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Final

Master Project Plan

Naval Station Norfolk
St. Juliens Creek Annex
Chesapeake, Virginia

Contract Task Order 15

July 2000

Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Under the

LANTDIV CLEAN II Program
Contract N62470-95-D-6007

Prepared by

CDM Federal Programs Corporation

Submitted by

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Herndon, Virginia

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SECTION 1.0

Preface

This document presents the Master Project Plans (MPs) for the activities to be performed for Installation Restoration Program investigations at St. Juliens Creek Annex to Naval Base, Norfolk (St. Juliens Creek Annex). The Atlantic Division of the Naval Facilities Engineering Command (LANTDIV), in conjunction with the United States Environmental Protection Agency (USEPA) Region III, and the Virginia Department of Environmental Quality (VDEQ) has agreed that one set of MPs will provide the background information needed to understand base-wide site conditions, the approach to be used for investigations, and general types of activities to be completed.

The MPs include three separate but related documents: the Master Work Plan (WP), the Master Sampling and Analysis Plan (SAP), and the Master Health and Safety Plan (HASP). The Master SAP consists of three documents: The Master Field Sampling Plan (FSP), the Master Quality Assurance Project Plan (QAPP), and the Master Investigation-Derived Waste Management Plan (IDWMP). The MPs will be updated by LANTDIV or the environmental contractor as necessary, and reviewed at least once every three years by USEPA and VDEQ personnel to ensure that the information contained therein is accurate and reflects current procedures and guidance. Any updates or necessary changes will be incorporated through addenda to the MPs.

SECTION 2.0

Document Organization

The Master Project Plan includes the Master Work Plan (WP), the Master Sampling and Analysis Plan (SAP), and the Master Health and Safety Plan (HASP), and master sets of Standard Operating Procedures (SOPs).

The organization of the Master Project Plan is outlined below. The Master Work Plan includes sections containing general information on:

- Site background - provides background information on St. Juliens Creek Annex (Section 2)
- Environmental setting - gives information on regional geology, climate, and topography for St. Juliens Creek Annex (Section 3)
- Potentially ARARs for St. Juliens Creek Annex - lists several ARARs that may be referenced throughout the course of the investigations at St. Juliens Creek Annex (Section 4)
- Investigation Tasks - discusses the technical approach to the investigative tasks to be performed at St. Juliens Creek Annex including fieldwork support, field investigation, sample analysis and data validation, risk assessment, the RI report, and the evaluation of SSAs (Section 5)
- Feasibility Study Tasks - describes the tasks involved in performing a FS (Section 6)
- References (Section 7)
- The Norfolk Partnering Team Human Health Risk Assessment Consensus Agreements (Appendix A)
- Site-specific Checklists (Attachment A)

The sections cited above will discuss the background information needed to understand base-wide site conditions, the approach to be used for the RI/FS and site screening processes (SSPs), and the general types of activities to be completed. Site-specific details, such as sampling locations, numbers of samples, and analytical parameters, will be provided in separate site-specific plans. The site-specific plans will supplement their respective MPs and will present information specific to each new area of investigation. Details, such as results of previous site investigations and site-specific maps, will be provided in the site-specific WPs

The Master SAP consists of three documents: The Master Field Sampling Plan (FSP), the Master Quality Assurance Project Plan (QAPP), and the Master Investigation Derived Waste Management Plan (IDWMP).

The Master FSP includes the following sections:

- Introduction - describes the document (Section 1)

- Field Activities - generally describes analytical/quality control protocol, field activities, and field sampling methods (Section 2)
- Documentation - describes sample tracking and shipping procedures (Section 3)

The Master QAPP describes general quality assurance and quality control procedures for conducting groundwater, surface water, sediment, soil, waste liquids and solids, and biota sampling at sites under investigation at the base. This includes sampling activities at sites to be investigated as part of future preliminary assessment (PA), remedial investigation (RI) or feasibility study (FS) action as well as initial investigations at site screening areas (SSAs).

The Master IDWP includes the following sections:

- Introduction - describes the document (Section 1)
- Waste Handling - discusses the waste handling procedures to be followed during any site investigation or other sampling event on the base (Section 2)
- General Considerations - documents information pertinent to the generation and handling of IDW (Section 3)

The Master HASP includes the following sections:

- Introduction - describes the document, how the document should be used, information regarding the environmental contractor's health and safety policy, and general site pre-entry requirements.
- Project Information and Description (Section 1.0) - provides general information about St. Juliens Creek Annex, such as accessibility, size, and history.
- Project Organization and Tasks (Section 2.0) - lists potential tasks (both Hazardous Waste Operations and Emergency Response [HAZWOPER]-REGULATED and NON-HAZWOPER-REGULATED) to be performed at St. Juliens Creek Annex.
- Hazard Evaluation and Control (Section 3.0) - discusses the evaluation and control of some hazards typically associated with St. Juliens Creek Annex.
- Personnel (Section 4.0) - describes the environmental contractor's medical surveillance and training program and lists employees of the environmental contractor who may potentially perform field work on St. Juliens Creek Annex. Also discusses the policy and procedures for covering subcontractors and other contractors under the HASP of the environmental contractor.
- Personal Protective Equipment (Section 5.0) - lists general personal protective equipment required for each level of personal protection and discusses reasons for upgrading or downgrading to a different level.
- Air Monitoring Specifications (Section 6.0) - lists the air monitoring equipment needed for some common field activities, air monitoring action levels, frequency of use, frequency of calibration, and calibration specifications.
- Decontamination (Section 7.0) - discusses general specifications for personnel, sampling equipment, and heavy equipment.

- Spill-Containment (Section 8.0) - describes general spill containment procedures.
- Confined-Space Entry (Section 9.0) - discusses confined-space entry policy.
- Site-Control Plan (Section 10.0) - outlines site control procedures and HAZWOPER compliance plan.
- Emergency Response Plan (Section 11.0) - discusses various aspects of the emergency procedures.
- Emergency Response (Section 12.0) - lists emergency contacts for St. Juliens Creek Annex, the environmental contractor, and any government agencies involved with the project.

The following describes the organization of the Master Set of SOPs which cover various procedures in the following general areas:

- Field Parameters
- Close Support Lab/Field Screening
- Health and Safety Monitoring
- Soil Sampling
- Surface Water and Sediment Sampling
- Groundwater Sampling
- Hydrogeologic Investigations
- Geophysics
- Sample Preparation
- Decontamination and Waste Management
- Other
- Ecological Sampling

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List of Acronyms and Abbreviations

AOC	Areas of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society of Testing Materials
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
bgs	below ground surface
BOA	Basic Ordering Agreement
BRA	Baseline Risk Assessment
CAA	Clean Air Act
CADD	Computer Aided Drafting and Design
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
C.L.E.A.N.	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
COPC	Chemical of Potential Concern
CSF	Carcinogenic Slope Factor
CTO	Contract Task Order
CWA	Clean Water Act
DOD	Department of Defense
DOT	Department of Transportation
ECAO	Environmental Criteria and Assessment Office
EDMS	Environmental Data Management System
EEQ	Environmental Effects Quotient
EPIC	Environmental Photographic Interpretation Center
ERA	Ecological Risk Assessment
FS	Feasibility Study
FSP	Field Sampling Plan
GIS	Geographic Information System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient

IAS	Initial Assessment Study
IDW	Investigation Derived Waste
IDWMP	Investigation-Derived Waste Management Plan
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
LOAEL	Lowest-Observed-Adverse-Effect-Level
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
mg/l	milligrams per liter
MP	Master Project Plan
MSDS	Material Safety Data Sheets
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	mean sea level
NACIP	Naval Assessment and Control of Installation Pollutants
NAD	Naval Ammunition Depot
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NFEC	Naval Facilities Engineering Command
NFESC	Naval Facility Environmental Service Center
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No-Observed-Adverse-Effect-Level
NPL	National Priorities List
NTR	Navy Technical Representative
NUS	NUS Corporation, Superfund Division
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyl
PMCL	Proposed Maximum Contaminant Level
PMCLG	Proposed Maximum Contaminant Level Goals
PPE	Personal Protective Equipment
POC	Point of Contact
ppm	parts per million
PRG	Primary Remedial Goals
PWC	Public Works Center
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality Control

RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objectives
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RDA	Recommended Dietary Allowance
RFA	RCRA Facility Assessment
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
RPM	Regional Project Manager
RRR	Relative Risk Ranking
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
SMDP	Scientific/Management Decision Points
SMP	Site Management Plan
SSA	Site Screening Area
SSP	Site Screening Process
SWMU	Solid Waste Management Unit
SWQS	Surface Water Quality Standards
TBC	To Be Considered
TIC	Tentatively Identified Compounds
TOC	Total Organic Carbon
TOX	Total Organic Halides
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage, Disposal
UCL	Upper Confidence Limit
USC	United States Code
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VDEQ	Virginia Department of Environmental Quality
VGS	Virginia Groundwater Standards
VHWMR	Virginia Hazardous Waste Management Regulation
VOC	Volatile Organic Compound
VPDES	Virginia Pollutant Discharge Elimination System
VR	Virginia Regulation
VSI	Visual Site Inspection
WP	Work Plan

SECTION 1.0

Introduction

1.1 Preface

This Master Work Plan provides general information about St. Juliens Creek Annex and the technical approach that will be used for environmental investigations at the Annex. Environmental contractors performing field investigations on St. Juliens Creek Annex will be able to reference this general material, such as regional geology, sampling procedures, and analytical methodologies, from one master set of documents. General information will not have to be reproduced for each report or for each investigation.

Site-specific details, such as sampling locations, numbers of samples, and analytical parameters, will be provided in separate site-specific plans. The site-specific plans will supplement the MP and will present information specific to each new area of investigation. Checklists of items to be included in each site-specific plan are provided in Attachment A of the Master WP.

1.2 Document Organization

This Master Work Plan includes sections containing general information on:

- Site background - provides background information on St. Juliens Creek Annex (Section 2)
- Environmental setting - gives information on regional geology, climate, and topography for St. Juliens Creek Annex (Section 3)
- Potentially ARARs for St. Juliens Creek Annex - lists several ARARs that may be referenced throughout the course of the investigations at St. Juliens Creek Annex (Section 4)
- Investigation Tasks - discusses the technical approach to the investigative tasks to be performed at St. Juliens Creek Annex including fieldwork support, field investigation, sample analysis and data validation, risk assessment, the RI report, and the evaluation of SSAs (Section 5)
- Feasibility Study Tasks - describes the tasks involved in performing a FS (Section 6)
- References (Section 7)
- The Norfolk Partnering Team Human Health Risk Assessment Consensus Agreements (Appendix A)
- Site-specific Checklists (Attachment A)

SECTION 2.0

Site Background

The Master WP for St. Juliens Creek Annex documents the general scope and objectives of the investigation activities. It serves as a reference for the general site history, environmental setting, potential ARARs, technical approaches to and overall project goals. It does not, however, describe any site-specific historical information or plans for investigation. Specific information will be provided in the site-specific work plans which will be developed as each site or group of sites is investigated (see Site Management Plan (SMP) for dates of activities to be implemented at St. Juliens Creek Annex). The Master WP will be reviewed/updated at least once every three years. Information contained in site-specific plans supersedes the information contained in this document.

2.1 Facility Description

Available site-background information is documented in this section. Information was obtained primarily from the the Phase II RCRA Facility Assessment of the St. Juliens Creek Annex Facility, Chesapeake, Virginia (A. T. Kearney, Inc. 1989) and the Navy Assessment and Control of Installation pollutants: Initial Assessment Study of St. Juliens Creek Annex, Norfolk Naval Shipyard, Portsmouth, VA (NEESA 1981).

2.1.1 Location and Surrounding Land Use

The St. Juliens Creek Annex Facility is situated at the confluence of St. Juliens Creek and the Elizabeth River in the city of Chesapeake, located in southeastern Virginia (Figure 2-1). The facility covers approximately 490 acres and includes 221 buildings, 653 feet of wharf, a central heating plant, numerous non-operational industrial facilities, and miscellaneous structures including a housing area (Figure 2-2). A Virginia Power Company power line runs diagonally across the facility in a northwest-southeast trending direction, splitting the area roughly in half.

The facility is bordered to the north by the Norfolk and Western Railroad, the City of Portsmouth, and residential areas, to the west by residential areas, to the south by St. Juliens Creek, and to the east by the south branch of the Elizabeth River. According to the 1982 U. S. Geological Survey (USGS) Norfolk South Quadrangle topographic map, a large industrial waste pond was located adjacent to the property boundary in the northeast portion of the Annex. Most of the surrounding areas are developed, and include residences, schools, recreational areas, and shipping facilities for several large industries. The Norfolk Naval Shipyard is located approximately three miles north. Some undeveloped areas are located in various areas surrounding the facility.

A large concentration of military installations is located within a 25-mile radius of the facility, including: Naval Base Norfolk, Fort Monroe, Langley Air Force Base, and Norfolk Naval Shipyard on the north, Naval Amphibious Base and Fort Story on the east, Naval Air Station Oceana on the southeast, and Naval Supply Center-Craney Island Fuel Terminal on the southwest.

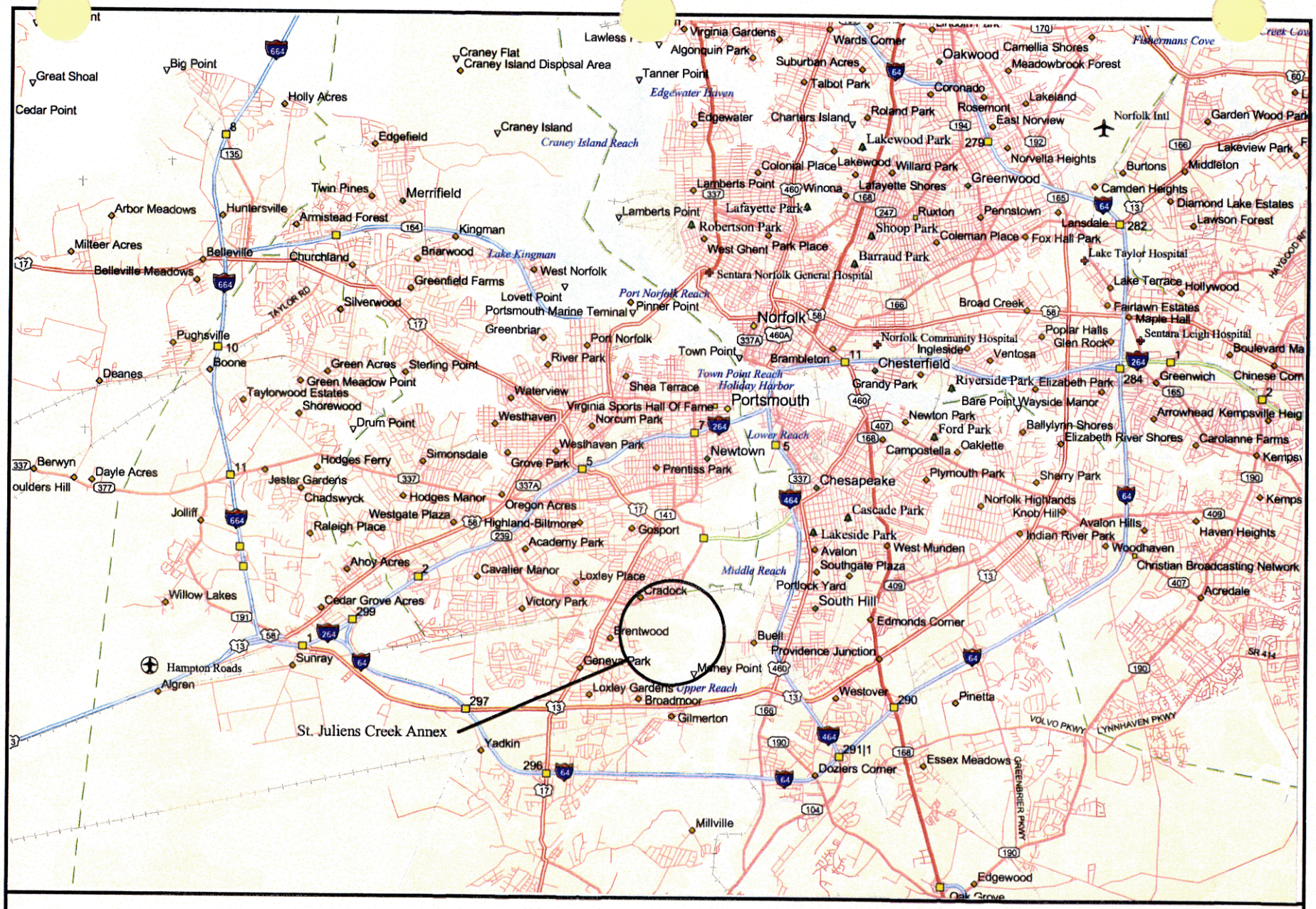

Figure 2-1

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Installation Location Map
Master Work Plan
St. Juliens Creek Annex

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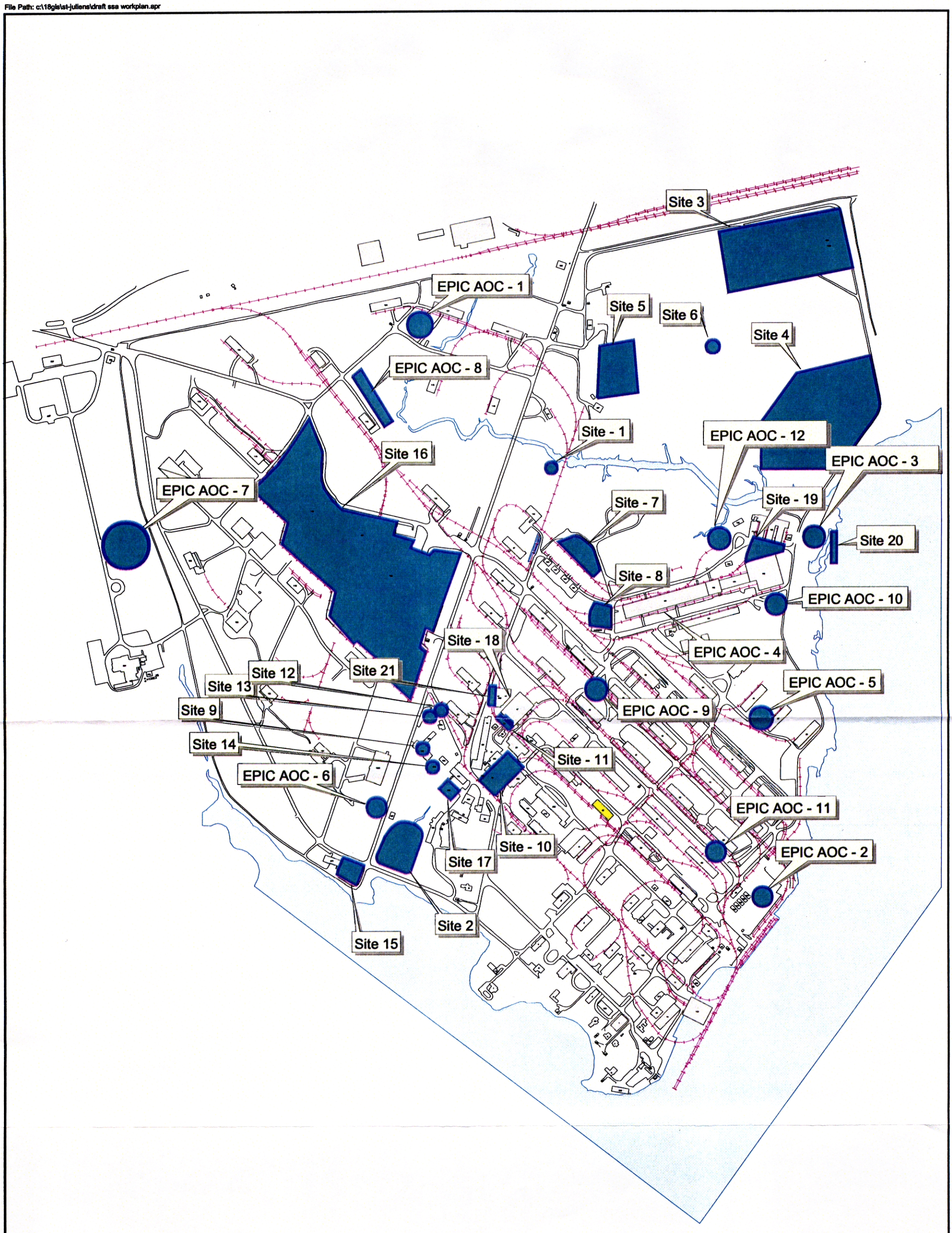

LEGEND

- Buildings
- Roads
- Hydrography Surface
- Railroad

N

0 500 1000 Feet

Figure 2-2

Site Location Map
Master Work Plan
St. Juliens Creek Annex

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2.1.2 Facility History

The St. Juliens Creek Annex began operations as a naval ammunitions facility in 1849. At that time, the area, known as Fort Norfolk, was transferred from the War Department to the Navy Department for use as a storage facility for ordnance and materials. The facility was renamed Magazine, Fort Norfolk. In 1896, the facility gained an additional 48 acres to accommodate additional magazines, wharves, housing, and administration buildings. In 1898, ordnance material and equipment were moved from Craney Island to the Magazine; the facility was renamed U.S. Arsenal, St. Juliens Creek.

