on past operational practices. The primary stressors are contaminants in the surface soil, surface water, sediment, and ground water. Because ecological receptors are not directly exposed to contaminants in the ground water, the secondary stressors are contaminants in the surface water and sediment. The primary receptors for contaminants in the surface soil will be plants and invertebrates, while the secondary receptors will be birds and mammals.

11.1.6 Measures of Effects

Measures of effects are measures of biological effects (i.e., survival, reproduction) that are used to evaluate the assessment endpoints and risk hypotheses. The following measures of effects will be used to evaluate the assessment endpoints and risk hypotheses in this SERA:

- Soil screening levels - Survival of plants and soil invertebrates will be evaluated by comparing the measured concentrations of chemicals in the surface soil to screening levels designed to be protective of ecological receptors.

- No Observed Adverse Effects Levels (NOAELs) and Lowest Observed Adverse Effects Levels (LOAELs) for surrogate wildlife species - Survival, reproductive, and/or developmental effects of birds and mammals will be evaluated by comparing the ingested dose from contaminants in the surface soil, plants, invertebrates, and/or small mammals, to these levels. The concentrations in the plants, invertebrates, and small mammals will be predicted from available bioaccumulation factors or using a default value of 1.

- No Observed Adverse Effects Levels and Lowest Observed Adverse Effects Levels for surrogate wildlife species - Survival, reproductive, and/or developmental effects of birds and mammals will be evaluated by comparing the ingested dose from contaminants in the surface water, sediment, invertebrates, and/or fish, to these levels. The concentrations in the invertebrates and fish will be predicted from available bioaccumulation factors or using a default value of 1.

- Sediment screening levels - Survival of benthic macroinvertebrates will be evaluated by comparing the measured concentrations of chemicals in the sediment to screening levels designed to be protective of ecological receptors.

- Surface water screening levels - Survival of aquatic organisms will be evaluated by comparing the measured concentrations of chemicals in the surface water to screening levels designed to be protective of ecological receptors.

The above measures of effects may be modified based on the results of the site visit and discussions with State and Federal regulators.

11.2 ANALYSIS PHASE

The analysis phase is the step between the problem formulation and the risk characterization. This phase consists of selection of contaminants of potential concern, characterization of exposure, and characterization of ecological effects.

11.2.1 Selection of Contaminants of Potential Concern

The first step in the analysis phase will be to select Contaminants of Potential Concern (COPCs) by comparing the contaminant concentrations in the surface water, sediment, and surface soil samples to Region V Ecological Data Quality Levels (EDQLs) (U.S. EPA, Region 5, April 1998). The following bullets summarize the procedures that will be used in each of the SWMU-specific SERAs to select COPCs. Calcium, magnesium, potassium, and sodium will not be retained as COPCs in any medium because of their relative low toxicity to ecological receptors, an their high natural variability in concentrations. They are not expected to be related to site activities. Contaminants without EDQLs will be retained as COPCs but only evaluated qualitatively.

Surface Water and Sediment for Benthic Macroinvertebrates, Fish, and Terrestrial Wildlife

1. Inorganic and organic contaminants that do not exceed EDQLs will not be retained as COPCs.
2. Inorganic contaminants that do not exceed the maximum upstream concentrations will not be retained as COPCs.
3. Organic contaminants in sediment that exceed the additive sediment guideline unit for narcotics will be retained as COPCs even if they are lower than the individual EDQLs.

Surface Soil for Invertebrates, Plants, and Terrestrial Wildlife

1. Inorganic and organic contaminants that do not exceed EDQLs will not be retained as COPCs.
2. Inorganic contaminants that exceed EDQLs, but do not exceed the site-specific background concentrations will not be retained as COPCs. Background concentrations are discussed in the Basewide Background Report.

Contaminants that are retained as COPCs then will be further evaluated using additional toxicity data in a lines of evidence approach to determine potential impacts to the ecological receptors. The following sections present the additional data sources that will be used to evaluate the COPCs.

11.2.2 Characterization of Exposure

This section describes the potential or actual contact or co-occurrence of the contaminants with the receptors to determine their exposure dose.

Terrestrial soil invertebrates and plants are exposed to contaminants in the surface soil through direct contact and/or ingestion. Maximum and average soil concentrations will be compared to the surface soil screening values to determine potential risk to these species because receptors that are not mobile (i.e., plants) may be exposed to maximum concentrations. Others (i.e., earthworms) will be exposed to an average concentrations as they move through the soil.

Total exposure of the terrestrial receptors to the COPCs in the soil will be determined by estimating the daily doses in mg/kg/day using exposure equations. The contaminant concentrations in the surface soil, surface water, and sediment are used to calculate the chronic daily intakes (CDI) doses. The following equation presents a generic food chain model that will be modified based on the surrogate species that are selected for the foodchain model, if necessary:

$$CDI = \frac{[(Cc * BAF * IR) + (Cc * Is)]H}{BW}$$

Where:

CDI	=	Chronic Daily Intake (mg/kg-day)
Cc	=	Contaminant concentration in surface soil, surface water, or sediment (mg/kg)
BAF	=	Bioaccumulation factor (unitless)

IR	=	Ingestion Rate (kg/day)
Is	=	Rate of Incidental surface soil ingestion or sediment (kg/day)
H	=	Food Intake from the Contaminated Area (percent)
BW	=	Body weight (kg)

Two foodchain models will be used for each species. The first model will be very conservative using the following assumptions:

- 95% UCL soil, surface water, or sediment concentration;
- Lowest receptor body weight;
- Highest receptor ingestion rate [The food ingestion rates are presented as g/g-day in U.S. EPA, (1993a). The highest ingestion rate will be multiplied by the highest body weight to obtain the maximum daily ingestion rate]; and
- Receptors spend 100% of their time at the site.

The second model will be more realistic using the following assumptions:

- Average soil, surface water, or sediment concentration;
- Average receptor body weight;
- Average receptor ingestion rate [The food ingestion rates are presented as g/g-day in U.S. EPA, (1993a). The average ingestion rate will be multiplied by the average body weight to obtain the average daily ingestion rate]; and
- Receptor's home range taken into account.

The exposure assumptions (i.e., ingestion rate, body weight) will be obtained from the Wildlife Exposure Factors Handbook (U.S. EPA, 1993a), or other sources if necessary.

The lower bound of the threshold effects is based on consistent conservative assumptions and NOAEL toxicity values (U.S. EPA, 1997). This bound will present the highest potential risks. The upper bound is based on observed impacts or predictions that ecological effects could occur and is developed using consistent assumptions, site-specific data, LOAEL toxicity values, or an impact evaluation (U.S. EPA, 1997). This bound will present the average potential risk. Both the upper and lower bounds will be evaluated in this SERA to present the overall range of potential risks.

11.2.3 Characterization of Ecological Effects

The following sections present the toxicological data that will be used to characterize the ecological effects of the COPCs.

11.2.3.1 Terrestrial Plants and Invertebrates

Risks to the terrestrial plants and invertebrates from the COPCs will be evaluated by comparing the contaminant concentrations in the surface soil to various soil standards/benchmark values. These screening values will be designated as Surface Soil Screening Levels (SSSLs). Currently, neither Indiana nor U.S. EPA has developed ecological SSSLs. The following list presents the SSSLs that have been developed by a few groups/agencies. The paragraphs following this list discuss the SSSLs in more detail:

- Dutch Intervention Values and Target Values – Soil Quality Standards (MHSPE, 1994)
- Canadian Soil Quality Guidelines (CCME, 1997 and CCME, 1999)
- Oak Ridge National Laboratory Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision (Efroymson R.A. et al., 1997a)
- Oak Ridge National Laboratory Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision (Efroymson R.A. et al., 1997b)

The Intervention Values and Target Values – Soil Quality Standards were developed by the Netherlands Ministry of Housing, Spatial Planning, and Environment, Department of Soil Protection and will be referred to as the Dutch Screening Values (MHSPE, 1994). The Dutch Screening Values for surface soil consist of Target Values and Intervention Values. The Target Values are the soil quality levels that are ultimately desired (MHSPE, 1994). The values for heavy metals, arsenic, and fluoride were derived from analysis of field data from relatively pollution-free rural areas. The Intervention Values indicate the "concentration levels of the contaminants in the soil above which the functionality of the soil for human, plant, or animal life is seriously impaired or threatened" (MHSPE, 1994). The negligible risk level is assumed to be 1% of the maximum permissible risk level for ecosystems, which is defined as HC95. The target value is calculated as 1% of the HC95 and will be used to determine ecological effects.