In 1902, the name was changed to U.S. Naval Magazine, St. Juliens Creek. The Magazine was at that time fully operational and provided critical support to the fleet during the end of the Spanish-American War.

In 1915, manually operated machines were replaced by modernized motor-powered machines. In 1917, the facility installed equipment for loading MARK VI mines. The facility's name was changed again, to Naval Ammunition Depot (NAD), St. Juliens Creek, and operated under the Commandant Fifth Naval District.

Between World War I and World War II, the facility assumed a peacetime mission of supplying ammunition to the fleet.

The facility operated at its peak level from 1942 to 1944, during World War II. An additional 119 acres of land were purchased and additional magazines, filling houses, and other facilities were constructed. A fence was erected to secure the facility. The mission of NAD St. Juliens Creek during World War II included loading, assembling, issuing, and receiving naval gun ammunition. The depot also served as the principal experimental and test loading facility for new ammunition types for the Bureau of Ordnance.

The depot also supplied ammunition during the Korean War. After the war, the depot again resumed its mission of peacetime service to the fleet. In 1964, the depot was the prime source of gun ammunition for Navy and Marine Corps operations in Southeast Asia.

In October 1969, after 50 years as an independent facility, NAD St. Juliens Creek was disestablished under the Department of Defense "Project 703", and was consolidated as an annex to the Naval Weapons Station, Yorktown, Virginia. On October 1, 1977, the Annex was transferred to the Norfolk Naval Shipyard.

The Norfolk Naval Shipyard transferred the Annex to Naval Base, Norfolk in July 1995. The Class II property on the Annex was transferred from Naval Base to Naval Station in April 1996.

2.1.3 Past Operations/Process Descriptions

Processes and operations at the St. Juliens Creek Annex facility have included general ordnance operations involving wartime transfer of ammunitions to various other U.S. Naval facilities throughout the United States and abroad. In addition, the Annex has been involved in specific ordnance operations and processes including those involving black powder operations, smokeless powder operations, projectile loading operations, mine loading, tracer mixing, testing operations, and decontamination operations.

The St. Juliens Creek Annex facility has also been involved in non-ordnance operations, including degreasing operations, paint shops, machine shops, vehicle and locomotive maintenance shops, pest control shops, battery shops, print shops, electrical shops, boiler plant operations, washrack operations, potable and salt water fire protection systems, and fire

training operations. Many of these operations have been discontinued, such as locomotive maintenance, printing, and pest control.

Materials stored at the St. Juliens Creek Annex facility have included oil, ordnance materials, non-ordnance chemicals, and disaster preparedness chemicals. Various parts of the facility are used to store small amounts of waste before transfer to accumulation points.

2.1.4 Current and Future Facility Mission

Activity at the Annex has decreased in conjunction with present national peacetime conditions. The current primary mission of the St. Juliens Creek Annex facility is to provide a radar testing range and various administrative and warehousing facilities for the nearby Norfolk Naval Shipyard and other local Navy activities. St. Juliens Creek Annex also provides administrative offices, light industrial shops and storage facilities for tenant naval commands.

Currently, structures northwest of the power line are predominantly used for storage and warehousing, and those southeast of the power line are light industrial and manufacturing, and housing facilities; the search radar test range for the Norfolk Naval Shipyard is also located in this area.

2.2 Regulatory Background

Information regarding previous base-wide investigations is documented below. The Installation Restoration Program (IRP) is described first, followed by summary information from previous base-wide investigations.

2.2.1 Installation Restoration Program

In 1975, the Department of Defense (DOD) began a program to assess past hazardous and toxic materials storage and disposal activities at military installations. The goals of this program, now known as the IRP, were to identify environmental contamination resulting from past hazardous materials management practices, to assess the impacts of the contamination on public health and the environment, and to provide corrective measures as required to mitigate adverse impacts to public health and the environment.

In 1976, RCRA was passed by Congress to address potentially adverse human health and environmental impacts of hazardous waste management and disposal practices. RCRA was legislated to manage the present and future disposal of hazardous wastes. In 1980, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or "Superfund" was passed to investigate and remediate areas resulting from past hazardous waste management practices. This program is administered by the USEPA or state agencies.

In 1981, the DOD's IRP was re-issued, with additional responsibilities and authorities specified in CERCLA delegated to the Secretary of Defense. The Navy subsequently restructured the IRP to match the terminology and structure of the USEPA CERCLA Program. The current IRP is consistent with CERCLA and applicable state environmental laws.

2.2.2 Status of St. Juliens Creek Annex

The St. Juliens Creek Annex Facility is not listed on the USEPA National Priorities List (NPL). Therefore the Navy is acting as the lead agency in environmental investigations at the Base, and the environmental condition of the Base is being investigated through the IRP.

2.2.3 Previous Base-Wide Investigations

Previous basewide investigations completed through the IRP include the initial assessment study (IAS), dated August 1981 and a Relative Risk Ranking (RRR) System Data Collection Report, dated April 1996. In addition, USEPA Region III conducted two assessments at the Annex: a Preliminary Assessment (PA), dated 1983, and a Phase II RFA, dated March 1989.

In 1981, the U.S. Navy conducted the IAS as part of the Naval Assessment and Control of Installation Pollutants (NACIP) Program. The purpose of the IAS was to identify and assess sites that posed a potential threat to human health or the environment because of contamination from past handling of and operations involving hazardous materials. Results of this study revealed that low level concentrations of ordnance materials were determined to exist throughout the facility. However, the sites identified were determined not to pose a threat to human health and the environment, and no confirmation study was conducted. No sampling was conducted as part of the study.

In 1983, NUS Corporation, Superfund Division (NUS), conducted PA at seven sites at the facility. These sites included: Cross and Mine (Solid Waste Management Unit [SWMU] #9); Building 249 (SWMU #13); Dump A (SWMU #1); Dump B (SWMU #2); Dump B Incinerator (SWMU #3); Dump C (SWMU #5); and Dump D (SWMU #6). Each site was monitored for volatile organic compounds (VOCs) and radiation with an organic vapor meter and radiation meter, respectively. No sampling was conducted as part of the PA. NUS did not observe significant signs of contamination at the sites observed. However, the PA report mentioned that various locations on the facility were contaminated with low level residues of pesticide and herbicide materials.

In 1989, A.T. Kearney, Inc. and K.W. Brown & Associates, Inc. prepared a Phase II RFA. The RFA included a preliminary review of all available relevant documents and a visual site inspection (VSI), including 34 SWMUs and Areas of Concern (AOCs). Eleven of the SWMUs and AOCs were recommended for RFIs. No sampling was conducted during the RFA.

In April 1996, CH2M Hill Federal Group, Ltd. submitted to the Department of the Navy an RRR System Data Collection Report for the St. Juliens Creek Annex. The report contained results from sampling conducted at 21 sites at the Annex where no sampling data had previously been available. The goal of the sampling effort was to gather data for the Navy to perform assessments of the sites using the Navy's RRR System.

Twelve potential AOCs were identified for investigation during the joint EPA, VDEQ, and Navy review of historical aerial photography (EPIC Study) of the facility in June 1999. In November 1999, a work-in –progress/site visit with representatives of the Navy, CDM Federal, VDEQ, and the EPA-BTAG was conducted to evaluate the twelve "EPIC AOC" locations. And review their current and past conditions (based on EPIC photographs) to determine if sampling was warranted at any of these EPIC AOCs. In addition, the group reviewed site conditions and historical photography of the IRP sites to be included in the SSA investigation, and those sites planned for the SI. The Navy, EPA, and VDEQ conducted an additional site visit on February 2, 2000 to confirm this determination. Descriptive information on these EPIC AOC sites can be found in the Site Management Plan.

2.3 Current Base Wide Investigations

NFEC LANTDIV has awarded the Navy C.L.E.A.N. II Contract to CH2M HILL. As of the date of preparing this work plan, five contract task orders (CTO) for investigations at the St. Juliens Creek Annex have been issued under the CLEAN II contract; CTO-015 includes the performance of a Base-wide background study, CTO-027 is the Remedial Investigation/Feasibility Study (RI/FS) for Landfill C and Landfill D, CTO-028 is the RI/FS for Landfill B and the Burning Grounds; CTO-141 is the Site Screening Assessment of nine IRP sites and 3 of 12 EPIC AOCs; and CTO-150 is the SI for IRP Site 17. The current status of the site investigations is documented and periodically updated in the Site Management Plan.

SECTION 3.0

Environmental Setting

This section presents general information regarding the environmental setting of St. Juliens Creek Annex, including information on climate and meteorology, topography, surface drainage, soils, and geology and hydrogeology. Localized, site-specific discussions of this type of information will be provided in each site-specific WP.

3.1 Climate and Meteorology

The Chesapeake region is situated in a humid Mesothermal Forest climate that is characterized by long, hot summers and mild winters. Summer temperatures average in the high 80s during the day and high 60s during the night. Precipitation averages 48 inches annually and is distributed evenly over the year; relative humidity averages 72%. Thunderstorms occur approximately 40 days per year, primarily during the summer months. Winds are generally northeasterly and moderate, averaging 10 miles per hour.

3.2 Topography, Surface Drainage, and Soils

The St. Juliens Creek Annex facility is a low-lying wedge of land between the Southern Branch of the Elizabeth River and St. Juliens Creek. Elevations range from sea level along the banks of the two bordering waterways, and along Blows Creek located in the northern part of the facility, to 15 feet above mean sea level (msl) northeast of Blows Creek. A northwest-southeast trending ridge generally bisects the area, dividing the St. Juliens Creek drainage basin to the southwest and the Blows Creek drainage basin to the northeast.

Blows Creek and St. Juliens Creek receive the majority of surface water runoff from the Annex. Both creeks flow east to empty into the Southern Branch of the Elizabeth River. The remaining runoff from the Annex flows directly into the Southern Branch of the Elizabeth River, or is diverted into storm drains that empty either into the Elizabeth River or St. Juliens Creek. The Southern Branch of the Elizabeth River flows through a highly industrialized area which includes oil storage and cresol facilities, and fertilizer plants. The river, which is part of the Intracoastal Waterway, is used by many recreational boaters during the summer and by larger commercial and naval craft throughout the year. The Southern Branch of the Elizabeth River flows north to discharge into the James River, which flows into the Chesapeake Bay. The entire downstream portion of surface water is tidally influenced.

The Commonwealth of Virginia has designated the watercourses in the area as IIB. This classification represents water that is contaminated. Historical releases of kepone and sediment disposal from the manufacturing activities of a private company located several miles away were a major contributor to present day contamination. Class IIB waters may be used for bathing and fishing, but taking shellfish is prohibited. A water classification of IIB indicates that the fecal coliform bacteria count should not exceed the geometric mean of 200 colonies per 100 milliliters; tidal water should have a dissolved oxygen content of at least 4.0 milligrams per liter (mg/l); and have a pH range of 6.0 to 8.5.

In the Spring of 2000, the Elizabeth River Project issued a "State of the River 2000" report using data collected by VDEQ. The report states that over the past 10 years dissolved oxygen has been increasing and nutrients levels has decreased in the Elizabeth River; both positive signs for the health of the river. That same report notes that the river sediments are severely contaminated in some locations. After one year of data, collected through the VDEQ Elizabeth River Monitoring Program, toxic effects from river sediments were noted at 21 of 23 stations located in the Elizabeth River and its main tributaries.

The St. Juliens Creek Annex facility was initially placed within the boundaries of the 100-year flood plain. However, a 1984 Environmental Assessment Addendum indicated that according to the 1983 National Flood Insurance Program flood maps, the 100-year flood level for the originally proposed St. Juliens Creek Annex facility is 8.5 feet above msl. Elevations for the majority of the Annex property are above 8.5 feet msl and therefore does not lie within the 100-year flood plain. Areas within the 100-year flood plain include those adjacent to St. Juliens Creek, Blows Creek, and the southern border of the Elizabeth River.

3.3 Geology and Hydrogeology

The St. Juliens Creek Annex facility is located in the outer Atlantic Coastal Plain Physiographic Province. A sediment wedge dips and thickens to the east and extends approximately 20 miles east to the Atlantic Ocean. These sediments overlie basement rocks, which are made up of downfaulted Triassic strata and Paleozoic igneous and metamorphic rocks, similar to those in the Piedmont Province. The contact between the basement rocks and the sediments, also known as the fall line, is exposed approximately 80 miles to the west of the facility.

The Annex is underlain by over 2,000 feet of gently dipping Recent to Lower Cretaceous sandy sediments. Geologic units underlying the area, from youngest to oldest are: the Columbia Group (Sand Bridge and Norfolk Formations), the Chesapeake Group (Yorktown and Calvert Formations), the Pamunkey Group (Nanjemoy Formation), the Mattaponi Formation, transitional beds, and the Patuxent Formation. Table 3-1 shows a stratigraphic column and hydrogeologic units of southeast Virginia.

The uppermost geologic unit is the Columbia Group. The Columbia Group is approximately 60 feet thick in southeastern Virginia. The upper 20 to 40 feet make up the unconfined Columbia aquifer, and consist of unconsolidated fine sands and silts with low to moderate permeability. The lower 20 to 40 feet consist of relatively impermeable silt, clay, and sandy clay. The Sand Bridge Formation is made up of tidal channel clayey sand facies and a shoal lagoonal silty sand facies. The tidal channel facies is made up of clayey sand, silt, and clay to well sorted fine to medium sand. This facies has low to high plasticity, low to moderate permeability, good erosion resistance, fair slope stability and fair to good aquifer recharge. The shoal lagoonal facies is made up of a clean, homogeneous, fine to medium sand with silt concentrations of 10% to 35%, and a thickness of 12 to 14 feet. This facies has a low to moderate plasticity; moderate permeability, erosion resistance, and slope stability; and fair aquifer recharge. The Norfolk Formation, which underlies the Sandbridge Formation, is made up of an upper member which consists of brackish marine silty sand and fluvial-estuarine silty sand, and a lower member which consists of clean quartz sand and fine gravel.

Surficial geology of the Annex includes the Sand Bridge Formation, alluvial sand, and marsh sediments. The clayey sand facies of the Sand Bridge Formation occurs on the eastern portion of the Annex facility, and the silty sand facies occurs on the western portion of the facility. The alluvial sand and marsh sediments occur along both Blows Creek and St. Juliens Creek. Boring

Table 3-1.
Stratigraphic and Hydrogeologic Units of Southeast Virginia
(from Meng and Harsh, 1988)

Geologic Age		Group	Stratigraphic Formation	Hydrogeologic Unit
Period	**Epoch**			
Quaternary	Holocene	Columbia	Holocene Deposits	Columbia aquifer
	Pleistocene		Undifferentiated Deposits	
Tertiary	Pliocene		Bacons Castle Formation	Yorktown confining unit
		Chesapeake	Yorktown Formation	Yorktown-Eastover aquifer
	Miocene		Eastover Formation	
			St. Mary's Formation	St. Mary's confining unit
			Choptank Formation	St. Mary's Choptank aquifer
			Calvert Formation	Calvert confining unit
			Old Church Formation	Chickahominy-Piney Point aquifer
	Oligocene	Pamunkey	Not Present in Study Area	
	Eocene		Chickahominy Formation	Chickahominy-Piney Point aquifer
			Piney Point Formation	
			Nanjemoy Formation	Nanjemoy-Marlboro Clay confining unit
	Paleocene		Marlboro clay	
			Aquia Formation	Aquia aquifer
			Brightseat Formation	Brightseat confining unit
				Brightseat aquifer
Cretaceous	Late Cretaceous		Undifferentiated Sediments	Upper Potomac confining unit
	Early Cretaceous		Potomac Formation	Upper Potomac aquifer
				Middle Potomac confining unit
				Middle Potomac aquifer
				Lower Potomac confining unit
				Lower Potomac aquifer

logs from 1946 to 1978 indicated mostly sandy soils; silty and clayey soils were observed in the remainder of the logs. The Norfolk and Yorktown Formations underlie the surficial deposits on the Annex.

The two significant shallow aquifer systems in the area are the Columbia aquifer located in the upper 20 to 40 feet of the Columbia Group, and in the underlying Yorktown Aquifer. The Columbia aquifer, which comprises the water table aquifer, is reportedly thin and consists of discontinuous heterogeneous sand and shell lenses. The depth to the water table at the Annex is usually 5 feet or less. The Yorktown Aquifer is separated from the water table aquifer by a clay layer in the upper Yorktown. Water bearing zones in the Yorktown Aquifer consist of fine to coarse sands and gravels.

SECTION 4.0

Potentially Applicable or Relevant and Appropriate Requirements (ARARs) for St. Juliens Creek Annex

The Superfund Amendments and Reauthorization Act of 1986 (SARA) mandates in Section 121(d) that site remediation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) achieves a level or standard of control for hazardous substances that at least attains such levels as specified in legally applicable or relevant and appropriate requirements (ARARs). Only promulgated Federal and State laws and regulations can be considered ARARs.

The Virginia Department of Environmental Quality (VDEQ), USEPA, and other agencies play a major role in guiding the activities to be implemented at the Base. ARARs from all regulatory agencies will be considered.

There are three basic types of ARARs:

- Chemical Specific ARARs are promulgated standards or levels for a specific chemical (e.g. maximum contaminant levels (MCLs) specified treatment technologies).
- Location Specific ARARs are those requirements triggered by site location where an action is occurring or will occur, and potential restrictions on activities conducted in these areas (e.g. wetlands, floodplains, etc.)
- Action Specific ARARs are those requirements triggered by a specific action taken as part of CERCLA activities (e.g. on-site incineration, groundwater extraction, treatment, and discharge).

In addition to ARARs, proposed rules, guidance documents, directives, etc. that may impact the conduct of a CERCLA action are called "to be considered" (TBC) documents. This document presents a summary list of potential ARARs and TBCs for St. Juliens Creek Annex.

The purpose of this ARARs section is to identify and summarize those Federal and State laws, regulations, and guidance that are most likely to affect CERCLA activities at St. Juliens Creek Annex. The list is intended to provide a starting point for site-specific ARARs/TBC analyses. The list is also intended to initiate and assist in discussions with regulatory agencies and, potentially, consensus agreements on an ARARs baseline for St. Juliens Creek Annex as well as site-specific agreements on ARARs/TBCs.

Action-specific ARARs will be identified in the site-specific work plans after the initial screening of remedial alternatives. Examples of potential federal ARARs for the Base are presented in the following paragraphs. The Commonwealth of Virginia has adopted many of the federal standards as state-specific standards. Examples of potential Commonwealth ARARs are presented following the federal ARARs.

Although the list is designed to be extensive, it is not meant to be exhaustive. It is not intended to cover every possible situation that may arise at St. Juliens Creek Annex. Instead, it attempts

to focus attention on the ARARs/TBCs that are most likely to impact remedial actions at St. Juliens Creek Annex (either under CERCLA or IRP). The laws, regulations, and guidance evaluated are believed to be current as of the date of this summary list. The reader is cautioned that environmental regulations can be dynamic, and any site-specific ARARs/TBC analysis needs to consider any additions or revisions to existing laws, regulations, and guidance, as well as any new laws.

The list of potential chemical-specific ARARs is presented in Table 4-1. The most common actions are listed in Table 4-2. Potential federal and state ARARs are in Table 4-3 through Table 4-11.

4.1 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) governs the remediation, release, and disposal of polychlorinated biphenyls (PCBs) (40 Code of Federal Regulations [CFR] 761). For example, if the remedy involves excavation of soils that contain PCBs, the requirements of this section must be satisfied.

4.2 Land Disposal Restrictions (40 CFR 268)

This regulation identifies RCRA Hazardous Wastes that are restricted from land disposal and describes general treatment requirements that must be met prior to disposal of a waste at a RCRA landfill. This regulation is applicable to the disposal of soil containing land disposal restricted RCRA hazardous waste.

4.3 Safe Drinking Water Act (1412)

The Safe Drinking Water Act (SDWA) was enacted as a response to accumulating evidence that called attention to the health threat posed by unsafe contaminants in public drinking water supplies. The SDWA, as amended, provides protection to water supplies through the establishment of drinking water standards. According to VDEQ, MCLs under the SDWA are the ARARs for contaminated ground water (per the National Contingency Plan [NCP]).

4.3.1 National Primary Drinking Water Standards, Maximum Contaminant Levels (40 CFR 141)

Maximum Contaminant Levels (MCLs) are applicable where potable water will be provided to a public water supply (25 or more people or to 15 or more service connections). When this occurs, the MCLs are the maximum levels allowed at the tap. In other cases, MCLs are relevant or appropriate for comparison to concentrations found in groundwater and, in some cases, surface water if the surface water is used as a source of drinking water. These are often used as clean up levels for contaminated groundwater. For example, if the remedy includes clean up of contaminated groundwater, requirements of this section must be satisfied.

4.4 Clean Air Act

The Clean Air Act (CAA) may require a discharge permit (40 CFR 50) if remedial activities have the potential for airborne discharges from the site. The best available technology that is

economically feasible must be used. The Commonwealth of Virginia also has standards and regulations regarding ambient air quality (VR 120-03-01) and air pollution control (VR 120-01).