The Canadian Soil Quality Guidelines were developed by the Canadian Council of Ministers of the Environment (CCME, 1997 and 1999). They are derived using toxicological data to determine the threshold level for key receptors (CCME, 1997 and 1999). The values are calculated for four land uses: agricultural, residential/parkland, commercial, and industrial. Exposure from direct soil contact is used to derive guidelines for the residential/parkland, commercial, and industrial land uses (CCME, 1997). However, the soil guidelines for the agricultural land use incorporates direct soil contact as well as soil and food ingestion (CCME, 1997 and 1999). A more detailed discussion of the derivation of the soil quality guidelines is presented in A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 1996).

The Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision (Efroymson R.A., et al., 1997a) and the Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision (Efroymson R.A. et al., 1997b) were developed by the Oak Ridge National Laboratory (ORNL). These benchmarks were intended to be used as screening values, and as such, may be overly conservative. They are based on a 20 percent reduction in growth, reproduction, or activity (for invertebrates) or growth and yield (for plants) as the threshold for significant effects (Efroymson R.A. et al., 1997a, b).

Additional sources of toxicity data from the literature may be used to evaluate potential risks to soil flora and invertebrates from contaminants in the surface soil for contaminants that are not evaluated in the above documents.

11.2.3.2 Terrestrial Wildlife

Most of the above-mentioned additional surface soil standards/benchmark values are not designed to screen out risks to terrestrial wildlife ingestion of the soil, plants, invertebrates, small mammals, or fish. Therefore, in addition to comparing the soil concentrations to toxicity values for terrestrial invertebrates and plants, a terrestrial intake model will used to estimate the exposure of the COPCs to terrestrial receptors.

Risk to terrestrial receptors to the COPCs in the soil will be determined by estimating the Chronic Daily Intake (CDI) (see Section 2.1.3.2) and comparing the CDI to Terrestrial Reference Values (TRVs) representing acceptable daily doses in mg/kg/day. The TRVs will be developed from No-Observed-Adverse-Effect-Levels (NOAELs) or Lowest-Observed-Adverse-Effect-Levels (LOAELs) obtained from wildlife studies, if available. The majority of the TRVs will most likely come from the ORNL Toxicological

Benchmarks for Wildlife: 1996 Revision (Sample et al., 1996). Toxicity data in the Agency for Toxic Substances and Disease Registry toxicity profiles and Integrated Risk Information System printouts will be utilized, when necessary.

Appropriate scaling factors to convert a NOAEL from one species to a NOAEL for another species will be agreed on by State and Federal regulators prior to preparing the SERA. If a subchronic study is used to develop the TRV, the final value will be multiplied by a factor of 0.1 to account for uncertainty between subchronic and chronic effects. Also, if a LOAEL study is used to develop the NOAEL TRV, then the LOAEL will be multiplied by a factor of 0.1 to obtain the NOAEL.

11.2.3.3 Surface Water

Water Quality Standards (WQS) for surface water have been developed for Indiana (IDEM, 1998). These are the primary enforceable surface water standards for the site. In addition, the U.S. EPA has established Ambient Water Quality Criteria (AWQC) for a few contaminants. Other, non-regulatory surface water screening values will be used to evaluate the surface water data that do not have WQS or AWQC. All will be collectively referred to as surface water screening levels (SWSLs) in this SERA work plan. The following presents the SWSLs that will be used in this evaluation:

1. Indiana Water Quality Standards (IDEM, 1998)
2. Ambient Water Quality Criteria (U.S. EPA, 1986)
3. "Eco Update-Ecotox Thresholds" (U.S. EPA, 1996)
4. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota, 1996 Revision (Suter and Tsao, 1996)

The Indiana WQS are the concentrations of toxic substances that will not result in acute or chronic toxicity to aquatic life. All of the WQS used in this SERA will be based on total recoverable metals in accordance with the Indiana WQS (IDEM, 1998).

The Ambient Water Quality Criteria were developed by U.S. EPA to provide states with guidance for developing their own criteria. These values are set to protect the majority of aquatic organisms from adverse impacts from contaminants in the surface water.

The publication "ECO Update-Ecotox Thresholds" was prepared by U.S. EPA for use as benchmark screening values in the first step of a baseline risk assessment (U.S. EPA, 1996). Most of the surface water thresholds for the contaminants that are evaluated in this SERA are based on Suter and Mabrey,

(1994) in the Ecotox Thresholds. Because Suter and Mabrey (1994) has been updated, Suter and Tsao (1996) values will be used when the Ecotox Thresholds were based on the Suter and Mabrey (1994) data. The Suter and Tsao (1996) benchmarks were calculated using Tier II methodology as described in the U.S. EPA's Proposed Water Quality Guidance for the Great Lakes System (U.S. EPA, 1993b). Tier II values are developed so that aquatic benchmarks could be established with fewer data than are required for the U.S. EPA AWQC.

Both the acute and chronic SWSLs will be used to evaluate the COPCs to determine potential impacts in a lines of evidence approach.

11.2.3.4 Sediment

Indiana has not established sediment-screening levels (SSLs) for any contaminants, and the U.S. EPA has established SSLs for only a few contaminants. Therefore, other, non-regulatory SSLs will be used to evaluate the sediment data. SSLs based on freshwater studies will be used where available. The following list presents the SSLs that will be used in this evaluation. The paragraphs following this list discuss the SSLs in more detail:

1. "Eco Update-Ecotox Thresholds" (U.S. EPA, 1996)
2. "Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario" (OMOE, 1993)
3. "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments" (Long et al., 1995)
4. "Revised Region III BTAG Screening Levels" (U.S. EPA, 1995)

The sediment Ecotox Thresholds include draft U.S. EPA Sediment Quality Criteria (SQC) that have been established for five contaminants (acenaphthene, dieldrin, endrin, fluoranthene, and phenanthrene), Sediment Quality Benchmarks (SQB) that have been established using equilibrium partitioning, and Effects Range-Low values from Long et al., (1995). The SQC and SQBs Ecotox Thresholds are based on an assumption of 1 percent organic carbon [10,000 mg/kg total organic carbon (TOC)]. It is the understanding of TtNUS (based on personal communication with Ms. Mary Riley from U.S. EPA) that the three PAH SQC documents (acenaphthene, fluoranthene, and phenanthrene) will be withdrawn in favor of a total PAH SQC document due out in the summer of 1999. In addition, a SQC document for metals also is due out in the summer of 1999. These documents will be utilized if they are available when the SERA is prepared.

The "Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario" (OMOE, 1993) are based on freshwater studies. The OMOE guidelines establish three effects levels, as follows:

- ***No Effect Level:*** Sediment will not affect fish or sediment-dwelling organisms. In addition, no transfer through the foodchain and no effect on water quality is expected.

- ***Lowest Effect Level:*** Sediment is considered marginally polluted but will not affect the majority of sediment-dwelling organisms.

- ***Severe Effect Level:*** Sediment is considered highly polluted and likely to affect the health of sediment-dwelling organisms.

The "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments" (Long et al., 1995) will be used if no freshwater data are available because they are generally accepted by many state agencies and U.S. EPA regions, even though they are based primarily on estuarine and marine studies. Long et al. (1995) establishes three effects levels, as follows:

- ***Below Effects Range-Low (ER-L):*** (Effects Range-Low) Minimal-effects range (adverse effects would be rarely observed);

- ***Between ER-L and Effects Range-Median (ER-M):*** Possible-effects range (adverse effects would occasionally occur); and

- ***Above the ER-M:*** Probable-effects range (adverse effects would probably occur).

Additive sediment toxicity for narcotics will be evaluated using additive sediment guideline unit for narcotics.

The Region III BTAG screening levels will be used if no other data are available. Some of their levels are based on less established and accepted methods than the above-referenced levels.

Contaminants that exceed the SSLs also will be compared to background contaminant levels developed in the Sediment Background Concentration Distributions of 172 Potential Pollutants in Indiana (Wente, 1994) document. The term "background" was interpreted in that document as "the concentration that would be present in the absence of any particular pollutant source." Background in that document was not meant to represent the concentrations of pollutants in the absence of all anthropogenic pollutant

sources. The background data were given as a mean and as a 95-percentile value for each contaminant. The inorganic background data were further divided assuming no spatial variability and on a per county basis. IDEM indicated in a personal communication that they typically use the 95 percentile number as a flag when a site may be contaminated. These background values will not be used to select COPCs or predict risk. They will be used as another piece of information in the lines of evidence approach for evaluating the sediments.