This requirement would be applicable if the action involves the demolition of existing structures, the removal and transportation of debris, or disturbing soil or other exposed surfaces.

4.5 Clean Water Act

The Clean Water Act (CWA) provides for the protection of surface water quality through permitting and the establishment of minimum national effluent standards for industry.

4.5.1 Virginia Pollutant Discharge Elimination System Permit (9 VAC 25-31 and 40 CFR 125)

The Virginia Pollutant Discharge Elimination System (VPDES) restores and maintains the quality of surface waters. The direct discharge of pollutants to surface waters is controlled through the Virginia Pollutant Discharge Elimination System (VPDES) program. Examples of direct discharges are point sources such as discharges from a treatment plant directly into or very close proximity to, a surface water body through a discernible conveyance such as a pipe, ditch, channel, tunnel, or well; wastewater from the site piped or discharged to an off-site surface water body. Direct discharges of treated ground water, decontamination water, or other wastewater to surface waters must meet the effluent discharge limits established by this section.

These limits are established on a case-by-case basis, and may be based on: technology-based effluent limitations; prevention of discharges that would cause a violation of the Surface Water Quality Standards (SWQS). (9 VAC 25-260); and prevention of discharges of toxic pollutants in amounts that have a reasonable likelihood of adversely affecting human health or the environment. An action that results in discharge to surface water must meet these criteria if it is more stringent than the federal criteria.

4.5.2 Ambient Water Quality Criteria (40 CFR 129)

Ambient Water Quality Criteria (AWQC) represent concentrations of toxic pollutants in navigable waters that will not result in adverse impacts on important aquatic life, or on human consumers of water or aquatic life, after exposure of that aquatic life to the pollutants for a period of time exceeding 96 hours and continuing through at least one reproductive cycle. These federal criteria were adopted, with revisions, by the VDEQ. These criteria are presented in Table 4-1. An action that results in discharge to surface water must meet these criteria if it is more stringent than the VPDES criteria.

4.6 Occupational Safety and Health Administration (29 CFR 1904, 1910 and 1926)

The Occupational Safety and Health Administration (OSHA) provides requirements for hazardous waste workers such as training, personal protective equipment (PPE), and clothing. If the action involves hazardous waste workers, the requirements of this regulation must be met.

4.7 Department of Transportation (9 VAC 20-110 and 49 CFR 107,171, and 172)

The VHWMR and Department of Transportation (DOT) provide regulations governing the transportation of hazardous materials. This includes rules and regulations designating the manner and method by which hazardous materials shall be loaded, unloaded, packed, identified, marked, placarded, stored, and transported. All off-site transport of material generated as a result of removal/remedial actions must comply with the requirements of this section.

4.8 Virginia Solid Waste Management Regulations (9 VAC 20-80)

The Virginia Solid Waste Management Regulations (VSWMR) establish standards and procedures pertaining to the construction, operation, maintenance, closure, and post-closure of Solid Waste Management Facilities in the Commonwealth of Virginia in order to protect the public health, public safety, the environment, and natural resources. If the remedy involves cleanup activities that do not include hazardous wastes, the requirements of this section must be considered. Specifically, VSWMR would be potentially applicable to solid waste management activities that received or managed waste on or after December 21, 1988, and potentially relevant and appropriate to sites that stopped receiving waste prior to that date.

4.8.1 Identification of Solid Wastes (9 VAC 20-80-140)

This subpart identifies a solid waste as any discarded material. The requirements of this section must be satisfied for wastes generated by removal/remedial actions, including IDW, provided the wastes are not also hazardous.

4.8.2 Management of Open Dumps and Unpermitted Facilities (9 VAC 20-80-180 through 200)

Open dumps and unpermitted facilities are defined in this section. Requirements for cleanup and corrective action for releases that may occur as a result of improper management of solid wastes are also included.

4.8.3 Solid Waste Disposal Facility Standards (9 VAC 20-80-240 through 310)

This subsection contains regulations for citing, design, construction, operation, ground-water monitoring, closure, and post-closure care for sanitary landfills, construction, demolition, for debris landfills and industrial landfills. These regulations also specify requirements for control of decomposition gases, leachate control and monitoring, and corrective action programs. If the action involves landfills that have operated after December 21, 1988, these regulations must be considered.

4.8.4 Special Wastes (9 VAC 20-80-320 through 470)

This subsection contains regulations for the disposal of special wastes. Special wastes are defined as wastes that require special handling and precautions. The regulations require that facilities may receive special wastes for processing or disposal only with the specific prior approval of the Virginia Department of Environmental Quality or by specific provisions with

the facility permit. Specific regulations in this section include limitations on the types of landfills in which PCB-contaminated waste and soils contaminated with petroleum can be disposed. This regulation is applicable if the nonhazardous wastes generated as a result of removal or remedial actions are being considered special wastes.

4.8.5 Voluntary Remediation Program (9 VAC 20-160-10 through 160)

This subsection contains regulations concerning the voluntary cleanup of contaminated sites in Virginia. The purpose of the program is to encourage hazardous waste cleanups that might not otherwise take place. The regulations require the site owners or operators to adhere to the six step process of: determining eligibility; registering with the state; submitting the necessary documents; achieving the remediation goals; terminating the program upon approval of the state; and including the public during the entire process.

4.9 Hazardous Waste Management Regulations (9 VAC 20-60)

In general, the applicable solid waste requirements will be action-specific, applying to the remedial activities undertaken. The following are some examples of RCRA-based requirements that may be applicable or relevant and appropriate. As noted previously, site-specific, and action-specific ARARs will be identified following the initial screening of remedial alternatives. Note that the Commonwealth of Virginia administers a state-authorized RCRA program under the VHWMR. These serve as the governing ARARs in place of the RCRA regulations, except for 40 CFR Part 268 (Land Disposal Restrictions).

4.9.1 Manifest Regulations for Hazardous Waste Management (9 VAC 20-60-260 through 320)

This section provides regulations specifying the preparation of manifests for transporting hazardous waste off-site for treatment, storage, or disposal. These regulations identify the minimum information required for the manifest. If the action requires off-site shipment of hazardous waste, this requirement of this section must be satisfied.

4.9.2 Regulations Applicable to Transporters of Hazardous Waste (9 VAC 20-60-420 through 510)

This subpart established procedures for transporters of hazardous waste that include requirements for record keeping and reporting, labeling, placarding and marking as well as use of the manifest system and spill procedures. If the remedy involves transporting hazardous waste off-site for treatment and/or disposal, the transporters must meet the requirements in this section.

4.9.3 General Facility Standards (9 VAC 20-60-530)

This section sets the general facility requirements including general waste analysis, security measures, inspections, and training requirements. The location standards in Section I requires facilities located in a 100-year floodplain to be designed, constructed, and maintained to prevent washout of any hazardous waste by a 100-year flood. This section is applicable to sites that have managed wastes since the effective date of the statute. In these cases, if the wastes were hazardous, these regulations would potentially be applicable.

4.9.4 Manifest System, Recordkeeping, and Reporting (9 VAC 20-60-560)

This section outlines procedures for manifesting hazardous waste for owners and operators of Treatment, Storage, and Disposal (TSD) facilities. Requirements are specified for manifesting, recordkeeping (quantity, waste analyses data, and location of the waste), and annual reporting. If the action involves sending hazardous wastes off-site for management, the manifesting requirements would be applicable.

4.9.5 Storage (9 VAC 20-60-600)

This section sets standards for the storage of containers of hazardous waste. These standards include requirements for: condition of the container; compatibility of stored wastes; management of the container; and inspections and containment systems. This regulation is applicable to IDW and removal and/or removal action wastes that are hazardous.

4.9.6 Site Closure with Waste in Place (9 VAC 20-60-580)

This section details general requirements for closure and post-closure care at hazardous waste facilities. Closure performance standards, closure and post-closure plans, timeframe requirements for closure, requirements for disposal and/or decontamination of equipment; and post-closure care and use of property (e.g., maintenance and monitoring requirements) are described. This section may be applicable if the waste is to be left in place. This could include capping, installation of slurry walls, grading and covering with vegetation, or consolidation of substances in one location.

4.10 Virginia Groundwater Standards

The Commonwealth of Virginia has established its own standards for groundwater. The Virginia Groundwater Standards (VGS) are presented in Table 4-1 along with the USEPA MCL, the proposed MCL, and the Secondary Maximum Contaminant Level (SMCL) for most contaminants. Virginia groundwater standards are a potential ARAR for establishing groundwater cleanup levels at the Base.

4.11 Other Potential ARARs or Guidelines To Be Considered

Other potential ARARs or guidelines to be considered (TBCs) include:

- Groundwater classification for aquifers underlying the site (USEPA, 1986a).
- Safe Drinking Water Act (42 United States Code [USC] 300(f) et seq.) Maximum Contaminant Level Goals (MCLGs), Proposed MCLs (PMCLs), and Proposed MCLGs (PMCLGs).
- EPA Region III Risk-Based Concentrations (RBCs)
- National Oceanic and Atmospheric Administration (NOAA) Sediment Screening Values (NOAA Technical Memorandum NOs OMA52, August 1991).
- Regulations pertaining to activities that affect the navigation of waters of the United States (33 CFR 320-329).

- Endangered Species Act of 1973 (16 USC 1531 and 50 CFR 81, 225, and 402).
- Fish and Wildlife Coordination Act (16 USC 661).
- Fish and Wildlife Improvement Act of 1978 (16 USC 742a).
- Fish and Wildlife Conservation Act of 1980 (16 USC 2901 and 50 CFR 83).
- Magnuson Fishery Conservation and Management Act (16 USC 1801).
- Wild and Scenic Rivers Act (36 CFR 297).
- Drinking Water Health Advisory: Munitions - a health advisory on munitions chemicals (USEPA, 1992a).
- Coastal Zone Management Act (16 USC 1451 et seq.).
- National Historic Preservation Act (36 CFR 800).
- Chesapeake Bay Preservation Act (Code of Virginia 10.1-2100).
- Wilderness Act (16 USC 1131 et seq.; 50 CFR 35.1 et seq.).
- Migratory Bird Treaty Act of 1972 (16 USC Section 703)
- Marine Mammal Protection Act (16 USC 1372 (2))
- Virginia Stormwater Management (9 VAC 25-170)
- Virginia Erosion and Sediment Control (9 VAC 50-30)
- Virginia Wetlands Act (Code of Virginia 62.1-13.1).
- Virginia Wetlands Policy (9 VAC 25-380).
- Federal Floodplain Management and Protection of Wetlands (Executive Orders 11988 and 11990, 40 CFR 6).

The laws, regulations, and guidance evaluated are believed to be current as of the date of this Master List. However, environmental regulations are dynamic, and site specific ARARs/TBC analysis needs to consider any revisions to existing laws, regulations, and guidance, as well as any new laws, regulations, and guidance. Potential changes should be considered when this section is updated and refined for each site-specific work plan.

Table 4-1
Potential Chemical-Specific ARARs for St. Juliens Creek Annex

Chemical Name	Federal Standards and Guidance					Commonwealth of Virginia Water Quality Standards			
	Safe Drinking Water Act (SDWA)	CWA Ambient Water Quality Criteria (b)				Water Quality Standards (c)			
		For Protection of Human Health		For Protection of Aquatic Life					
	Drinking Water MCLs and SMCLs (µg/L) (a)	Water and Fish Consumption (µg/L)	Fish Consumption Only (µg/L)	Fresh Water Acute/Chronic (µg/L)	Salt Water Acute/Chronic (µg/L)	Virginia Groundwater Standards (µg/L)	Freshwater Chronic Level (µg/L)	Saltwater Chronic Level (µg/L)	Human Health - All Other Surface Water (µg/L)
VOLATILE ORGANICS									
benzene	5	1.2	71	-	-	-	-	-	710
bromodichloromethane (dichlorobromomethane)	100 (1)	0.56	46	-	-	-	-	-	460
bromoform	100 (1)	4.3	360	-	-	-	-	-	3,600
carbon tetrachloride	5	0.25	4.40	-	-	-	-	-	45
chlorobenzene (monochlorobenzene)	100	680	21,000	-	-	-	-	-	21,000
chloroform (chloromethane methyl chloride)	100 (1)	5.7	470	-	-	-	-	-	4,700
dibromochloromethane (chlorodibromomethane)	100 (1)	0.41	34	-	-	-	-	-	57,000
1,2-dichloroethane	5	0.38	99	-	-	-	-	-	990
1,1-dichloroethene (1,1-dichloroethylene)	7	0.057	3.2	-	-	-	-	-	17,000
cis-1,2-dichloroethene (cis-1,2-dichloroethylene)	70	-	-	-	-	-	-	-	-
trans-1,2-dichloroethene (trans-1,2-dichloroethylene)	100	700	140,000	-	-	-	-	-	-
dichloromethane	5	-	-	-	-	-	-	-	16,000
1,2-dichloropropane	5	0.52	39	-	-	-	-	-	-
ethyl benzene	700	3,100	29,000	-	-	-	-	-	29,000
methylene chloride (dichloromethane)	5	4.7	1,600	-	-	-	-	-	-
styrene	100	-	-	-	--	-	-	-	-
1,1,2,2-tetrachloroethane	-	0.17	11	-	-	-	-	-	-
tetrachloroethylene (1,1,2,2-tetrachloroethylene)	5	0.8	8.85	-	-	-	-	-	3,500
toluene	1,000	6,800	200,000	-	-	-	-	-	200,000

Table 4-1
Potential Chemical-Specific ARARs for St. Juliens Creek Annex

Chemical Name	Federal Standards and Guidance					Commonwealth of Virginia Water Quality Standards			
	Safe Drinking Water Act (SDWA)	CWA Ambient Water Quality Criteria (b)				Water Quality Standards (c)			
		For Protection of Human Health		For Protection of Aquatic Life					
	Drinking Water MCLs and SMCLs (µg/L) (a)	Water and Fish Consumption (µg/L)	Fish Consumption Only (µg/L)	Fresh Water Acute/Chronic (µg/L)	Salt Water Acute/Chronic (µg/L)	Virginia Groundwater Standards (µg/L)	Freshwater Chronic Level (µg/L)	Saltwater Chronic Level (µg/L)	Human Health - All Other Surface Water (µg/L)
total recoverable petroleum hydrocarbon	-	-	-	-	-	1,000	-	-	-
1,1,1-trichloroethane	200	-	-	-	-	-	-	-	-
1,1,2-trichloroethane	5	0.6	42	-	-	-	-	-	-
trichloroethene (trichloroethylene)	5	2.7	81	-	-	-	-	-	810
vinyl chloride	2	2	525	-	-	-	-	-	5,300
xylenes (total)	10,000	-	-	-	-	-	-	-	-
SEMIVOLATILE ORGANICS									
acenapthene	-	1,200	2,700	-	-	-	-	-	2,700
anthracene	-	9,600	110,000	-	-	-	-	-	110,000
benzo(a)anthracene	-	0.0044	0.049	-	-	-	-	-	0.49
benzo(b)fluoranthene	-	0.0044	0.049	-	-	-	-	-	0.49
benzo(k)fluoranthene	-	0.0044	0.049	-	-	-	-	-	0.49
benzo(a)pyrene	0.2	0.0044	0.049	-	-	-	-	-	0.49
4-chloro-3-methylphenol (4-chloro-m-creosol)	-	-	-	-	-	-	-	-	-
bis(2-chloroethyl) ether	-	0.031	1.4	-	-	-	-	-	-
2-chloronaphthalene	-	1,700	4,300	-	-	-	-	-	-
chrysene	-	0.0044	0.049	-	-	-	-		0.49
dibenz(a,h)anthracene	-	0.0044	0.049		-	-	-	-	0.49
2-chlorophenol	-	120	400	-	-	-	-	-	400
1,2-dichlorobenzene (o-dichlorobenzene)	600	2,700	17,000	-	-	-	-	-	17,000
1,3-dichlorobenzene (m-dichlorobenzene)	-	400	2,600	-	-	-	-	-	2,600
1,4-dichlorobenzene (p-dichlorobenzene)	75	400	2,600	-	-	-	-	-	2,600

Table 4-1
Potential Chemical-Specific ARARs for St. Juliens Creek Annex

Chemical Name	Federal Standards and Guidance					Commonwealth of Virginia Water Quality Standards			
	Safe Drinking Water Act (SDWA)	CWA Ambient Water Quality Criteria (b)				Water Quality Standards (c)			
		For Protection of Human Health		For Protection of Aquatic Life					
	Drinking Water MCLs and SMCLs (µg/L) (a)	Water and Fish Consumption (µg/L)	Fish Consumption Only (µg/L)	Fresh Water Acute/Chronic (µg/L)	Salt Water Acute/Chronic (µg/L)	Virginia Groundwater Standards (µg/L)	Freshwater Chronic Level (µg/L)	Saltwater Chronic Level (µg/L)	Human Health - All Other Surface Water (µg/L)
3,3'-dichlorobenzidine	-	0.04	0.077	-	-	-	-	-	-
2,4-dichlorophenol	-	9.3	790	-	-	-	-	-	790
diethylphthalate	-	23,000	120,000	-	-	-	-	-	120,000
dimethylphalate	-	313,000	2,900,000	-	-	-	-	-	-
2,4-dimethylphenol	-	540	2,300	-	-	-	-	-	2,300
2,4-dinitrophenol	-	70	14,000	-	-	-	-	-	-
2,4-dinitrotoluene	-	0.11	9.1	-	-	-	-	-	91
2,6-dinitrotoluene	-	-	-	-	-	-	-	-	-
1,2-diphenylhydrazine	-	0.040	0.54	-	-	-	-	-	-
epichlorohydrin	-	-	-	-	-	-	-	-	-
ethylene dibromide	0.05	-	-	-	-	-	-	-	-
bis(2-ethylhexyl)phthalate (di-2-ethylhexylphthalate)	6	1.8	5.9	-	-	-	-	120	59
fluoranthene	-	300	370	-	-	-	-	-	370
hexachlorobenzene	1	0.00075	0.00077	-	-	-	-	-	-
hexachlorobutadiene	-	0.44	50	-	-	-	-	-	-
hexachlorocyclopentadiene	50	240	17,000	-	-	-	-	-	-
hexachloroethane	-	1.9	8.9	-	-	-	-	-	-
indeno(1,2,3-d)pyrene	-	0.0044	0.049	-	-	-	-	-	0.49
isophorone	-	36	2,600	-	-	-	-	-	490,000
naphthalene	-	-	-	-	-	-	-	-	-
nitrobenzene	-	17	1,900	-	-	-	-	-	1,900
nitrophenols	-	-	-	-	-	-	-	-	-
N-nitrosodiphenylamine	-	5	16	-	-	-	-	-	-
pentachlorophenol	1	0.28	8.2	19/15 (3)	13/7.9	-	-	7.9	82
phenanthrene	-	-	-	-	-	-	-	-	-

Table 4-1
Potential Chemical-Specific ARARs for St. Juliens Creek Annex

Chemical Name	Federal Standards and Guidance					Commonwealth of Virginia Water Quality Standards			
	Safe Drinking Water Act (SDWA)	CWA Ambient Water Quality Criteria (b)				Water Quality Standards (c)			
		For Protection of Human Health		For Protection of Aquatic Life					
	Drinking Water MCLs and SMCLs (µg/L) (a)	Water and Fish Consumption (µg/L)	Fish Consumption Only (µg/L)	Fresh Water Acute/Chronic (µg/L)	Salt Water Acute/Chronic (µg/L)	Virginia Groundwater Standards (µg/L)	Freshwater Chronic Level (µg/L)	Saltwater Chronic Level (µg/L)	Human Health - All Other Surface Water (µg/L)
phenol	-	21,000	-	-	-	1	-	-	4,600,000
1,2,4-trichlorobenzene	70	260	940	-	-	-	-	-	950
2,4,5-trichlorophenol	-	2,600	9800	-	-	-	-	-	-
2,4,6-trichlorophenol	-	2.1	6.5	-	-	-	-	-	65
PESTICIDES/PCBS									
alachlor	2	-	-	-	-	-	-	-	-
aldicarb sulfoxide	7	-	-	-	-	-	-	-	-
aldicarb sulfone	7	-	-	-	-	-	-	-	-
aldrin	-	0.00013	0.00014	3/ -	1.3/ -	0.003	0.3	0.13	0.0014
atrazine	3	-	-	-	-	-	-	-	-
beta-BHC	-	0.014	0.046	-	-	-	-	-	-
carbofuran	40	-	-	-	-	-	-	-	-
chlordane	2	0.0021	0.0022	2.4/0.0043	0.09/0.004	0.01	0.0043	0.004	0.0059
chlorpyrifos	-	-	-	0.083/0.041	0.011/0.0056	-	0.041	0.0056	-
dalapon	200	-	-	-	-	-	-	-	-
gamma-BHC (Lindane)	0.2	0.019	0.063	0.95/ -	0.16/ -	100	0.08	0.01	25
2,4-D	70	100	-	-	-	100	-	-	-
4,4-DDE	-	0.00059	0.00059	-	-	-	-	-	-
4,4-DDT	-	0.00059	0.00059	1.1/0.001	0.13/0.001	0.001	0.001	0.001	0.0059
demeton	-	-	-	- /0.1	- /0.1	-	0.1	0.1	-
dibromochloropropane	0.2	-	-	-	-	-	-	-	-
dieldrin	-	0.00014	0.00014	0.24/0.056	0.71/0.0019	-	0.0019	0.0019	0.0014
di(2-ethylhexyl)adipate	400	-	-	-	-	-	-	-	-
dinoseb	7	-	-	-	-	-	-	-	-
dioxin (2,3,7,8-TCDD)	3×10^{-5}	1.3×10^{-8}	1.3×10^{-8}	-	-	-	-	-	1.2×10^{-12}
diquat	20	-	-	-	-	-	-	-	-