11.3 RISK CHARACTERIZATION

The risk characterization is the final phase of a risk assessment characterization that compares the exposure to the ecological effects. It is at this phase that the likelihood of adverse effects occurring as a result of exposure to a stressor will be evaluated.

A Hazard Quotient (HQ) approach will be used to characterize the risk to terrestrial receptors. This approach characterizes the potential effects by comparing exposure concentration with the effects data. The HQ for terrestrial plants and invertebrates will be calculated as follows:

$$HQ = \frac{C_{ss}}{SSSL}$$

Where:

HQ = Hazard Quotient (unitless)

C_{ss} = Contaminant concentration in surface soil (µg/kg or mg/kg)

SSSL = Plant or Invertebrate Screening Level in Soil (µg/kg or mg/kg)

The HQ for the terrestrial wildlife model will be calculated as follows:

$$HQ = \frac{CDI}{TRV}$$

Where:

HQ = Hazard Quotient (unitless)

CDI = Chronic Daily Intake Dose (mg/kg-day)

TRV = Terrestrial Reference Value (NOAEL or LOAEL) (mg/kg-day)

The HQ for the aquatic receptors will be calculated as follows:

$$HQ = \frac{C_{sw}}{SWSL} \text{ or } \frac{C_{sd}}{SSL}$$

Where:

HQ = Hazard Quotient (unitless)

C_{sw} = Contaminant concentration in surface water (µg/L)

C_{sd} = Contaminant concentration in sediment (µg/kg or mg/kg)

SWSL = Surface Water Screening Level (µg/L)

SSL = Sediment Screening Level (µg/kg or mg/kg)

A HQ of greater than "unity" will be considered to be indicative of potential risk. Such values do not necessarily indicate that an effect will occur but only that a lower threshold has been exceeded.

Four terrestrial wildlife HQs will be calculated in the SERA to present the range of risks are discussed in Section 2.1.3.2: 1) $NOAEL_{max}$ (HQ using maximum exposure and NOAEL); 2) $LOAEL_{max}$ (HQ using maximum exposure and LOAEL); 3) $NOAEL_{avg}$ (HQ using average exposure and NOAEL); and 4) $LOAEL_{avg}$ (HQ using average exposure and LOAEL). The $NOAEL_{max}$ will be considered the lower bound of the threshold effects because it will be based on conservative assumptions and NOAEL toxicity values. The $LOAEL_{avg}$ will be considered the upper bound of the threshold effects because it will be based on less conservative assumptions, site-specific data (i.e., home range compared to area of SWMU), and LOAEL toxicity values.

The risk description is the technical narrative supporting the risk estimates. The risk description will provide a description of the risk estimates in terms of the extent, magnitude, and potential ecological significance. Specifically, the risk description portion of the risk characterization will describe the location and areal extent of existing contamination where the hazard quotient of 1 is exceeded for a chemical(s). This information will provide an area of the bounds of impact above the threshold for adverse effects. Other relevant information related to the risk estimate that will be provided in the ecological risk assessment includes the expected half-life (qualitative or quantitative) in the environment for those site-related contaminants which exceed the hazard quotient of 1 as well as a qualitative discussion of the uncertainties associated with the ecological risk assessment.

11.4 UNCERTAINTY ANALYSIS

Uncertainties are associated with most steps of an SERA, from selecting endpoints, collecting data, and evaluating toxicity. The following sections describe some of the sources of uncertainty that may be associated with this SERA.

11.4.1 Endpoints

Measures of effects are used to evaluate the assessment endpoints that are selected for the SERA. For this SERA, the measures of effects are not the same as the assessment endpoints. Therefore, the measures are used to predict effects to the assessment endpoints by selecting surrogate species that will be evaluated. For example, survival of a robin is used to assess survival of the song bird population. However, predicting the survival of a robin may either under or overprotect the song bird population resulting from differences in ingestion rates, toxicity, food preferences, etc. between different bird species.

Several endpoints will not be quantitatively evaluated in this SERA. Risks to burrowing animals will not be quantitatively evaluated because the methods for quantifying risks to these species have not been well developed. In addition, risks to reptiles and amphibians will not be quantitatively evaluated because exposure factors are not established for most species, and toxicity data are very limited. Therefore, there is uncertainty in risks to these species.