Table 4-1
Potential Chemical-Specific ARARs for St. Juliens Creek Annex

Chemical Name	Federal Standards and Guidance					Commonwealth of Virginia Water Quality Standards			
	Safe Drinking Water Act (SDWA)	CWA Ambient Water Quality Criteria (b)				Water Quality Standards (c)			
		For Protection of Human Health		For Protection of Aquatic Life					
	Drinking Water MCLs and SMCLs (µg/L) (a)	Water and Fish Consumption (µg/L)	Fish Consumption Only (µg/L)	Fresh Water Acute/Chronic (µg/L)	Salt Water Acute/Chronic (µg/L)	Virginia Groundwater Standards (µg/L)	Freshwater Chronic Level (µg/L)	Saltwater Chronic Level (µg/L)	Human Health - All Other Surface Water (µg/L)
endosulfan (I and II)	-	110	240	0.22/0.056	0.034/0.0087	-	0.056	0.0087	240
endothall	100	-	-	-	-	-	-	-	-
endrin	2	0.76	0.81	0.86/0.036	0.037/0.0023	0.004	0.0023	0.0023	0.81
glyphosate	700	-	-	-	-	-	-	-	-
guthion	-	-	-	- /0.01	- /0.01	-	0.01	0.01	-
heptachlor	0.4	0.00021	0.00021	0.52/0.0038	0.053/0.0036	0.001	0.0038	0.0036	0.0021
heptachlor epoxide	0.2	0.00010	0.00011	0.52/0.0038	0.053/0.0036	0.001	-	-	-
hexachlorocyclohexane	-	-	-	-	-	-	0.08	0.01	25
malathion	-	-	-	- /0.1	-	-	0.1	0.1	-
methoxychlor	40	100	-	- /0.03	- /0.03	0.03	0.03	0.03	-
mirex	-	-	-	- /0.001	- /0.001	-	0	0	-
oxamyl (vydate)	200	-	-	-	-	-	-	-	-
parathion	-	-	-	0.065/0.013	-	-	0.013	-	-
PCBs	0.5	0.00017	0.00017	- /0.014	- /0.03	-	0.014	0.03	0.00045
picloram	500	-	-	-	-	-	-	-	-
silvex (2,4,5-TP)	50	10	-	-	-	10	-	-	-
simazine	4	-	-	-	-	-	-	-	-
toxaphene	3	0.00073	0.00075	0.73/0.0002	0.21/0.0002	-	0.0002	0.0002	0.0075
METALS/INORGANICS									
aluminum	50 – 200 (6)	-	-	750/87	-	-	-	-	-
antimony	6	14	4,300	-	-	-	-	-	4,300
arsenic	50 (7)	0.018 (7)	0.14 (7)	340/150 (7)	69/36 (7)	50	-	-	-
arsenic (III)	-	-	-	-	-	-	190	36	-
arsenic (V)	-	-	-	-	-	-	-	-	-
barium	2,000	1,000	-	-	-	1,000	-	-	-
beryllium	4	-	-	-	-	-	-	-	-

Table 4-1
Potential Chemical-Specific ARARs for St. Juliens Creek Annex

Chemical Name	Federal Standards and Guidance					Commonwealth of Virginia Water Quality Standards			
	Safe Drinking Water Act (SDWA)	CWA Ambient Water Quality Criteria (b)				Water Quality Standards (c)			
		For Protection of Human Health		For Protection of Aquatic Life					
	Drinking Water MCLs and SMCLs (µg/L) (a)	Water and Fish Consumption (µg/L)	Fish Consumption Only (µg/L)	Fresh Water Acute/Chronic (µg/L)	Salt Water Acute/Chronic (µg/L)	Virginia Groundwater Standards (µg/L)	Freshwater Chronic Level (µg/L)	Saltwater Chronic Level (µg/L)	Human Health - All Other Surface Water (µg/L)
cadmium	5	-	-	4.3/2.2 (4)	43/9.3	0.4	1.1 (4)	9.3	-
chromium	100	-	-	-	-	50	-	-	-
chromium (III)	-	-	-	570/74 (4)	-	-	210 (4)	-	-
chromium (VI)	-	-	-	16/11	1,100/50	-	11	50	-
copper	1,300 (5)	1,300	-	13/9 (4)	4.8/3.1	1,000	12 (4)	3.8	-
cyanide	200	700	220,000	22/5.2	-	5	5.2	1.0	215,000
iron	300 (6)	300	-	- /1,000	-	300	-	-	-
lead	15 (5)	-	-	65/2.5 (4)	210/8.1	50	14 (4)	9.3	-
magnesium	-	-	-	-	-	-	-	-	-
manganese	-	50	100	-	-	50	-	-	-
mercury	2	0.050	0.051	1.4/0.77	1.8/0.94	0.05	0.012	0.025	0.053
nickel	100	610	4,600	470/52 (4)	74/8.2	-	20 (4)	8.3	4,600
selenium	50	170	1,100	185.9 (8)/ 5 (4)	290/71	10	5	71	11,000
silver	100 (6)	-	-	3.4/ - (4)	1.9/ -	-	-	-	-
sodium	-	-	-	-	-	270,000	-	-	-
thallium	2	1.7	6.3	-	-	-	-	-	-
zinc	5,000 (6)	9,100	69,000	120/120 (4)	90/81	50	110 (4)	86	-
MISCELLANEOUS									
chloride	250,000 (6)	-	-	860,000/230,000	-	50,000	230,000	-	-
cyanides	200	700	220,000	22/5.2	-	5	-	1.0	215,000
fluorene	-	-	-	-	-	-	-	-	14,000
fluoride	4,000	-	-	-	-	1,400	-	-	-
hydrogen sulfide	-	-	-	- / 2	- / 2	-	2.0	2.0	-
nitrates	10,000	10,000	-	-	-	5,000	-	-	-
nitrite (as N)	1,000	-	-	-	-	25	-	-	-
pH	6.5 – 8.5 (6)	5 - 9	-	- / 6.5 - 9	- / 6.5 – 8.5	6.0 / 9.0	-	-	6.0 - 9.0

Table 4-1
Potential Chemical-Specific ARARs for St. Juliens Creek Annex

Chemical Name	Federal Standards and Guidance					Commonwealth of Virginia Water Quality Standards			
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		For Protection of Human Health		For Protection of Aquatic Life					
	Drinking Water MCLs and SMCLs (µg/L) (a)	Water and Fish Consumption (µg/L)	Fish Consumption Only (µg/L)	Fresh Water Acute/Chronic (µg/L)	Salt Water Acute/Chronic (µg/L)	Virginia Groundwater Standards (µg/L)	Freshwater Chronic Level (µg/L)	Saltwater Chronic Level (µg/L)	Human Health - All Other Surface Water (µg/L)
RADIONUCLIDES									
radium$_{226/228}$	5 pCi/L	-	-	-	-	5 pCi/L	-	-	-
gross alpha	15 pCi/L	-	-	-	-	15 pCi/L	-	-	15 pCi/L
beta particle	4 mrem/yr	-	-	--	-	50 pCi/L	-	-	4 mrem/yr

SOURCES:
(a) USEPA, "Drinking Water Standards and Health Advisories," Office of Water, Washington, DC, October 1996.
(b) USEPA, "National Recommended Water Quality Criteria; Republication," Federal Register, Vol. 63, No. 237, December 10, 1998.
(c) Virginia Water Quality Standards (9VAC 25-260, December 1997).

ACRONYMS AND ABBREVIATIONS:
Class II Shellfish Propagation or Harvesting
CWA Clean Water Act
MCL Maximum Contaminant Level
SMCL Secondary Maximum Contaminant Level
mrem/yr Millirem per year
pCi/L Picocuries per liter
mg/L Micrograms per liter

NOTES:
(1) Standard indicated is the standard for total trihalomethanes (i.e., the sum of concentrations of chloroform, bromodichloromethane, dibromochloromethane, and bromoform). Refer to 56FR3579.
(2) Standard indicated is for chlorinated benzenes as a group.
(3) pH dependent criteria (7.8 used).
(4) Hardness dependent criteria (100 mg/l $CaCO_3$ used).
(5) Action level for copper is 1,300 ug/l and action level for lead is 15 ug/l according to Drinking Water Standards.
(6) Secondary Maximum Contaminant Level (SMCL).
(7) Water quality criteria derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive.
(8) Concentration given for selenium is for selenite.

Table 4-2 ARARs Summary of Most Common Anticipated Remedial Actions at St. Juliens Creek Annex		
Chemical Specific	**Action Specific**	**Location Specific**
On-site or In Situ Treatment of Soils		
Cleanup levels at landfills *(VSWMRs, 9 VAC 20-80-230)*	Stormwater management *(VA Stormwater Management Regulations, 9 VAC 25-170)* Air emissions from treatment process *(VA Air Pollution Control Regulations, 9 VAC 5-66; and, if hazardous waste, VHWMRs, 9 VAC 20-60-264)* Fugitive dust emissions *(VA Air Pollution Control Regulations, 9 VAC 5-40-90)* If hazardous waste, hazardous waste management requirements *(VHWMRs, 9 VAC 20-60-230 through 380)*	Mitigation of impacts on wetlands *(VA Wetlands Regulations, 9 VAC 25-380)*
Ground-water Treatment[1]		
Federal MCLs and/or VA Surface Water Quality Standards *(9 VAC 25-260-140)*	Discharge to surface water *(VPDES, 9 VAC 25-260)* Discharge to POTW *(VPDES, 9 VAC 25-31-800 through 850)* Air emissions from treatment process *(VA Air Pollution Control Regulations, 9 VAC 5-66; and, if hazardous waste, VHWMRs, 9 VAC 20-60-264)*	

KEY:

MCLs = Maximum contaminant levels
PCBs = Polychlorinated biphenyls
VA = Virginia
VHWMRs = Virginia Hazardous Waste Management Regulations
VSWMRs = Virginia Solid Waste Management Regulations

[1]For the purpose of this table, ground-water treatment includes natural attenuation.

Table 4-2 ARARs Summary of Most Common Anticipated Remedial Actions at St. Juliens Creek Annex		
Chemical Specific	**Action Specific**	**Location Specific**
Landfill Capping		
	Capping/Closure requirements *(VSWMRs, 9VAC 20-80-250 through 270)* Landfill gas emissions *(VSWMRs, 9 VAC 20-80-280 and VA Air Pollution Control Regulations, 9 VAC 5-60)* Stormwater management *(VA Stormwater Management Regulations, 9 VAC 25-170)*	Mitigation of impacts on wetlands *(VA Wetlands Regulations, 9 VAC 25-380)*
Excavation and Removal of Waste and/or Soils		
Cleanup levels at landfills *(VSWMRs 9 VAC 20-80-230)*	Hazardous waste identification *(VHWMRs 9 VAC 20-60-261)* Waste transportation *(VA Regulations on Transport of Hazardous Materials, 9 VAC 20-262 and 263)* Depending on waste, potential for PCB management requirements *(TSCA 40 CFR 761)* Stormwater management *(VA Stormwater Management Regulations, 9 VAC 25-170)* Fugitive dust emissions *(VA Air Pollution Control Regulations, 9 VAC 5-40-90)*	Mitigation of impacts on wetlands *(VA Wetlands Regulations, 9 VAC 25-380)*
	<u>If Hazardous:</u> Potential for land disposal restrictions requirements *(VHWMRs 9 VAC 20-60-1440 through 1480)* Waste manifesting *(VHWMRs, 9 VAC 20-60-262 and 263)* Air emissions from treatment process *(VA Air Pollution Control Regulations, 9 VAC 5-60; and VHWMRs, 9 VAC 20-60-720)*	
	<u>If nonhazardous:</u> Waste management and storage *(VSWMRs, 9 VAC 20-80-140 through 160)* Air emissions from treatment process *(VA Air Pollution Control Regulations, 9 VAC 5-30)*	

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
9 VAC 25-580, **Underground Storage Tanks**	Provides procedures for the design, construction, operation, and maintenance of underground storage tanks, and also established requirements for closure of tanks.	A, RA	Unlikely that any removal/remedial actions at SJC will involve the installation of new underground storage tanks. This section would be a potential ARAR where unauthorized storage of hazardous wastes, or wastes with the same constituents as listed wastes, in underground storage tanks occurred. In these cases, the closure provisions of this section would be potential ARARs.
EPA Region III Risk-Based Concentrations (RBCs)	Combines toxicity constants with standard exposure scenarios to calculate chemical concentrations corresponding to fixed levels of risk in water, air, fish tissue, and soil. Fixed levels of risk are defined as a hazard quotient of one or a lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration.		At SJC, RBCs will be used to screen contaminants of concern in human health risk assessments performed as part of hazardous waste site investigations. In accordance with the Virginia Voluntary Remediation Program, RBCs (along with EPA cross-media transfer values) will also be considered as soil remediation levels.
Resource Conservation and Recovery Act (RCRA)			
RCRA, **Land Disposal Restrictions for Newly Listed Wastes and Hazardous Debris**	Provides several treatment options for the management and disposal of contaminated debris. Redefines indoor waste piles as "containment buildings" and provides design and operating standards that ensure containment of waste equivalent to the containment achieved by tanks.	A, RA	This rule is a potential ARAR for remedies involving on-site treatment, storage, or disposal of contaminated debris outside of an AOC or CAMU. Contaminated debris could include demolished structures, drums, rubble, etc. If any removal/remedial actions involve the management (e.g., storage or treatment) of hazardous wastes in contaminant buildings (indoor waste piles), or of wastes that contain the same constituents as listed hazardous wastes in containment buildings, this section would be potentially applicable.

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
9 VAC 20-60-68, **Land Disposal Restrictions (LDRs)**	9 VAC 20-60-68 adopts 40 CFR 268 by reference. 40 CFR 268 establishes restrictions on land disposal of untreated hazardous wastes and treatment standards for hazardous wastes that are to be land disposed. These treatment standards are usually concentration-based. Certain wastes are required to be treated by a specified technology prior to land disposal.	A	At SJC, the most probable issue will be with wastes that are determined to be toxicity characteristically hazardous as determined by TCLP analysis. Under the LDRs, treatment standards have been established for all hazardous wastes. If it is determined that hazardous wastes are considered subject to LDRs, the material must be handled and treated in compliance with these regulations if the waste is managed offsite or outside of an on-site AOC or CAMU. LDR requirements are not considered relevant and appropriate when hazardous constituents are found in soil and/or debris. Absent specific soil and debris requirements, the relevant and appropriate approach outlined in CERCLA guidance is contained in a series of guidance documents.
9 VAC 20-60-160, **Voluntary Remediation Program**	This subsection contains regulations concerning the voluntary cleanup of contaminated sites in Virginia. The purpose of the program is to encourage hazardous waste cleanups that might not otherwise take place. The regulations require the site owners or operators to adhere to the six step process of: determining eligibility; registering with the state; submitting the necessary documents; achieving the remediation goals; terminating the program upon approval of the state; and including the public during the entire process. The Voluntary Remediation Program promulgates a three tiered approach for derivation of remediation levels. In general, any one tier or combination of tiers may be applied to establish remediation levels for contaminants present at a site.	A, RA	This regulation is a potential ARAR for hazardous waste site remediations at SJC. Soil remediation levels shall be based on Tier II levels rather than Tier I.

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
9 VAC 20-60-264, **General Facility Standards, Preparedness and Prevention, Contingency Plan and Emergency Procedures, Manifest System, Recordkeeping, and Reporting, Closure and Post-Closure, Use and Management of Containers, Tanks, Surface Impoundments, Waste Piles, Land Treatment Units, Landfills, Miscellaneous Units, Air Emission Standards for Process Vents, and Air Emission Standards for Equipment Leaks**	9 VAC 20-60-264 adopts 40 CFR 264 by reference. **Subpart B of 40 CFR 264** presents facility requirements including general waste analysis, security measures, inspections, construction requirements, and training requirements. Location standards require facilities located in a 100-year floodplain to be designed, constructed, and maintained to prevent washout of any hazardous waste by a 100-year flood.	A, RA	Most of the existing sites at SJC are believed not to manage hazardous wastes since the effective date of the statute. These standards are not believed to be applicable to the majority of the existing sites. Some sites may have managed wastes since the effective date of the statute. If the wastes were hazardous, these regulations potentially would be applicable. If the wastes were the same or similar to hazardous wastes, the regulations potentially would be relevant and appropriate. May be relevant and appropriate to existing sites that managed hazardous wastes, or wastes that are the same or similar to hazardous wastes, before the effective date of the statute. If, during removal or remedial actions new on-site treatment, storage, or disposal units are created that manage hazardous wastes, this section would be potentially applicable unless such waste remains within the area of contamination (AOC) or is within a corrective action management unit (CAMU). If new TSD units are created that manage wastes with constituents that are identical or similar to hazardous wastes, this section may potentially be relevant and appropriate. Parts of SJC are located in the 100-year floodplain. New on-site storage (i.e., longer than 90 days) and on-site treatment facilities managing hazardous wastes would be potentially subject to the location standards contained in this part.

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Virginia Hazardous Waste Management Regulations			
9 VAC 20-60-261, **Identification and Listing of Hazardous Waste**	9 VAC 20-60-261 adopts 40 CFR Part 261 by reference. 40 CFR Part 261 identifies solid wastes which are subject to regulation as hazardous waste. Wastes are defined as hazardous either because they exhibit a hazardous characteristic (i.e., ignitability, corrosivity, reactivity, or toxicity) or because the waste is "listed" as hazardous.		This Part, in and of itself, would not be an ARAR. However, because it identifies those wastes that are hazardous, it triggers whether the remaining Parts of these regulations are or are not likely to be ARARs. Would potentially apply to Investigation Derived Wastes (IDW) shipped offsite during a removal or remedial action, provided the waste would be considered a "hazardous waste." Some wastes at SJC sites may exhibit the characteristic of toxicity as measured by the toxicity characteristic leaching procedure (TCLP). For nonhazardous wastes, the requirements could be relevant and appropriate if the wastes contain constituents identical or similar to those for which a hazardous waste was listed.
9 VAC 20-60-262 and 263, **Manifest Regulations for Hazardous Waste Management**	9 VAC 20-60-262 and 263 adopts 40 CFR Parts 262 and 263 by reference. 40 CFR Part 262 provides regulations specifying the preparation of manifests for transporting hazardous waste offsite for treatment, storage, or disposal. These regulations identify the minimum information required for the manifest (e.g., name and address, EPA I.D. number, DOT classification, and quantity).	A	Would pertain to off-site shipment of hazardous waste. The most likely SJC scenario under which this part would apply would be the off-site shipment of IDW or other wastes (e.g., removal or remedial action wastes) that exhibit the characteristic of toxicity for metals or pesticides (i.e., TCLP for metals or pesticides).
9 VAC 20-60-420 through 500, **Regulations Applicable to Transporters of Hazardous Waste**	Establishes procedures for transporters of hazardous waste that include requirements for: recordkeeping and reporting, labeling, placarding, and marking; use of the manifest system; and spill procedures.	A	Some SJC IDW and removal/remedial action wastes are likely to exhibit the toxicity characteristic. If these wastes are transported offsite for treatment and/or disposal, SJC must assure that transporters meet these requirements.

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	Subpart C of 40 CFR 264 outlines requirements for safety equipment and spill control measures for hazardous waste at TSD facilities. Facilities must be designed, maintained, constructed, and operated to minimize the possibility of an unplanned release that could threaten human health or the environment. **Subpart D of 40 CFR 264** outlines requirements for emergency procedures to be used in the event of explosions, fires, etc.	A, RA	Some SJC removal/remedial action wastes may exhibit the characteristic of toxicity. If, in these cases, the removal/remedial action involves on-site storage (i.e., longer than 90 days) or on-site treatment (e.g., in-situ bioventing, soil vapor extraction), the substantive portions of this section are potentially applicable to the new storage or treatment facility unless the waste is managed within the AOC or a CAMU is created. If the removal/remedial action involves on-site storage (i.e., longer than 90 days) or on-site treatment of wastes which, although not hazardous, contain the same constituents as those for which a waste was listed, the requirements of this section may be relevant and appropriate. Most of the existing sites at SJC are believed to have not managed any wastes since the effective date of the statute. These sections are not expected to be applicable to the majority of the existing sites or to removal and remedial actions that do not involve on-site treatment or storage of hazardous wastes (e.g., would not be applicable to closure of a landfill that has not received waste since the effective date of the statute, regardless of whether the landfill contained hazardous wastes). At existing sites that did not manage wastes after the effective date of the statute, these regulations may be relevant and appropriate depending on the site-specific circumstances (e.g., circumstances of the release, hazardous properties of the waste, characteristics of the site, and nature and purpose of the requirement). Potentially applicable to existing sites that managed hazardous waste after the effective date of the statute, and potentially relevant and appropriate to sites that managed nonhazardous wastes that are identical or similar to listed hazardous wastes.

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	Subpart E of 40 CFR 264 outlines procedures for manifesting hazardous waste for owners and operators of TSD facilities. Requirements are specified for: manifesting; recordkeeping (quantity, waste analyses data, and location of the waste); and biennial reporting.	A	If SJC were to send hazardous wastes offsite for management, the manifesting requirements would be applicable. Because the recordkeeping and reporting requirements outlined in this section are administrative, not substantive, they would not be relevant or appropriate or applicable to on-site management of removal or remedial action wastes at SJC even if the wastes were hazardous.
	Subpart G of 40 CFR 264 details general requirements for closure and post-closure care at hazardous waste facilities. This section describes closure performance standards, closure and post-closure plans, timeframe requirements for closure, requirements for disposal and/or decontamination of equipment; and post- closure care and use of property (e.g., maintenance and monitoring requirements).	A, RA	Because most of the sites did not manage wastes after the effective date of the statute, this Part is unlikely to be applicable to the existing sites at SJC. They may, however, be relevant and appropriate if the sites managed hazardous wastes or wastes that are identical or similar to hazardous wastes, and the situation at the site matches the situation addressed by the regulations. However, the NCP and compliance with other laws process outlines a "hybrid" risk-based closure as the relevant and appropriate requirement. If, however, a site did manage hazardous wastes after the effective date of the statue, this part would be potentially applicable. Potentially applicable to any new hazardous waste treatment, storage, or disposal units constructed onsite as part of a removal or remedial action. Potentially relevant and appropriate to any new treatment, storage, or disposal units constructed onsite as part of a removal or remedial action that manages wastes identical or similar to listed hazardous wastes.
	Subpart I of 40 CFR 264 sets standards for the storage of containers of hazardous waste. These standards include requirements for: condition of the container; compatibility of stored wastes; management of the container; and inspections and containment systems.	A, RA	This Part would be applicable to IDW and removal and/or remedial action wastes that are hazardous. This Part would be potentially relevant and appropriate to wastes that are identical or similar to hazardous wastes. *[Note: The reader is cautioned that specific provisions of this Part will vary depending on the length of storage and the amount of waste generated.]*

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	Subparts J, K, L, and M of 40 CFR 264 establish design and operating requirements for both closure and post-closure for tanks, surface impoundments, waste piles, and land treatment units. These regulations also provide requirements for containment and detection of releases, response to spills, and monitoring and inspection. These regulations require (for certain units) that if removal or decontamination of all contaminated subsoils/contaminated materials/residues is not possible, closure <u>and</u> post-closure requirements must be attained (i.e., closure as a landfill).	A, RA	Some wastes at SJC may exhibit the characteristic of toxicity or contain the same constituents as listed wastes. However, it is believed that most, if not all, of these sites did not manage waste after the effective date of the statute. As a result, these regulations are probably not applicable, but may be potentially relevant and appropriate. On the other hand, if any of these sites did manage hazardous wastes after the effective date of the statute, these regulations would be potentially applicable. Although not a likely scenario at SJC, should a removal or remedial action involve placement of hazardous wastes in surface impoundments (e.g., lagoons for the treatment and/or storage of extracted waste or ground water), or waste piles, this regulation would be applicable to these sites. This would be potentially relevant and appropriate to any new surface impoundments or wastes piles constructed as part of a removal or remedial action that manage wastes identical or similar to listed hazardous wastes.
	Subpart N of 40 CFR 264 provides requirements for design, operation, monitoring, inspection, recordkeeping, closure, and permit requirements for VHWMR-regulated landfills. As part of a Virginia closure, a final cover must be designed and constructed that prevents migration of liquids, requires minimum maintenance, promotes drainage, minimizes erosion, accommodates settling, and has a permeability less than or equal to that of any bottom liner or natural subsoils present.	A, AR	Landfills that were used to dispose of various wastes exist at SJC, and may meet the definition of a hazardous waste. The SJC landfills probably ceased operation prior to the effective date of the statute, therefore these requirements are unlikely to be applicable, but may be potentially relevant and appropriate to the implementation of removal or remedial alternatives for landfills containing hazardous waste. This would also be potentially relevant and appropriate to removal/ remediation actions at landfills containing wastes with the same or similar constituents as those for which a waste was listed.

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	Subpart X of 40 CFR 264 provides standards that apply to miscellaneous units not previously defined under VHWMR. This section outlines performance requirements that miscellaneous units must be designed, constructed, operated, and maintained to prevent releases to the subsurface, ground water, and wetlands that may have adverse effects on human health and the environment.	A, RA	These requirements may be potentially applicable for removal and/or remedial actions that involve activities not specifically regulated under other parts of VHWMR, such as demilitarization waste management activities (e.g., burn pits, ordnance detonation areas, etc.), innovative technologies (e.g., in-situ bioventing, soil vapor extraction), etc. These regulations may be relevant and appropriate if the wastes treated in the miscellaneous unit contain the same, or similar, constituents as a listed waste.
	Subpart AA of 40 CFR 264 establishes air pollutant emission standards for process vents, closed-vent systems, and control devices at hazardous waste TSD Facilities (TSDFs). Performance standards for total organic emissions are 3 lb/hr (3.1 tons/year), or reduce total organic emissions (using a control device) from all affected process vents by 95 weight percent. Regulations apply to various processes (e.g., distillation, fractionation, solvent extraction, etc.) used to manage hazardous wastes with organic concentrations of at least 10 parts per million by weight (ppmw).	A, RA	This rule may be applicable for remedial actions involving hazardous wastes at SJC which might generate air emissions (e.g., in-situ bioventing, soil vapor extraction) if total organic concentration exceeds the 10 parts per million by weight (ppmw) threshold. The requirements may be relevant and appropriate if the total organic concentration is less than 10 ppmw or if the organics are from nonhazardous waste.
	Subpart BB of 40 CFR 264 Establishes air pollution emission standards for equipment leaks at TSD facilities. Design specifications for equipment such as pumps and compressors are provided in this section. This rule requires that equipment be monitored for leaks and repaired within 15 days of detection of a leak.	A, RA	These requirements are potentially applicable for equipment components that contain or contact hazardous waste with organic constituent concentrations of at least 10 percent by weight.

Table 4-3
Summary of Potential Federal and State Hazardous Waste ARARs
St. Juliens Creek (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
RCRA, **Corrective Action Management Units, and Temporary Units; Corrective Action Provisions Under Subtitle C**	This rule establishes CAMUs and temporary units (TUs) as two options for corrective actions at TSD facilities. The CAMU rule allows treaters to manage hazardous waste in an EPA designated place without triggering the LDRs.	A, RA	For SJC sites where hazardous wastes may be treated, stored, or disposed onsite, the substantive requirements of the CAMU/TU Rule is potentially applicable. May involve the consolidation of wastes from several sites into a "waste pile" prior to shipment offsite for treatment and/or disposal. The CAMU/TU rule would be potentially relevant to the on-site management of nonhazardous wastes that are the same as or similar to hazardous wastes. [Note: Because the CAMU/TU rule provides for regulatory flexibility, it would be considered less stringent, and therefore, not applicable in States that are authorized for the Hazardous and Solid Wastes Amendments (HSWA) corrective action program, but have not adopted comparable provisions. As of the date of preparation of this table, the Commonwealth of Virginia has not been authorized for the HSWA corrective action program. As a result EPA administers the corrective action program and the CAMU/TU requirements.]

Table 4-4
Summary of Potential Federal and State Solid Waste ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation Comment
Virginia Solid Waste Management Act			
Code of VA, Sections 10.1-1400	Enacted laws to govern solid waste activities within the Commonwealth, including the operation of sanitary landfills and other facilities involved with the treatment, storage, or disposal of nonhazardous solid waste.		
Virginia Solid Waste Management Regulations (VSWMRs)			
VSWMRs 9 VAC 20-80	Establishes standards and procedures pertaining to citing, design, construction, operation, maintenance, closure, and post-closure care of solid waste management facilities.		The VSWMRs are potential ARARs for cleanup activities at SJC that do not involve hazardous wastes. (See the VHWMRs section for regulations regarding hazardous wastes.) Specifically, VSWMRs would be potentially applicable to solid waste management activities that received/managed waste on or after Dec 21, 1988, and potentially relevant and appropriate to sites that stopped receiving waste prior to that date. See below for comments on the specific provisions of the VSWMRs.
9 VAC 20-80-140, **Identification of Solid Wastes**	Identifies a solid waste as any discarded material. Materials are solid wastes if they are used, reused, or reclaimed; accumulated; stored; or treated before such use, reuse, or reclamation, when they are: (1) hazardous wastes, (2) used in a manner constituting disposal by being applied or placed on the land.	A	This section is a potential ARAR for wastes generated by removal/ remedial actions, including IDW, provided the wastes are not also hazardous. (See the VHWMRs for regulations regarding hazardous wastes.)
9 VAC 20-80-180 through 200, **Management of Open Dumps and Unpermitted Facilities**	Provides a definition of open dumps and unpermitted facilities and prescribes requirements for cleanup and corrective action for releases that may occur as a result of the improper management of solid wastes.	RA	If "Landfills" at SJC meet the definition of open dumps; the substantive requirements for open dumps are potentially ARARs for SJC.
9 VAC 20-80-220, **Action Levels**	Establishes methods for determining action levels for constituents in ground water, air, surface water, and soils that may have occurred due to a release at a site.	RA	This section is a potential ARAR for determining whether action is required at a site. However, portions of this section will likely be superseded by specific action levels.

Table 4-4
Summary of Potential Federal and State Solid Waste ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation Comment
9 VAC 20-80-230, **Cleanup Standards**	Establishes a process to develop cleanup standards for remediation of media (ground water, surface water, air, and soils) contaminated with solid wastes. Requires releases from solid waste management facilities be established that are protective of human health and the environment, and sets performance goals for developing chemical specific requirements. Criteria for determining the point of compliance with the cleanup standards is also set.	RA	This section is a potential ARAR for determining cleanup levels and the point of compliance for SJC sites that do not involve hazardous wastes. However, portions of this section will likely be superseded by specific cleanup levels.
9 VAC 20-80-240 through 310, **Solid Waste Disposal Facility Standards**	Contain regulations for citing, design/construction, operation, ground-water monitoring, closure, and post-closure care for sanitary landfills, construction/ demolition/debris landfills, and industrial landfills. These regulations also specify requirements for control of decomposition gases, leachate control and monitoring, and corrective action programs.	RA	For the landfills on SJC that did not operate after Dec 21, 1988, these regulations are not believed to be applicable. However, because none of the landfills are known to have managed hazardous wastes or to have operated after the date of enactment of the VHWMRs, parts of these regulations are probably relevant and appropriate for the design and construction of caps, closure, post-closure care, ground-water monitoring, decomposition gas control, leachate control and monitoring, and corrective actions at landfills on SJC.
9 VAC 20-80-320 through 470, **Other Solid Waste Management Facility Standards**	Specifies regulations for citing, design, operation, closure, and post closure care at solid waste management facilities that are not landfills (e.g., compost facilities; solid waste transfer stations; surface impoundments and lagoons; waste piles; and other miscellaneous units).	RA	Some sites at SJC may meet the definition of a waste pile or miscellaneous units. These regulations will be applicable to any of the solid waste management units on SJC that have operated after Dec 21, 1988. These regulations are probably relevant and appropriate for closure and post-closure care at those sites on SJC which may be classified as waste piles or miscellaneous units.
9 VAC 20-80-630 through 710, **Special Wastes**	Contains regulations for the disposal of special wastes. Special wastes are wastes that require special handling and precautions. Regulations require that facilities may receive special wastes for processing or disposal only with the specific prior approval of the VDEQ or by specific provisions with the facility permit. Specific regulations in this section include limitations on the types of landfills in which PCB- contaminated waste and soils contaminated with petroleum can be disposed.	A or RA	Nonhazardous wastes generated as a result of removal or remedial actions at SJC, including IDW, may be considered special wastes. Consequently, these regulations are potentially applicable to off-site treatment and disposal of nonhazardous wastes, and are potentially applicable or relevant and appropriate for on-site treatment and disposal of nonhazardous wastes.

Table 4-5
Summary of Potential Federal and State Water ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Virginia State Water Control Law			
Code of Virginia, Title 62.1	Protects the existing high quality of State waters and restores the quality of all other State waters; safeguards the clean waters and prevents pollution increases; and promotes water conservation efforts. The law specifies: requirements for oil discharge contingency plans; regulations for above ground storage tanks; prohibitions of waste discharges; regulation of sewage discharges; controls on discharges of sewage and other waste from boats and vessels; and discharge of oil into waters.	A or RA	See explanations for specific regulations below.
Virginia Water Protection Permit Regulations			
9 VAC 25-210	Delineates the procedures and requirements associated with dredging and filling activities that cause a discharge of any pollutants into, or adjacent to surface waters, or which impact the physical, chemical, or biological properties of surface waters. Specific substantive requirements could include: --A duty to avoid, minimize, or mitigate all adverse environmental impacts associated with dredge and fill activities; --Compliance with the Virginia Surface Water Quality Standards; --Limitations on toxic pollutants necessary to protect beneficial uses of receiving waters; --Monitoring requirements; and --The use of Best Management Practices (BMP) to control the discharge of toxic pollutants.	A or RA	This section is a potential ARAR for dredge and/or fill activities that cause a discharge of pollutants into, or adjacent to, surface waters, or which change the physical, chemical, or biological properties of the surface waters. Such activities may include construction of a landfill cap, installation of slurry walls, and excavation of soils. *[Note: According to 9 VAC 25-210-60: Part 2, activities regulated under VPDES are NOT subject to this section. Consequently, this section would not be an ARAR for direct or indirect discharges of water to surface water.]*
Virginia Water Regulations, "Water Quality Standards"			
9 VAC 25-260	The State Water Control Law mandates the protection of existing high quality state waters and provides for the restoration of all other state waters to such condition of quality that any such waters will permit all reasonable public uses and will support the propagation and growth of	RA	Virginia SWQS are a potential ARAR for establishing soil and ground-water cleanup levels, as well as direct surface water discharge levels at SJC. Where ground water discharges to surface water, the ground-water cleanup level at that discharge point would be the more stringent level between the established cleanup level for ground water and the Virginia or Federal surface water standard or criteria

Table 4-5
Summary of Potential Federal and State Water ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	all aquatic life that might reasonably be expected to inhabit them. The adoption of water quality standards under Section 62.1-44.15(3) of the Code of Virginia is one of the board's methods of accomplishing the Law's purpose. Establishes Surface Water Quality Standards (SWQS) necessary to maintain all State waters at a level that will protect beneficial uses and support the propagation and growth of aquatic life. Also contains an antidegradation policy that requires "existing instream uses and the level of water quality necessary to protect the existing uses" be maintained and protected. Narrative and numeric surface water quality standards are included. Separate numeric standards are presented for freshwater and saltwater. The section contains numeric standards for a series of toxic pollutants, as well as, limitations for dissolved oxygen, temperature, pH, chlorine, and ammonia.		for the protection of aquatic life. (See below for discussion of MCLs.) Typically, **soil** cleanup levels will be the more stringent concentration resulting from the following: --Risk assessment taking into account all potential soil exposure pathways; --Soil modeling to determine the concentration of contaminants that can remain in the soil so that water in equilibrium with the soil will not result in contaminant concentrations in the ground water above MCLs (if ground water is a potential future drinking water source); and --Soil modeling to determine the concentration of contaminants that can remain in the soil such that water in equilibrium with the soil will not lead to a natural discharge to surface water resulting in an in-stream contaminant concentration greater than the SWQS contained in this section. In this case, the SWQS are a potential ARAR for establishing soil cleanup levels.
Virginia Pollutant Discharge Elimination System (VPDES)			
9 VAC 25-31	Restores and maintains the quality of surface waters. Controls the direct discharge of pollutants to surface waters through the Virginia Pollutant Discharge Elimination System (VPDES) program. Examples of direct discharges are point sources such as discharges from a treatment plant directly into or very close proximity to, a surface water body through a discernible conveyance (pipe, ditch, channel, tunnel, or well); wastewater from the site piped or discharged to an off-site surface water body. Direct discharges of wastewater to surface waters must meet the effluent discharge limits established by this section. These limits are established on a case-by-case basis, and may be based on:	A or RA	At SJC, these regulations are potential ARARs for remedial actions that involve direct discharges to surface waters. Such discharges could include treated ground water, decontamination water, or other wastewater to be discharged directly to surrounding surface waters. An on-site discharge from an SJC site to surface waters must meet the substantive VPDES requirements, but need not obtain a VPDES permit nor comply with the administrative requirements of the permitting process, consistent with CERCLA section 121(e)(1). However, an off-site discharge from an SJC site to surface waters is required to obtain an VPDES permit and to meet both the substantive and the administrative VPDES requirements. On-site discharges are wastewaters that are discharged directly into a surface water body on site or in very close proximity to the site via a pipe, ditch, conduit, or other means of "discrete conveyance." Off-site discharges are those in which wastes from the site are piped or otherwise discharged through a point source to an off-site surface water.

Table 4-5 Summary of Potential Federal and State Water ARARs St. Juliens Creek Annex (SJC)			
Federal or State Citations	**Requirements Synopsis**	**Applicability**	**SJC Situation/Comment**
	Technology-based effluent limitations;		
9 VAC 25-31-800 through 850, **Pretreatment**	VPDES regulations also cover Publicly Owned Treatment Works (POTWs). Specifically, they forbid industrial users from discharging pollutants to the POTW that will pass through or interfere with the operation of the POTW; require POTWs to establish pretreatment requirements for industrial discharges to prevent pass through or upset of the POTW; and contain specific limitations on discharges to the POTW for various industrial categories.	A	SJC discharges to a POTW are considered an off-site activity. Dischargers must comply with both the substantive and administrative requirements. At SJC, these regulations are ARARs for remedial actions that involve indirect discharges to POTWs. Such discharges could include treated ground water, decontamination water, or other wastewater to be discharged to a POTW. These discharges would have to comply with the pretreatment requirements of the receiving POTW before being discharged. Industry specific standards would not be applicable because remedial actions are not one of the industrial categories covered. However, they may be relevant and appropriate if the pollutants in the discharge are similar to those covered by one (or more) of the industrial categories. *[Note: POTWs have the authority to reject wastewater discharges and require compliance with control mechanisms such as permits and orders. If discharge to a POTW is being considered as part of a removal or remedial action, the acceptability of the discharge should be investigated with the POTW early (e.g., during the RI/FS stage).]*
9 VAC 25-32, **Virginia Pollution Abatement (VPA) Permit Requirements**	Outlines the procedures and requirements to be followed in connection with Virginia Pollution Abatement (VPA) permits issued by the State Water Control board pursuant to the CWA or the State Water Control Law. VPA permits are designed to cover nonpoint source discharges to surface waters from pollutant management activities. A pollutant management activity is defined as "a treatment works with a potential or actual discharge to State waters, but which does not have a point source discharge to surface waters." The regulations prohibit the discharge of pollutants (including sewage, industrial wastes, and other wastes)	A or RA	The substantive portion of this regulation is a potential ARAR for all remediation activities that involve non-point source discharges to surface waters from pollutant management activities as defined in 9 VAC 25-32. The VPA permitting and administrative requirements are **not** potential ARARs. include, duration of permits, monitoring requirements, limitations to control toxic pollutants, best management practices, and schedules of compliance.

Table 4-5
Summary of Potential Federal and State Water ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	into or adjacent to State waters, or otherwise altering the physical, chemical or biological properties of State waters, except in compliance with a VPA permit, or another permit issued by the board. Permit limitations and conditions are established based on the nature of the pollutant management activity to ensure compliance with technology-based limitations, water quality standards, the law and all regulations promulgated thereunder. These limitations and conditions may		
9 VAC 25-40, **Policy for Nutrient Enriched Waters**	The policy provides for the control of discharges of nutrients from point sources affecting state waters that have been designated as "nutrient enriched waters." The regulation restricts discharges of total phosphorus to 2 mg/l and total nitrogen to 10 mg/l during the months of April through October. *[Note: Although this regulation is referred to as a "policy," it is a promulgated regulation, and, therefore, is a potential ARAR as opposed to a potential TBC.]*	A or RA	The Chesapeake Bay and its tidal tributaries have been designated as nutrient enriched waters. Since the rivers and creeks around SJC are tidal tributaries of the Bay, they would also be classified as nutrient enriched. Consequently, this regulation would be potentially applicable to remedial actions which would result in point source discharges of wastewaters to the area and potentially relevant and appropriate to remedial action resulting in non-point source discharges of wastewaters to the area.
9 VAC 25-170, **General Permit Regulation for Storm Water Discharges Associated with Industrial Activity from Transportation Facilities, Landfills, Land Application Sites and Open Dumps, Materials Recycling Facilities, and Steam Electric Power Generating Facilities**	This regulation governs storm water discharges associated with the following industrial activities: landfills, land application sites and open dumps; materials recycling facilities; steam electric power generating facilities; and transportation facilities, as defined in the regulation. The general permit covers only discharges comprised solely of storm water, or as otherwise defined in the permit, from these facilities provided that the discharge is through a point source to surface water of the state or through a separate storm sewer system to surface waters of the state. Landfills, land application sites, and open dumps are defined as those that receive or have received any industrial wastes including those that are subject to regulation under Subtitle D of RCRA. Biannual monitoring requirements are specified for an active or inactive landfill, land application site or open	A	The substantive portions of this regulation are potential ARARs for remedial actions at landfills on SJC. The administrative requirements are **not** potential ARARs.