11.4.2 Exposure Characterization

The contaminant dose to terrestrial wildlife is calculated using an equation that incorporates ingestion rates, body weights, bioaccumulation factors, and other exposure factors. These exposure factors are obtained from literature studies or predicted using various equations. Ingestion rates and body weights vary between species, especially between species inhabiting different areas. For example, the food ingestion rate for the robin was calculated as 0.89 g/g-day in California, and 1.52 g/g-day in Kansas (U.S. EPA, 1993a). Therefore, there is uncertainty in applying exposure factors from the literature to the species at NSWC Crane.

Bioaccumulation of contaminants into various biological media (i.e., plants, invertebrates, fish, small mammals) depend on characteristics of the media such as pH, organic carbon, etc. Therefore, actual bioaccumulation factors at the site may be different than the ones used in the SERA which were obtained from the literature.

There is uncertainty in the chemical data that is collected at the site. Sampling programs are frequently biased toward locations that have a higher expectation of being contaminated. Therefore, the concentrations do not actually represent the site, but they represent the higher concentrations at a site. As such, predicted exposure doses probably will be higher than actual exposure doses.

Finally, under the conservative scenario, terrestrial wildlife are assumed to live and feed only at the site or only in the portion of a waterbody affected by the site. These assumptions will tend to overpredict risk because it is unlikely that most receptors will obtain all their food from within the site boundaries and from the most contaminated areas. Risk also may be overpredicted in the average scenario, where percent of food intake from the contaminated area is taken into account because of the biased sampling in the most contaminated areas.

11.4.3 Ecological Effects Data

There is uncertainty in the ecological toxicity value comparison. The AWQC developed by the U.S. EPA in theory protect 95 percent of the exposed species. Therefore, some sensitive species may be present at the site that are not protected by the use of these criteria. There also may be situations where the SWSLs are over-predictive of risk if the sensitive species used to develop the criteria are not present. Finally, with the exception of hardness for a few metals, the SWSLs do not account for site-specific factors such as TOC, pH that may affect toxicity.

Potential adverse impacts to aquatic receptors from constituents in the sediment are evaluated by comparing the COPC concentration in the sediment to screening values. The SSLs have more uncertainty associated with them than do the SWSLs for the following reasons: 1) the procedures for developing them are not as well established so screening values have been developed using different methodologies; and 2) there are less sediment toxicity data than surface water toxicity data. Sediment characteristics (i.e., pH, acid volatile sulfide, total organic carbon) also will have a large impact on the bioavailability and toxicity of constituents. Finally, screening values based on equilibrium partitioning have uncertainty associated with Log K_{ow} values; the assumed relationship between K_{ow} and K_{oc}, and the assumption that pore water exposure is the most important route for sediment-dwelling organisms.

Potentially adverse impacts to terrestrial plants and invertebrates from constituents in the surface soil are evaluated by comparing the COPC concentration to surface soil screening values. The SSSLs are similar to the sediment screening values in that they are less established than the SWSLs. Fewer studies and less data are available for establishing SSSLs than SSLs and many of the SSSLs are based on the results of only a few studies. In addition, the SSSLs are based on different endpoints depending on the preference of the agency that developed them. Therefore, they have more uncertainty than surface water and sediment screening levels.

The NOAELS and LOAELs that were selected for the wildlife endpoint species likely will be based on species other than the endpoint species (i.e., rats, mice, ducks). There is uncertainty in the application of

a toxicity data across species because the contaminant may be more or less toxic to the endpoint species than it was to the test study species.

The toxicity of chemical mixtures is not well understood. All the toxicity information used in the SERA for evaluating risk to the ecological receptors is for individual chemicals. Chemical mixtures can affect the organisms very differently than the individual chemicals because of synergistic or antagonistic effects.

Finally, toxicological data for a few of the COPCs are limited or do not exist. Therefore, there is uncertainty in any conclusions involving the potential impacts to ecological receptors from these constituents.

11.4.4 Risk Characterization

Risks are projected if a hazard quotient is greater than one regardless of the magnitude of the HQ. Although the relationship between the magnitude of a HQ and toxicity is not necessarily linear, the magnitude of an HQ can be used as rough approximation of the extent of potential risks, especially if there is sufficient confidence in the guideline used. Finally, there is uncertainty in how the predicted risks to a species at the site, translates into risk to the population in the area as a whole.

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