Table 4-5
Summary of Potential Federal and State Water ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	dump, for the following parameters: Flow, Oil and Grease, Chemical Oxygen Demand, Total Organic Carbon, Total Dissolved Solids, Total Kjeldahl Nitrogen, Magnesium, Arsenic, Barium, Cadmium, Chromium, Cyanide, Lead, Mercury, Selenium, Silver, pH, and Fecal Coliform. In addition, the regulation forbids the discharge of floating solids or visible foam in other than trace amounts. The regulation also contains requirements for the development of a storm water pollution prevention plan.		
9 VAC 25-180, **General Permit Regulation for Stormwater Discharges from Construction Sites**	Contains regulations for the permitting and control of stormwater discharges from construction activities. Construction activities include, but are not limited to, clearing, grading, and excavation activities. This regulation only covers discharges comprised solely of stormwater from construction activities that disturb 5 or more acres of land area. In addition, the discharge must be through a point source to a surface water, or through a municipal or nonmunicipal storm sewer system to surface waters. The regulations provide for permitting, development of effluent limitations, monitoring requirements, contents of a construction stormwater pollution prevention plan, and stormwater management requirements.	A	At SJC, the substantive parts of these regulations are potential ARARs for remedial actions that disturb 5 or more acres, and where the stormwater from these sites discharges to surface water as a point source or via the existing SJC storm sewer. The most likely scenario under which these regulations would be ARARs at SJC involves "construction" activities at landfills (e.g., excavation, capping, grading, etc.). Due to the acreage limitations, these regulations are less likely to be ARARs at the smaller sites, even though construction activities may be involved (e.g., excavation).
Underground Storage Tanks			
Virginia Law, Title 62.1, Chapter 3.1, Article 9 and 9 VAC 25-580, **Underground Storage Tanks: Technical Standards and Corrective Action Requirements**	This regulation applies to all owners and operators of a UST system as defined in the Virginia code, except as provided otherwise. An "UST" is defined to be any one or combination of tanks (including underground pipes connected to it) that is used to contain an accumulation of "regulated substances," and the volume of which (including the volume of underground pipes connected to it) is 10 percent or more beneath the surface of the ground. A "regulated substance" is an element, compound, mixture, solution, or substance that, when released into the environment,	A or RA	This regulation would be a potential ARAR for remedial actions at SJC in which new USTs were installed as part of the cleanup action, or a remedial actions in which existing USTs were left in place.

Table 4-5
Summary of Potential Federal and State Water ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	may present substantial danger to the public health or welfare, or the environment, and includes any substance defined in §101(14) of CERCLA but not any substance regulated as a hazardous waste under subtitle C of RCRA.		
Federal Safe Drinking Water Act			
SDWA §1412	Requires EPA to set primary and secondary drinking water regulations. EPA identifies contaminants that may have adverse effects on human health and sets a maximum contaminant level (MCL) that is economically and technologically feasible for public water systems (PWSs). MCLs are the highest permissible level, i.e., concentration of a contaminant in tap water. MCLs are set as close as possible to Maximum Contaminant Level Goals (MCLGs). MCLGs are "set at the level at which no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety." MCLs are enforceable standards, but MCLGs are not. In Section 121(d) of CERCLA, standards (i.e., under the SDWA) are potential ARARs and specifies that a remedial action "shall require a level or standard of control which at least attains MCLGs established under the Safe Drinking Water Act . . where such goals or criteria are relevant and appropriate under the circumstances of the	RA	According to VDEQ, MCLs under the SDWA are the ARARs for contaminated ground water (per the NCP). Although Virginia has ground-water quality standards, the appropriate ground-water cleanup standards, according to VDEQ, are the MCLs and MCLGs in the National Primary Drinking Water Regulations. In the absence of MCLs, other health-based cleanup standards, based on site-specific risk assessment, may be used. Where ground water discharges to surface water, the cleanup level at that discharge point would be the more stringent level between the MCL or a State or Federal surface water criterion or standard for the protection of aquatic life.

Table 4-5
Summary of Potential Federal and State Water ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	release or threatened release." According to 40 CFR 300.430(e)(2)(i) of the NCP, MCLGs set at levels above zero are potentially relevant and appropriate. If an MCLG is determined not to be relevant and appropriate, the corresponding MCL becomes the potential ARAR. Where an MCLG has been set at zero, the corresponding MCL is the potential ARAR. Under EPA's ground-water policy, set forth in the NCP, preliminary remediation goals for Class I and II ground waters (i.e., current and future drinking water) are to be set at MCLs and non-zero MCLGs where relevant and appropriate or more stringent State standards.		
Federal Drinking Water Standards			
Subpart G -- National Primary Drinking Water Regulations: Maximum Contaminant Levels 40 CFR 141.50 Maximum Contaminant Level Goals (MCLG) for Organic Contaminants	Sets MCLGs for nearly five dozen organic contaminants. About one-third of these, EPA has set the MCLG at zero. The term MCLG means the maximum level of a contaminant in drinking water at that no known or anticipated adverse effect on the health of persons would occur and that allow an adequate margin of safety.	RA	Some organic contaminants for which EPA has set MCLGs are known or suspected to contaminate the ground water at SJC. The ground water is assumed to be a current or future source of drinking water. Therefore, the MCLG will be the potential relevant and appropriate if it is above zero; otherwise, the MCL will be potentially relevant and appropriate. If unregulated organic constituents are in the ground water, a health-based standard may be used. If ground water to be remediated discharges to surface water, the potentially relevant and appropriate standard is the more stringent of the MCL, a State or Federal surface water criterion, or a State/Federal standard for the protection of aquatic life.
Subpart G -- National Primary Drinking Water Regulations: Maximum Contaminant Levels 40 CFR 141.51 Maximum Contaminant Level Goals for Inorganic Contaminants	Sets 15 MCLGs for inorganic contaminants. Of these, only one (for lead) is set at zero.	RA	Some inorganics for which EPA has set MCLGs are known or suspected to be present in the ground water at SJC. For contaminants with an MCLG of zero, the MCLG potentially will be relevant and appropriate. For unregulated inorganics, a health-based standard derived from site-specific risk assessment may be used. If the ground water to be remediated discharges to surface water, the potentially relevant and appropriate standard is the more stringent of the MCL, a State or Federal surface water criterion, or a State/Federal standard for the protection of aquatic life.

Table 4-5
Summary of Potential Federal and State Water ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Subpart G -- National Primary Drinking Water Regulations: Maximum Contaminant Levels 40 CFR 141.52 Maximum Contaminant Level Goals for Microbiological Contaminants	Sets MCLGs for giardia lambia, viruses, legionella, and total coliforms.	RA	Both MCLGs and corresponding MCLs are aimed at surface rather than ground-water sources of drinking water. Therefore, they are not likely to come into play at SJC sites.
Subpart G -- National Primary Drinking Water Regulations: Maximum Contaminant Levels 40 CFR 141.61 Maximum Contaminant Levels for Organic Contaminants	Sets MCLs for nearly five dozen organics, including a number of synthetic organics. The regulation consists of two elements: a concentration level and the best available technology (BAT) for achieving that concentration level. The concentration standards are listed on Table 3.1. BATs include granular activated carbon (GAC), packed tower aeration (PTA), or oxidation (OX). The regulation contains a chart listing BAT for each contaminant.	RA	Ground water at SJC contains at least some regulated contaminants. For ground-water remediation, these MCLs may be potentially relevant and appropriate if the MCLGs exceed zero. If unregulated organic constituents are in the ground water, a health-based standard may be used. Further, if the ground water to be remediated discharges to surface water, the potentially relevant and appropriate standard is the more stringent of the MCL, a State or Federal surface water criterion, or a State/Federal standard for the protection of aquatic life.
Subpart G -- National Primary Drinking Water Regulations: Maximum Contaminant Levels 40 CFR 141.62 Maximum Contaminant Levels for Inorganic Contaminants	Sets MCLs for 15 inorganics, primarily metals. These MCLs are included in Table 3.1. The regulation identifies BAT for each contaminant.	RA	At least some chemicals governed by this rule are known or suspected to contaminate ground water at SJC. However, most MCLGs for these constituents are above zero and will become potentially relevant and appropriate.

Table 4-5
Summary of Potential Federal and State Water ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Subpart B -- Maximum Contaminant Levels 40 CFR 141.11 Maximum Contaminant Levels for Inorganic Chemicals	Sets MCLs for arsenic and nitrate. The nitrate standard, however, is superseded by 40 CFR 141.62.	RA	This rule may become a potential ARAR if any arsenic is detected in the ground water.
Subpart B -- Maximum Contaminant Levels 40 CFR 141.12 Maximum Contaminant Levels for Organic Chemicals	Sets MCLs for total trihalomethanes (TTHMs), the sum of the concentrations of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform), and trichloromethane (chloroform) at 0.1.	RA	TTHMS are byproducts of the disinfectants added in drinking water systems. These MCLs are not likely to be potential ARARs because ground-water cleanup typically does not entail disinfection.

[1] Key A = Applicable RA = Relevant and Appropriate TBC = To Be Considered
[2] The three types of ARARs are chemical specific, action specific, and location specific.

Table 4-6 Summary of Potential Federal and State Air ARARs St. Juliens Creek Annex (SJC)			
Federal or State Citations	**Requirements Synopsis**	**Applicability**	**SJC Situation/Comment**
Virginia Air Pollution Control Regulations			
Existing and Certain Other Sources (9 VAC 5-40)	Regulates existing (rather than new) stationary sources (point and area) of air emissions. Sets standards for visible emissions, fugitive dust, odor, and toxic pollutants from these sources. Sets standards for emissions from sources in various industry categories and process operations.	A or RA	Sites at SJC may have currently unregulated area sources (e.g., wind blown soil or dust) but are not known to have unregulated point sources in the categories covered under Part IV. Potential ARARs are more likely to be derived from 9 VAC 5-50 (New and Modified Sources) and 9 VAC 5-60 (Hazardous Air Pollutants).
New and Modified Sources (9 VAC 5-50)	Sets emissions standards for all (point and area) newly constructed stationary sources or modifications of existing sources. Standards are for visible emissions, fugitive dust, odor, and toxic pollutants. Sets standards for emissions of criteria pollutants from sources in specific industrial categories as well as from processes not covered by those categories. The Federal Clean Air Act and the Virginia Air Law subjects new sources/major modifications to the "new source review" (NSR) program. For non-CERCLA sources, the NSR is a prerequisite for a preconstruction permit that sets emissions limits and monitoring requirements. Sources at CERCLA sites are subject to those emissions limits and monitoring requirements although no permit is required. As described below, the NSR and resulting emission limits/monitoring requirements depend upon whether a source is located in an "attainment" or "nonattainment" area. The term "nonattainment area" refers to a geographic region that has not met Federal air quality standards for one or more of the following six "criteria" pollutants: sulfur dioxide (SO_2), particulates (PM-10), carbon monoxide (CO), ozone, nitrogen oxides, and lead. The emissions limits are based on New Source Performance	A or RA	Sites at SJC would not have to obtain permits, the substantive requirements that the permits typically would contain would be potentially applicable to major sources and potentially relevant and appropriate for other sources. Types of activities for which 9 VAC 5-50 may be potential ARARs include: demolition, excavation, construction of remedies (e.g., construction of soil vapor extraction unit, or air stripper), and operation of ground-water and/or soil treatment units. More detail on each section of 9 VAC 5-50 is provided below. Virginia has designated Hampton and nearby Chesapeake, Newport News, Norfolk, Suffolk, Williamsburg, and Virginia Beach as nonattainment areas for ozone. All of Virginia is in attainment for the remaining criteria pollutants, with two exceptions for carbon monoxide. NSPS most likely to pertain to SJC activities and to be applicable are those for incinerators. However, a case-by-case comparison between the activity and each NSPS category is necessary to ascertain whether any requirements in those categories would be relevant and appropriate. EPA maintains a BACT/LEAR clearinghouse designed to assist in identifying the appropriate source-specific emission standards.

Table 4-6
Summary of Potential Federal and State Air ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	Standards (NSPS) which are set on an industry-by-industry basis.		
Compliance (9 VAC 5-50-20)	Establishes restrictions on the disposal and handling of VOCs and the construction of stack heights. VOC emissions are to be minimized, and intentional spills are prohibited. VOCs cannot be (1) discarded in sewers that are not connected to a treatment plant, (2) stored in open containers, or (3) handled in any other manner that would "result in evaporation beyond that consistent with air pollution control practices and minimizing emissions." Stack heights and dispersion techniques must be consistent with Section 111(a)(3) of the Clean Air Act (CAA) and Good Engineering Practice (GEP).	A or RA	Stacks -- Construction of new sources/major modification of existing sources with stacks is not anticipated. The exception might be air strippers or soil vapor extraction systems for which stacks typically are not in excess of 20 feet high. VOCs -- CERCLA requirements for remedy selection and design are consistent with the VOC disposal/spill provisions of this section.
Performance Testing (9 VAC 5-50-30)	Stipulates which test methods sources subject to Rule 5-5 (see below) should use; specifies procedures in the event the test methods are inappropriate, no appropriate methods exist, the specified number of test runs are interrupted, and/or samples are accidentally lost.	A or RA	Testing requirements would be potentially applicable to new sources at SJC for which Rule 5-5 is a potential ARAR. (See below.)
Monitoring (9 VAC 5-50-40)	Requires installation and operation of continuous monitoring systems and monitoring devices prior to the conduct of the performance testing specified in 9 VAC 5-50-30. Also requires evaluation of the monitoring systems/devices during the performance tests or within 30 days thereafter in accordance with the requirements and procedures in Appendix B of 40 CFR Part 60.	A or RA	Potentially applicable to new sources for which 9 VAC 5-50-30 "Performance Testing" is potentially applicable.

Table 4-6 Summary of Potential Federal and State Air ARARs St. Juliens Creek Annex (SJC)			
Federal or State Citations	**Requirements Synopsis**	**Applicability**	**SJC Situation/Comment**
Rule 5-1 Visible Emissions and Fugitive Dust/Emissions (9 VAC 5-50-60 through 9 VAC 5-50-120)	The term "fugitive emissions" refers to unintended emissions that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening. Mandates that reasonable precautions be taken to prevent particular matter from becoming airborne during: handling, transporting, storing, using, constructing, altering, or repairing any materials; demolition, construction modification, or operation of any stationary source or any other bridling, structure, facility, or installation. Examples of reasonable precautions (9 VAC 5-50-90) include dust suppression during demolition (water or chemical); dust suppression on roads, material stockpiles, or other surfaces; paving/cleaning roads; equipment installation (e.g., vents, hoods, fans, fabric filters) to enclose and vent dusty materials; use of containment methods during sandblasting or similar operations; and covering of transportation/conveyance equipment. Testing is required and the standard to be met is that visible emissions cannot exceed 20 percent opacity, except for one 6-minute period in any 1 hour of not more than 30 percent opacity. Continuous monitoring systems and other monitoring devices shall be installed, calibrated, maintained, and operated in accordance with 9 VAC 5-50-40 and 9 VAC 5-10-20, Appendix J.	A or RA	These regulations are likely to be applicable at SJC in connection with activities that demolish existing structures; remove/transport/convey debris and/or excavated materials; disturb the soil during excavation and/or capping; disturb soil or other exposed surfaces during construction of haul roads or stationary sources such as air strippers or soil vapor extraction units.
Rule 5-2 Odorous Emissions (9 VAC 5-50-130 through 9 VAC 5-50-150)	Requires the use of best available control technology (BACT) for all sources of odorous emissions and prohibits discharge of any odorous emissions in excess of that resulting from use of BACT.	A or RA	May be applicable to drying beds from old wastewater treatment facilities, residual oil and chemicals from contaminated soil around USTs, and hot spot removals at old landfills. EPA's BACT Clearinghouse may provide information on odor control techniques.

Table 4-6
Summary of Potential Federal and State Air ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Rule 5-3 Toxic Pollutants (9 VAC 5-50-160)	Regulates emission of any toxic pollutant from new/modified sources. Exemptions may be available for certain sources with emissions of toxic pollutants below the Threshold Limit Values (TLVs) set forth in the regulation, for sources subject to regulation under §112 of the Federal Clean Air Act, and for sources regulated under the incineration provisions of 9 VAC 20-60-10 (Virginia's Hazardous Waste Management Regulations); prohibits discharges of toxic pollutants in quantities that may cause or contribute to the endangerment of human health; and prohibits discharges that cause or contribute to any significant ambient air concentration.	A or RA	This rule may be applicable to SJC facilities that emit toxic pollutants (e.g., air strippers, soil vapor extraction units), if these facilities do not meet one of the exemption criteria or are regulated under §112 of the CAA and 9 VAC 20-60-10.
Rule 5-4 Stationary Sources (9 VAC 5-50-240 Applicability and Designation)	Regulates "facilities that emit or cause air pollution throughout the Commonwealth of Virginia;" requires facilities to use BACT, except facilities in nonattainment areas must use lowest achievable emission rate (LAER) for each "qualifying" pollutant. See detailed discussion below on regulated pollutants, types of standards, and pertinence for SJC.		
Rule 5-4 Stationary Sources (9 VAC 5-50-270)	*Major sources in nonattainment areas.* Prohibits emissions in excess of that resulting from the use of LAER. LAER applies to each qualifying pollutant and typically is set on a case-by-case basis during the NSR process described above (See 9 VAC 5-50 - New and Modified Sources.) LAER is defined as the more stringent rate of emissions based on the following: a. The most stringent emissions limitation in the implementation plan of any State for such class or category of stationary source, unless the owner of the proposed stationary source demonstrates limitations are not achievable; or	A or RA	SJC is not in an area designated as a nonattainment area for any criteria pollutants. Thus, BACT, rather than LAER, would be pertinent for controlling emissions. Because few new sources at SJC sites are expected to be "major" sources, the requirements are likely to only be potentially relevant and appropriate, rather than applicable.

Table 4-6 Summary of Potential Federal and State Air ARARs St. Juliens Creek Annex (SJC)			
Federal or State Citations	**Requirements Synopsis**	**Applicability**	**SJC Situation/Comment**
	b.The most stringent emissions limitation that is achieved in practice by such class or category of stationary source. This limitation, when applied to a modification, means the lowest achievable emissions rate for the new or modified emissions units within the stationary source.		
	In no event shall the emissions rate exceed the amount allowable under an applicable new source standard of performance. For air pollutants other than HAPs, a "major source" is defined as a "source that directly emits or has the potential to emit 100 tons per year or more of any air pollutant (including any major source of fugitive emissions of any such pollutant). The fugitive emissions of a stationary source shall not be considered in determining whether it is a major stationary source, unless the source belongs to one of 27 specified categories. In ozone nonattainment areas, certain stationary sources with potential to emit between 10 tons per year and 100 tons per year or more of VOCs or NOx are major sources.		
Rule 5-4 Stationary Sources (9 VAC 5-50-280)	***Major sources in attainment areas.*** Prohibits emissions in excess of that resulting from BACT. BACT must be met for each pollutant subject to regulation under the Federal CAA that it would have potential to emit in significant amounts. BACT is set on a case-by-case basis and is "standard of performance (including a visible emissions standard) based on the maximum degree of emissions reduction for any pollutant which would be emitted from any proposed stationary source... taking into account energy, environmental and economic impacts and	A or RA	SJC in an area that is attaining the NAAQS for all pollutants. Thus, BACT, rather than LAER, would be pertinent. Because few, new sources at SJC CERCLA sites are expected to be "major" sources, the requirements are likely to be relevant and appropriate, rather than applicable.

Table 4-6
Summary of Potential Federal and State Air ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
	other costs, determines is achievable for such source through the application of production processes or available methods, systems and techniques, include fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutants." Application of BACT shall not result in emissions that exceed the applicable standards in Rule 5-5 or Rule 6-1.		
Rule 5-4 Stationary Sources (9 VAC 5-50-290 and 9 VAC 5-50-300)	***Visible Emissions and Fugitive Dust/Emissions.*** Provisions of rule 5-1 (above) apply.	A or RA	See Rule 5-1 above.
Rule 5-4 Stationary Sources (9 VAC 5-50-310)	***Odorous Emissions.*** Provisions of Rule 5-2 (above) apply.	A or RA	See Rule 5-2 above.
Rule 5-4 Stationary Sources (9 VAC 5-50-320)	***Toxic Pollutants.*** Provisions of Rule 5-3 (above) apply.	A or RA	See Rule 5-3 above.
Rule 5-4 Stationary Sources (9 VAC 5-50-340)	***Test Methods.*** Provisions of 120-05-03 (emission testing) apply. (See above.)	A or RA	See §120-05-03 (emission testing) above.
Rule 5-4 Stationary Sources (9 VAC 5-50-350)	***Monitoring.*** Provisions of 120-05-04 (monitoring) apply. (See above.)	A or RA	See 120-05-04 (monitoring) above.

Table 4-6
Summary of Potential Federal and State Air ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Rule 5-5 Environmental Protection Agency Standards of Performance for New Stationary Sources (9 VAC 5-50-410)	Incorporates EPA rules for specific categories of facilities such as various kinds of steam generating units, incinerators, and manufacturing facilities.	A or RA	Few facilities at SJC sites are likely to fall into the industry categories for which EPA has set New Source Performance Standards (NSPS). If cleanup activities call for new/major modifications to sewage treatment plants or landfills, NSPS for those source categories would be applicable. NSPS also may be relevant and appropriate for air stripping units, soil vapor extraction units, and other facilities that emit some regulated pollutants but for which industry category standards have not been set.
Hazardous Air Pollutant Sources (9 VAC 5-60)	Incorporates EPA's standards for Hazardous Air Pollutants under §112 of the CAA, as amended in 1990 (40 CFR 61). Section 112 requires EPA to identify source categories for 189 toxic pollutants listed in the statute and to set Maximum Available Control Technology (MACT) for each category. EPA has published a list of 174 source categories of major and area sources that will be regulated. Lists of the 189 HAPs and the deadlines for issuing regulations for the 174 categories are attached. National Emission Standards for Hazardous Air Pollutants (NESHAPs) pertain to both existing and new/major modification sources. In addition to requiring MACT, the Federal and State regulations requiring testing, specify the test methods, and set monitoring requirements.		
Rule 6-1 Environmental Protection Agency National Emission Standards for Hazardous Air Pollutants (9 VAC 5-60-70)	Incorporates EPA's NESHAPs (40 CFR 61), requiring the use of MACT for regulated pollutants from regulated source categories. EPA has identified sources categories within the waste treatment industry group for HAP regulation including: POTWs, municipal landfills, hazardous waste incineration, sewage sludge incineration, site remediation, solid waste treatment, storage and disposal facilities. The rule for POTWs is scheduled for final promulgation in March 1997. The others will not be final until at least the year 2000.	A or RA	HAPs for the waste treatment industry are likely to be applicable to any POTWs, municipal landfills, hazardous waste incineration, sewage sludge incineration, site remediation, solid waste treatment, storage and disposal facilities; if they are proposed, they will be TBCs.

Table 4-6
Summary of Potential Federal and State Air ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Rule 6-2, National Emission Standards for Hazardous Air Pollutants (NESHAPs)	This regulation incorporates by reference most of the Federal NESHAPs promulgated under 40 CFR Part 63 requiring the use of MACT standards for various source categories. [Note: See the Virginia regulations at 9 VAC 5-60-100 for a listing of those 40 CFR Part 63 provisions incorporated by reference.]	A or RA	This regulation is a potential ARAR for remedial actions which may involve the release of hazardous air emissions from equipment leaks (e.g., pumps, compressors, pressure relief devices, valves, etc.). Such actions might include air strippers, soil vapor extraction systems, etc.
40 CFR 61.145 to 40 CFR 61.156 NESHAP for Asbestos	Regulates asbestos emissions from asbestos manufacturing, building renovation and demolition activities, asbestos waste disposal, and processing. Mandates specific actions/procedures to reduce asbestos-containing emissions to the ambient air. Virginia's regulations parallel Federal ones, but Virginia requires additional labeling and handling. All asbestos contractors must be licensed. *[Note: See Table 2.2 (VSWMRs) for regulations governing disposal preparation, transportation, and disposal of asbestos.]*		None of the sites at SJC are known to involve asbestos; however, they should be investigated carefully. If any asbestos is present, asbestos NESHAPs regulations may be applicable for cleanup activities that entail demolition of structures containing asbestos materials.
Virginia Ambient Air Quality Standards			
Ambient Air Quality Standards (9 VAC 5-30)	These provisions are designed to assure that ambient concentrations of air pollutants are consistent with established criteria, and, unless specified otherwise, apply throughout the Commonwealth of Virginia. The regulation specifies primary and secondary air quality standards for the following: Particulate matter (TSP); Sulfur oxides (sulfur dioxide); Carbon monoxide; Ozone; Particulate matter (PM10); Nitrogen dioxide; and Lead.	A	This regulation is a potential ARAR for remedial actions which could involve emissions of any of the pollutants for which primary and/or secondary ambient air quality standards have been established. Such remedial actions may include excavation activities, demolition activities, air stripping, soil vapor extraction, etc.

[1] Key A = Applicable RA = Relevant and Appropriate TBC = To Be Considered
[2] The three types of ARARs are chemical specific, action specific, and location specific.

Table 4-7
Summary of Potential Federal and State Stormwater ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Virginia Stormwater Management Regulations			
9 VAC 25-170	Inhibits deterioration of existing waters and waterways by requiring that post development stormwater runoff characteristics, including water quality and quantity, are maintained, to the extent practicable, equal to or better than the pre-development runoff characteristics. Establishes minimum acceptable technical criteria to control non-point pollution, localized flooding, and stream channel erosion. The regulations require that all land development projects have a stormwater management plan that specifies how stormwater will be controlled such that the post-development runoff rate will not exceed the pre-development runoff rate. The Section also contains specific methods for calculating runoff rates, standards for water volume control facilities (e.g., detention basins, infiltration facilities), and requires compliance with the Virginia Erosion and Sediment Control Regulations. (See below.) *[Note: A land development project is a manmade change to the land surface that potentially changes its runoff characteristics.]*	A or RA	This Section is a potential ARAR for "land development projects" undertaken as part of a removal or remedial action, and would require that such projects develop a stormwater management plan. At the SJC sites, land development projects could include capping landfills and excavation of soils.
Virginia Erosion and Sediment Law; Virginia Erosion and Sediment Control Regulations			
10.1-560 et seq.; 4 VAC 50-30	Establishes minimum standards for the control of soil erosion, sediment deposition, and runoff, and requires that an erosion and sediment control plan be prepared and submitted for activities that disturb the land. Specific requirements include: minimum standards for sediment basins and traps; soil stabilization procedures; protection of waterways and properties from erosion, sediment deposition, and damage due to increased volume, velocity or peak flow rate of stormwater runoff.	A or RA	This is a potential ARAR for "land development projects" undertaken as part of a removal or remedial action, and would require that such projects develop an erosion and sediment control plan. At the SJC sites, land development projects could include capping landfills, and excavation of soils. *[Note: A land development project is a manmade change to the land surface that potentially changes its runoff characteristics.]*

Table 4-8
Summary of Potential Federal and State TSCA/PCB ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation/Comment
Toxic Substances Control Act			
15 U.S. Code 2601 and implementing regulations 40 CFR 761	The Toxic Substances Control Act (TSCA), contains two basic regulatory features: the acquisition of information to identify and evaluate the potential hazards from chemical substances (primarily through the requirement for pre-manufacture notices); and, regulation of the production, use, distribution, and disposal of such substances, as necessary. The provisions of TSCA that are potential ARARs at CERCLA sites are the regulations covering the management of PCBs. Specifically, TSCA regulates the storage, containerization, labeling, manifesting, and disposal of wastes containing PCBs in concentrations of 50 parts per million (ppm) or greater.	A	TSCA regulations are potentially applicable to IDW and removal/ remedial action wastes from SJC sites that contain PCBs at concentrations of 50 ppm or higher. Such wastes would be subject to the containerzation, labeling, and storage requirements, as well as the manifesting and disposal requirements when shipped offsite for disposal. *[Note: wastes containing PCBs, even at concentrations below 50 ppm, are also considered special wastes by the VSWMRs. (See VSWMR Section, Part VIII - Special Wastes.)]*

Table 4-9
Summary of Potential Federal and State Transportation ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation Comment
Virginia Regulations Governing the Transportation of Hazardous Materials			
Regulations Governing the Transportation of Hazardous Materials (9 VAC 20-110)	Establishes rules and regulations designating the manner and method by which hazardous materials shall be loaded, unloaded, packed, identified, marked, placarded, stored, and transported.	A or RA	All off-site transport (i.e., off SJC proper) of hazardous materials generated as a result of removal/remedial actions, including IDW, at SJC must comply with the substantive **and** administrative requirements of this section. In addition, the substantive regulations in this section may be relevant and appropriate for on-site (i.e., on SJC) transport of hazardous materials.

Table 4-10
Summary of Potential Federal and State Miscellaneous ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation Comment
Federal National Historic Preservation Act Virginia Historic Resource Law Virginia Antiquities Act			
National Historic Preservation Act, Section 106 and Code of VA, Sections 10.1-2200 et seq; 10.1-2300 et seq	Requires that a reasonable and good faith effort be made to identify and evaluate historic properties, to assess the project's effects when historic properties are found, and to offer the Virginia Department of Historic Resources an opportunity to comment on the affected property when it is either listed or eligible for listing on the National Register of Historic Places.	A	These regulations are potential ARARs for remedial/removal actions at sites in the SJC. The requirements to provide the opportunity to comment would likely be considered administrative. The substantive requirements would be either applicable or relevant and appropriate.
Federal Executive Order 11988 (Floodplain Movement)			
40 CFR Part 6, Appendix A	Any activity located in a floodplain must comply with the provisions of this Executive Order. The Order requires that Federal activities in floodplains must reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and preserve the natural and beneficial values served by floodplains. All actions located in floodplains should: be designed or modified to minimize potential harm to or within the floodplain; be constructed in accordance with standards and criteria and to be consistent with the intent of those promulgated under the National Flood Insurance Program; and include accepted floodproofing and other flood protection measures. *The term "floodplain" refers to the lowland and relatively flat areas adjoining inland and coastal waters including floodprone areas of offshore islands, and, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year.*	A	Parts of SJC are located in the 100-year floodplain. As a result, this Order is likely to be an ARAR for some sites at SJC.

Table 4-10
Summary of Potential Federal and State Miscellaneous ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation Comment
Fish and Wildlife Coordination Act			
16 USC 661 - 666c - Fish and Wildlife Coordination Act	Section 663(a) of the Fish and Wildlife Coordination Act states that when the waters of any stream or other body of water are "impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States," adequate provision, consistent with the primary purpose of such impoundment, diversion, or other control, must be made for the use of such water, and for the conservation, maintenance, and management of associated wildlife resources and habitats. [Note: Wildlife and wildlife resources are defined as "birds, fishes, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent."]	A or AR	This Act is a potential ARAR for remedial actions involving the modification of surface waters. The Act does not apply to projects involving the impoundment of water where the surface area of the impoundment is less than ten acres.
Chesapeake Bay Preservation Act			
Code of VA Section 10.1-2100 et seq	Requires that certain locally designated tidal and nontidal wetlands, as well as other sensitive land areas, be subject to limitations regarding land use, development, or redevelopment. Criteria for such actions include: Minimal land disturbance; Maximum indigenous vegetation preservation; Utilization of best management practices; Minimization of impervious cover; Incorporation of stormwater criteria and buffer area requirements; and Development of a water quality impact assessment. Developments exceeding 2,500 square feet must	A, RA	· The waters surrounding SJC are tributaries of the Chesapeake Bay. As a result, these regulations are potential ARARs for removal/remedial actions that impact water quality. Such actions may include land-disturbing activities, removal of vegetation, and use of an impervious cover.

Table 4-10
Summary of Potential Federal and State Miscellaneous ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation Comment
	comply with the requirements of any local erosion and sediment control ordinances.		
Federal Endangered Species Act Virginia Endangered Species Act Virginia Board of Game and Inland Fisheries			
16 U.S.C. 1531 and Code of VA Section 29.1-100 et seq; 29.1-563 et seq	Requires a determination as to whether any action is likely to jeopardize the continued existence of any endangered species or the critical habitat designated for such species. To comply with the above, biological assessments must be conducted to determine whether endangered species or their habitats are threatened by the site and, if necessary, to take reasonable mitigation and enhancement measures including live propagation, transplantation, and habitat acquisition and improvement.	A	There may be endangered or threatened animal species in the SJC area. Consequently, a substantial portion of these regulations may be ARARs for actions that may jeopardize endangered or threatened species.
Virginia Wetlands Act			
Code of VA Section 28.2-1300 et seq	Requires that any activity that impacts a wetland meet the provisions of the Virginia Wetlands Act and regulations. Wetlands of primary ecological significance must be not altered so that ecological systems in the wetlands are unreasonably disturbed. Developments in Tidewater, Virginia, to the maximum extent practical, must be concentrated in wetlands of lesser significance. Any anticipated public and private benefit resulting from the activities occurring in a wetland should exceed the anticipated public and private detriment. The term "wetlands" means both vegetated and nonvegetated wetlands. "Vegetated wetlands" are lands lying between and contiguous to mean low water and an elevation above mean low water equal to the factor one and one-half times the mean tide range and upon which is growing a species of vegetation. "Nonvegetated wetlands" are unvegetated lands lying contiguous to mean low	A	This regulation may be an ARAR for activities occurring in areas that meet the definition of a wetland.

Table 4-10
Summary of Potential Federal and State Miscellaneous ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation Comment
	water and between mean low water and mean high water. (VR 450-01-0051 pertains to Wetlands Mitigation - Compensation Policy)		
Virginia Wetlands Policy			
9 VAC 25-380 Wetlands Policy	This policy establishes the preservation and protection of wetlands ecosystems by: requiring proper control of any construction activities and of non-point sources to prevent discharges which would impair the quality of the wetland area; ensuring that wastewaters will be kept below a level that would alter the natural, physical, chemical, or biological integrity of the wetland; minimizing the alteration of the quality and quantity of the natural flow of water to the ecosystem; protection of the wetlands from adverse dredging or filling practices, solid waste management practices, siltation, or the addition of contamination from non-point source wastes and through construction activities; and preventing violations of applicable water quality standards. [Note: Although this regulation is referred to as a "policy," it is a promulgated regulation, and, therefore, is a potential ARAR as opposed to a potential TBC.]	A	This activity is a potential ARAR for activities which would effect or which occur in areas which meet the definition of a wetland (see Virginia Wetlands Act above).

Table 4-10
Summary of Potential Federal and State Miscellaneous ARARs
St. Juliens Creek Annex (SJC)

Federal or State Citations	Requirements Synopsis	Applicability	SJC Situation Comment
Federal Clean Water Act: Section 404			
Clean Water Act Section 404 40 CFR 230	Regulates activities that dredge in or dispose of dredged materials (spoil) in navigable waters of the US. The degradation Section requires that degradation or destruction of wetlands and other aquatic sites be avoided to the extent possible. Dredged or fill material must not be discharged to navigable waters if the activity: contributes to the violation of Virginia water quality standards; violates any toxic effluent standard (CWA Sec. 307); jeopardizes endangered or threatened species; or violates Title III of the Marine Protection, Research, and Sanctuaries Act of 1972. If wetland has been severely degraded due to prior discharges of waste, dredging activities conducted as part of the remedy would serve as an economic benefit and, therefore, the lead agency would not be obligated under Section 404 to mitigate the impacts which preceded the remedial fill operation. Dredging actions that impact a wetland and cannot be avoided or minimized, enhancement, restoration, or creation of another wetland may be required.	A	This regulation may be an ARAR for sites at SJC that conduct the following activities: • Dredging of a contaminated river or marine sediment; • Capping of a site; • Disposal of dredged materials in surface water, to include wetlands; and • Excavation to contain effluent.

SECTION 5.0

Investigation Tasks

This section details the technical approach to perform the RI activities at St Juliens Creek Annex. FSs are discussed in Section 6.0 of this document. The technical approach is broken into major tasks. General procedures for conducting these tasks are presented in this section, while information on the procedures for the collection and analysis of samples are presented in the Master FSP and Master QAPP documents, respectively. The tasks included in the technical approach are listed below. Details of sample locations, sampling methods, and sample analyses will be presented in the site-specific FSPs and QAPPs.

Task 1:	Project Planning
Task 2:	Fieldwork Support
Task 3:	Field Investigation
Task 4:	Sample Analysis and Data Validation
Task 5:	Risk Assessment
Task 6:	RI Report
Task 7:	Evaluating SSAs

5.1 Task 1: Project Planning

This task includes project management, project meetings, the preparation of site-specific plans for each area of investigation at St. Juliens Creek Annex. The site-specific plans will be based on the MP, which addresses the future RI/FS and SSA activities in a general sense. The site-specific plans will supplement each MP and will present information specific to each new area of investigation. The site-specific plans are used in conjunction with the MP at each site.

5.1.1 Work Plan

The Master WP encompasses a broad range of anticipated activities at RI/FS sites and provides the background information needed to understand site conditions and the approach to be used for the RI/FS process. A site-specific work plan will include the following information:

- Site background information that focuses only on the area of investigation, rather than the entire Base, including a description of past investigations conducted at the site
- Information concerning the site's environmental setting including site-specific geology and topography and the water table elevation at the site.
- A map illustrating the area of investigation in relation to the entire Base
- A description of the field investigation and activities to be performed at the site, including methods and locations of drilling and sampling and types of analyses to be performed
- A map displaying boring and sample locations
- A description of the feasibility study tasks to be performed at the site

- A section explaining staff organization and task order management
- A task order schedule

5.1.2 Sampling and Analysis Plan

The Master SAP consists of a Master FSP, a Master QAPP, and a Master IDWMP.

The Master FSP will be referenced during field activities as general guidance for all sampling and data collection activities. A site-specific FSP will include the following information:

- A detailed description of the field procedures and practices to be used at the site, including the types of activities to be performed; locations, methods, depths, and dimensions of drilling; locations, methods, types, depths, and frequency of sampling; Quality Control (QC) sampling; sample designation/identification; parameters for sample analyses; types of monitoring equipment to be used; and decontamination procedures
- A map displaying boring and sample locations
- A table indicating the depths of monitoring wells and their associated lithology/geologic unit (if applicable)
- A table organizing information for the site sampling program (i.e., sample name, location, parameters for analysis)
- An attachment including the SOPs for field activities conducted at the site, including but not limited to those activities listed above
- Site-specific changes to protocol established in the Master FSP as needed

The Master QAPP describes the general Quality Assurance/Quality Control (QA/QC) procedures used when performing sampling activities. A site-specific QAPP will include the following information:

- A brief summary of site background information and the sampling objectives at the site
- A list of the Data Quality Objectives
- A brief description of the sample collection procedures (referencing the site-specific addendum to the FSP for further detail)
- A list of monitoring equipment to be used in the field (referencing the site-specific addendum to the FSP for details of operation and calibration)
- A summary of samples, including QC samples, to be submitted to the laboratory and of the analyses to be performed on the samples
- Site-specific changes to protocol established in the Master QAPP as needed

The Master IDWMP describes methodologies and procedures that field personnel of environmental contractors on St. Juliens Creek Annex will implement to characterize, handle, manage, and dispose of all investigation-derived waste (IDW) during RI/FS or SSA field activities. A site-specific IDWMP will include the following information:

- A list of site-specific sampling parameters

- Specific areas on site to stockpile IDW until the field activities are completed and sampling analytical results have returned
- Site-specific changes to protocol established in the Master IDWMP as needed

5.1.3 Health and Safety Plan

The Master HASP presents the conditions and hazards known or anticipated to be present on St. Juliens Creek Annex. The Master HASP addresses safe working procedures, general restrictions that will apply to the Base work, and potential human exposure to hazardous substances and the toxicological effects of these substances. A site-specific HASP will include the following information:

- Details of task order information such as task number, task manager, dates of initial site visits, and field work start date
- A map of the area of investigation in relation to the entire Base
- A description of the task organization, including names and phone numbers of the project manager, field team leader, subcontractors, contractors, and additional field team members not already listed in the Master HASP
- A table containing site-specific hazards and contaminants of concern not already listed in the Master HASP and information on their symptoms, controls, and exposure limits
- A description of activities to be performed in the field, the level of personal protection expected, and a complete list of personal protective equipment required to perform the activities at this level
- A description of the monitoring equipment required during field activities, action levels, how often to take readings from the equipment, and how often to calibrate the instruments
- A list of emergency equipment not already included in the Master HASP
- Environmental contractor's field cellular phone number and any emergency contacts/telephone numbers not already included in the Master HASP
- MSDSs for the chemicals used on site and the site's contaminants of concern
- Directions to and the point-of-contact (POC) for the hospital

5.1.4 Meetings

During the course of future investigations, meetings will be necessary to discuss proposed project schedules and findings with the Restoration Advisory Board (RAB), the regulatory community, and Navy personnel. The environmental contractor will provide minutes of the meetings to LANTDIV.

5.1.5 Project Management

Project management will include overall coordination of all work to be performed at St. Juliens Creek Annex. Management structures for Base environmental contractors involved in multiple Contract Task Orders (CTOs) should be designed such that there is one central administrative point of contact, the Activity Manager, and multiple Technical Task Managers who will manage each technical task as their expertise is required. The Activity Manager will maintain

close contact with LANTDIV Navy Technical Representative (NTR). The NTR will also keep the USEPA Remedial Project Manager (RPM) and VDEQ Federal Facilities Project Officer informed of project progress and discuss with them any issues which need to be resolved with respect to the RI/FS activities at St. Juliens Creek Annex. Figure 5-1 presents the project organization.

The Activity Manager will oversee and coordinate each project to maintain the overall project schedule and coordinate the Monthly Progress Report effort. In addition, the Activity Manager and the Technical Task Managers will conduct weekly internal program review meetings to update all Team members on individual project status and upcoming technical needs and to discuss technical issues which may impact the course and/or completion of other technical tasks. After the weekly internal review meetings, the Activity Manager will relay the pertinent issues to the LANTDIV NTR via weekly teleconferences. The Activity Manager will also provide general program support, interaction with the client and regulatory agencies, and documentation of decisions on technical issues which may affect future work at St. Juliens Creek Annex.

Responsibilities for the Technical Task Managers include such activities as daily technical support and oversight, budget and schedule review and tracking, personnel resources planning and allocation, and project-specific coordination with LANTDIV, the Activity and subcontractors.

The following responsibilities will be shared by the Activity Manager and the Technical Task Managers:

1. Monitoring technical, cost, and schedule performance,
2. Orchestrating the environmental contractor's overall QA efforts - audit, document reviews, cost/schedule reviews - with the Program Manager, audit and senior technical staff,
3. Maintaining close ties with the LANTDIV NTR.

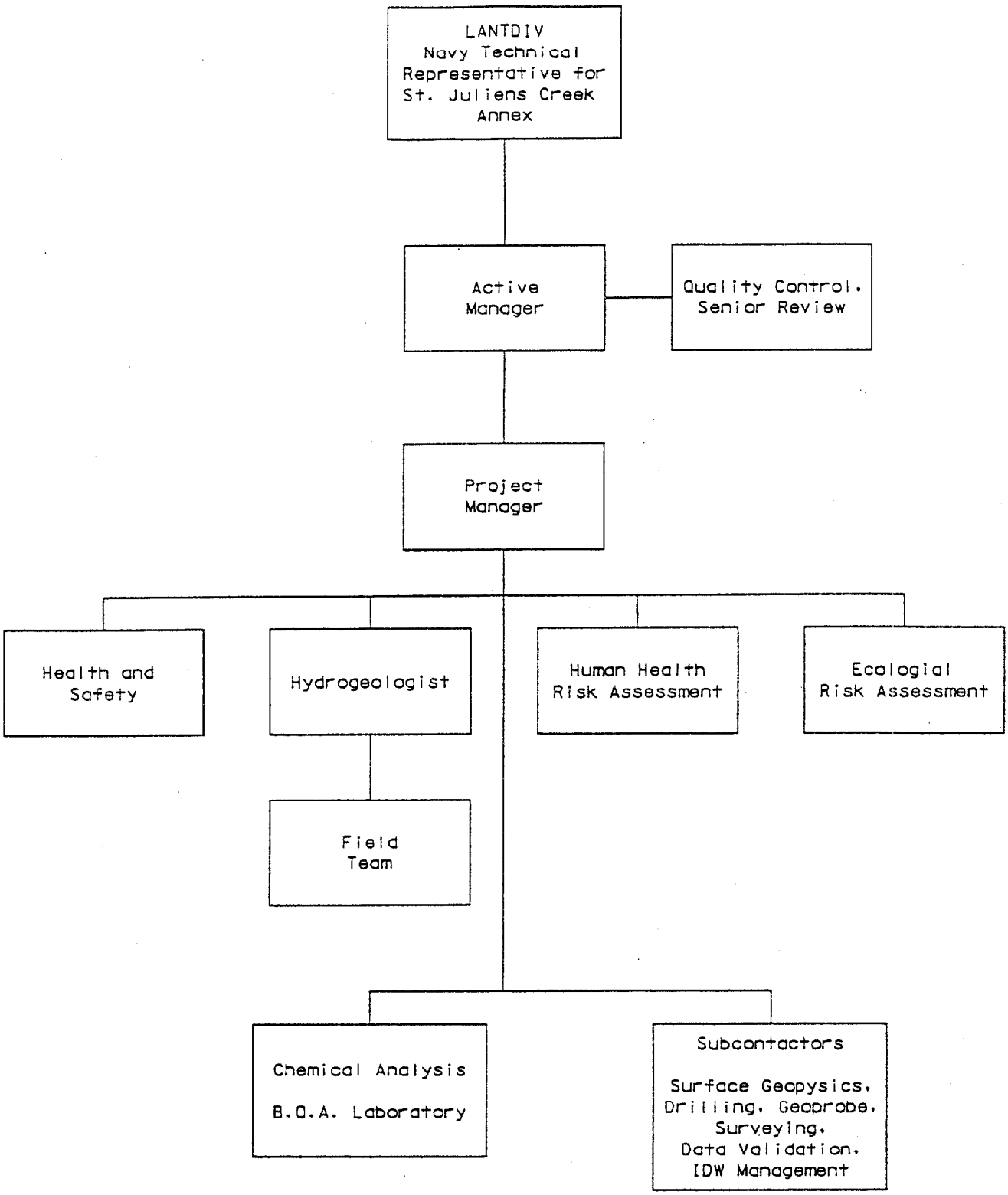
5.2 Task 2: Fieldwork Support

This task consists of Subcontractor Procurement, Mobilization/Demobilization, and Utility Clearance procedures.

5.2.1 Subcontractor Procurement

Base environmental contractors will procure services for a wide variety of tasks including drilling, well installation, environmental sampling, soil gas surveys, geophysical surveys, land surveying, laboratory analyses, data validation, and IDW disposal services. The subcontracted analytical laboratories will meet Naval Facility Environmental Service Center (NFESC) Level D quality control.

Environmental contractors shall procure firms that provide these services by using Basic Ordering Agreements (BOAs). Many BOAs have already been established with various subcontractors. In cases where BOAs are not in place for services required, or at such a time when the Navy shall consider it appropriate to establish new BOAs, the environmental contractor will provide subcontractor services in accordance with procedures that will be established between the environmental contractor's contract administrator and LANTDIV's contracting officer.



CDM Federal Programs Corporation

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FIGURE 5-1
PROJECT ORGANIZATION
St. Juliens Creek Annex

5.2.2 Mobilization and Demobilization

Mobilization includes the procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be shipped to the environmental contractor's field team before field activities begin.

Demobilization activities include those necessary for the general restoration of the site prior to the return transport of field equipment and crew. Equipment will be recalibrated and stored subsequent to the field effort.

5.2.3 Utility Clearances

Utility clearances will be performed at each site on St. Juliens Creek Annex before the start of any subsurface investigation activities. The environmental contractor will coordinate subsurface utility clearances with the Miss Utilities group and the Public Works Center (PWC) at the Base. The environmental contractor will be responsible for ensuring that all appropriate contacts have been made with base personnel, that clearances have been given for proposed drilling locations, and that all utilities will be marked near the areas of potential drilling prior to the initiation of field operations.

5.3 Task 3: Field Investigation

Field activities which may be included in one or more site investigations include:

- Geophysical surveys
- Soil gas surveys
- Surface water sampling
- Sediment sampling
- Surface soil sampling
- Soil boring drilling
- Subsurface soil sampling
- Monitoring well/drive point installation
- Monitoring well abandonment
- Direct push groundwater, soil, and soil gas sampling (Geoprobe®)
- Groundwater sampling
- Aquifer testing
- Hydrologic measurements
- Biota sampling
- Trenching
- Drum sampling
- Land surveying
- Investigation derived waste sampling.

The SOPs for these activities are included at the end of the in the Master FSP, and a general description of the above activities is presented in Section 3.0 of the Master FSP. Other specialized field activities may also be required in unusual cases (e.g., cultural resources evaluation). SOPs for specialized activities will be attached to the site-specific FSPs.

Specific field activities required for different investigations will be listed on the FSP site-specific checklists. The checklists will reference the SOPs for these activities. Page numbers

will be noted when the SOPs are referenced so that the SOPs may be easily accessed. Details of sample locations, sampling methods, and sample analyses will be presented in site-specific SAPs and site-specific WPs.

5.4 Task 4: Sample Analysis and Data Validation

The environmental contractor will be responsible for tracking sample analyses and obtaining results from the laboratory. The analytical data generated during RI and SSA field programs will be validated by an independent data validator following NFESC guidance.

5.4.1 Sample Analysis

All analyses of soil, groundwater, surface water, and sediment will be conducted at a contracted laboratory that fulfills all requirements of the NFESC Navy Installation Restoration Laboratory Quality Assurance Guide (February 1996), EPA's Contract Laboratory Program, or at a laboratory that is approved by the US Army Corps. A signed certificate of analysis will be provided with each laboratory analysis, along with a certificate of compliance certifying that all work was performed in accordance with the applicable federal, state, and local regulations. All analyses will be performed following NFESC guidance.

5.4.2 Field Quality Control Procedures

Quality control duplicate samples and blanks are used to provide a measure of the internal consistency of the samples and to provide an estimate of the components of variance and the bias in the analytical process.

5.4.2.1 Blanks

Blanks provide a measure of cross-contamination sources, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. American Society of Testing Materials (ASTM) Type II water will be used for blanks. Three types of blanks will be generated during sampling activities: trip blanks, field blanks, and equipment blanks.

One trip blank will be included in each cooler containing samples for VOC analysis. Pre-prepared trip blanks will be obtained from the laboratory, if possible. Otherwise, the trip blanks will be prepared prior to each sampling event, shipped or transported to the field with the sampling bottles, and sent to the laboratory unopened for analysis. Trip blanks will not be prepared or handled in the field. Trip blanks will indicate if any contamination occurred during shipment to the field, field storage, or during shipment from the field to the analytical laboratory.

One field blank will be collected per source, per sampling event, or daily during very windy or dusty conditions. The field blanks will indicate if any contaminants were introduced during the handling of the sample containers in the field or during sample analysis at the laboratory. The sample container will be filled with ASTM Type II water in the field at the time of sampling. This is the same source of water used in decontamination and steam cleaning. Pre-preserved bottles will be obtained from the laboratory, if possible. Otherwise, preservatives will be added in the field. Field blank sample containers will be capped, packed, and shipped with the samples.

One equipment blank will be collected and analyzed every day during sampling activities. The equipment blanks will indicate the efficiency of equipment decontamination procedures. Pre-preserved bottles will be obtained from the laboratory, if possible. Otherwise, preservatives will be added in the field. Equipment blank sample containers will be capped, packed, and shipped with the samples.

5.4.2.2 Duplicates

Field duplicate samples will be collected at a frequency of 1 per 10 field samples per matrix. Duplicates are collected from locations where the greatest amount of contamination is suspected. The duplicate sample will be submitted for analysis as an independent sample. The sample and its duplicate will be numbered non-sequentially. Duplicates for soil (excluding VOCs) should be homogenized first

5.4.2.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at a frequency of 1 per 20 field samples. Analytical results of these samples indicate the impact the matrix (water, soil, sediment) has on extracting the analyte for analysis. Data validators will use these results to evaluate the accuracy and precision of the analytical data.

5.4.3 Data Validation

The data validation will be performed by an independent subcontractor and will conform to the NFESC and EPA guidance. Validation subcontractors will follow EPA Region III Modifications to the National Functional Guidelines for Organic and Inorganic Data Review. All data from analytical laboratories will be validated before the project staff finalizes their interpretation. Non-Contract Laboratory Program (CLP) analyses will be validated using the Region III modifications as appropriate and professional judgement.

5.4.4 Data Management and Evaluation

Environmental analytical samples and various types of field data will be collected during field investigations at St. Juliens Creek Annex. This information will ultimately be used to determine the risk to human health and the environment and to support decisions for remedial action. The environmental contractor will employ an environmental data management system (EDMS) to manage information collected from St. Juliens Creek Annex sites. The EDMS will provide an accurate, structured, easily accessible data set.

Data will be analyzed and graphically presented in reports and for meetings using computer-aided drafting and design (CADD) and/or geographic information system (GIS) technology. Where GIS technology is utilized, geologic, analytical, and geographical data will be converted to a GIS format to allow for two and three-dimensional data evaluation and visualization. By using GIS technology the environmental contractor will be able to prepare such data analysis products as geologic cross sections, fence diagrams, chemical isoconcentration maps, water table maps, three dimensional block diagrams, and well construction diagrams.

5.5 Task 5: Risk Assessment

This task includes the preparation of a Baseline Risk Assessment (BRA). A BRA will be developed for each RI/FS site located at St. Juliens Creek Annex and will consist of a baseline

human health risk assessment and a baseline ecological risk assessment. The risk assessments will be conducted in accordance with current EPA national and Region III guidelines.

The BRA will identify existing or potential risks to human health and/or the environment and will provide valuable input to the development and evaluation of remedial alternatives during the FS. The following sections present a general approach for conducting both elements of the BRA.

5.5.1 Baseline Human Health Risk Assessment

Human health assessments will be conducted in accordance with the NCP (USEPA, 1990b). The primary guidance document for all human health assessments will be the Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A) Interim Final (USEPA, 1989d). Other EPA Risk Assessment guidance documents will be used including RAGS D - Standardized Planning, Reporting, and Review of Superfund Risk Assessments (USEPA, 1998).

In addition to EPA RAGS guidance, the Navy will also follow a tiered risk assessment approach. The tiered approach is intended to simplify and streamline risk assessments. The first tier (Tier I), consists of risk-based screening where concentrations of site contaminants are compared to Risk-Based Screening Concentrations (RBCs), Preliminary Remediation Goals (PRGs), Soil Screening Values and/or Maximum Concentration Levels (MCLs). Those chemicals which are retained after the screen are then evaluated using site-specific screening values developed in concert with the EPA site toxicologist (Tier IIA). The chemicals which remain are then evaluated in a full baseline risk assessment (Tier II B). The last tier, Tier III, is a calculation of the risk associated with implementing a remedial action. In order for this approach to be successful, communication with the EPA toxicologist assigned to the site is essential, throughout the process.

As defined in these reference documents, the human health evaluation contains five fundamental sections. These are the hazard assessment, which includes the selection of chemicals of potential concern; the exposure assessment; the toxicity assessment; the risk characterization; and the uncertainty assessment. Consensus agreements developed by the Norfolk Partnering Team Human Health Risk Assessment Subgroup are being used for Sites 2, 3, 4, and 5, as discussed with EPA during development of the work plans for these investigations. The Subgroup consisted of risk assessors from the Navy, CH2M HILL, Baker Environmental, EPA, and VADEQ. These consensus agreements are also provided for EPA review in Appendix A of this Master Work Plan. Upon approval of this Master Work Plan, these agreements will be used in future Site Human Health Risk Assessments.

5.5.1.1 Hazard Assessment

The hazard assessment includes an evaluation of available analytical data and the selection of chemicals of potential concern (COPCs). The evaluation of available analytical data results in the identification of the data set to be used in the risk assessment. This evaluation includes a review of the quality of the data and the identification of data gaps and uncertainties associated with the data. In order to determine which constituents are COPCs, the maximum detected concentrations will be compared to risk-based concentrations (RBCs) or other screening levels. The primary selection criteria for COPCs will be the EPA Region III guidance *Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening,* dated January 1993. Region III COC levels have been established for tap water and soil. The document references a Region III RBC table that is periodically updated as new toxicological information

becomes available. The most recent revision of this table will be used in determining the COPCs at a site.

The identification of COPCs in surface water will be made by comparing the maximum detected concentrations to the Federal Ambient Water Quality Criteria (AWQCs) and Virginia Water Quality Standards. Constituents detected in sediment will be evaluated for inclusion as COPCs using the approach discussed in the Region III RBC Table and exposure assumptions agreed to by the Navy and EPA. Site specific exposure assumptions previously developed for Naval Base Norfolk in Consensus Agreement No. 6.A.4 are shown in Appendix A. This agreement was reached by the Naval Base Norfolk Partnership in order to provide guidance for the selection of COPCs for sediments while conducting human health risk assessments for sites at Naval Base Norfolk. A similar approach may be used at St. Juliens as part of the Tier II.

The inclusion of lead as a COPC in soil, sediment, and groundwater will use the screening values agreed to by the Navy and EPA. Consensus agreement 6.A.6 shown in Appendix A is the agreement reached by the Naval Base Norfolk Partnership in order to provide guidance for evaluation of lead as a COPC, while conducting human health risk assessments for sites at Naval Base Norfolk. A similar approach may be used at St. Juliens.

5.5.1.2 Exposure Assessment

The objective of the exposure assessment is to evaluate potential exposure to site-related COPCs present at, or migrating from, the sites based on reasonable maximum exposure. Exposure assessment involves three steps: 1) characterization of exposure setting with respect to the physical characteristics of the site and populations on or near the site, 2) identification of exposure pathways, and 3) quantification of exposure which includes estimation of exposure concentrations and calculation of intakes.

Characterization of the exposure setting consists of two components, 1) characterization of the site with respect to physical characteristics, and 2) characterization of the site with respect to human populations on or near the site. This information is needed to identify potential current and future exposure pathways and exposure points.

Potential exposure pathways will be identified for each site. An exposure pathway is defined as the path a chemical travels from its source to an exposed organism. A complete exposure pathway includes a source and a mechanism for chemical release, a retention or transport medium, an exposure point, and an exposure route. Complete or potentially complete pathways will be selected for quantitative evaluation in the risk assessment.

After the exposure pathways are identified, the exposure is quantified. This process involves two steps, estimating the chemical concentration at the exposure point, and quantifying pathway specific intakes by developing exposure scenarios to estimate the amount of contaminants that a hypothetical receptor may ingest, inhale, or absorb.

The exposure concentration is the concentration at the point of contact. It can either be measured directly (i.e., soil concentration) or calculated using fate and transport models. The upper 95 percent confidence limit on the mean (95% UCL) will be used as the exposure concentration. The distribution of the data must be determined prior to calculating the 95% UCL. The W-test will be used to determine if the data fit a normal or lognormal distribution. The 95% UCL will then be calculated based on the distribution of the data.

To quantify pathway specific intakes, exposure parameters, such as media contact rates, exposure frequency, and human body weight, are needed for the potentially exposed populations. When available and applicable, exposure parameter values will be selected from

USEPA risk assessment guidance. Site specific information and professional judgment will also be used in the exposure parameter selection process.

The quantification of exposure is based on an estimate of the average daily intake. The following equation is used to estimate chemical intake:

- Intake = (C x CR x EF x ED) / (BW x AT)

Where:

Intake = average daily intake (mg/kg/day)
C = concentration of chemical (mg/kg or mg/L)
CR = contact rate (mg/day or L/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)

5.5.1.3 Toxicity Assessment

The toxicity assessment will evaluate the toxic effect(s) for each selected COPC. Toxicity indices (i.e., numerical values derived from dose-response toxicity data for individual compounds) will be obtained from the following sources:

- Integrated Risk Information System (IRIS, USEPA, 1993c and as updated)
- Health Effects Assessment Summary Tables (HEAST, USEPA, 1993b and as updated)
- Other USEPA sources such as USEPA National Center for Environmental Assessment (NCEA)

Toxicity indices that will be used for risk assessment include reference doses (RfDs) to evaluate noncarcinogenic effects and carcinogenic slope factors (CSFs) to evaluate carcinogenic endpoints.

5.5.1.4 Risk Characterization

Risk characterization combines the results of the hazard assessment, exposure assessment, and toxicity assessment to produce a quantitative estimate of current and potential future risks to human health. Estimates of carcinogenic risks and noncarcinogenic hazards will be calculated for each COPC for each complete exposure pathway. The equation to calculate noncarcinogenic hazard is as follows:

- Noncarcinogenic Hazard (HQ) = Intake/RfD

Where:

HQ = hazard quotient
Intake = average daily intake (mg/kg/day)
RfD = reference dose (mg/kg/day)

The individual chemical hazard quotients (HQs) will be summed for an exposure pathway to calculate the hazard index (HI). HIs may be summed across exposure pathways to determine the total hazard index to an exposed population due to site related contamination. HI values equal to or greater than 1.0 indicate the potential for noncarcinogenic health effects to occur.

Carcinogenic risk is calculated as follows:

- Carcinogenic Risk = Intake x CSF

Where:

Risk = probability of an individual developing cancer
Intake = average daily intake (mg/kg/day)
CSF = cancer slope factor $(mg/kg/day)^{-1}$

Risk estimates will be summed by media for all sites. Risks will also be summed across media and exposure pathways, where appropriate. Risk estimates will be compared to USEPA's target risk range of 1×10^{-6} to 1×10^{-4}, which is considered to be generally acceptable at most sites.

5.5.1.5 Uncertainties

Uncertainty in risk assessment may arise from many sources, including:

- Environmental sampling and analysis.
- Use of standardized input parameters or professional judgment in the exposure assessment.
- Lack of available toxicological indices and uncertainty in deriving RfDs and CSFs.
- Assumptions of additivity in the risk characterization.
- Comparison to naturally occurring or background levels.

The uncertainty analysis will assess non-site and site-specific factors that may produce uncertainty in the risk assessment.

The use of Monte Carlo analysis will be conducted for carcinogenic risks which only slightly exceed the upper end of USEPA's target risk range and noncarcinogenic hazards which slightly exceed 1.0. The use of Monte Carlo analysis will provide USEPA and State decision makers with information pertaining to the conservatism associated with the use of the Reasonable Maximum Exposure (RME) to describe site specific conditions. USEPA Region III publications (February 1994) will be used as guidance in the performance of the quantitative evaluation of uncertainty.

5.5.2 RI Baseline Ecological Risk Assessment

This section documents the technical approach to the ERA. The approach outlined below addresses both the screening ERA (Steps 1 and 2 of the ERA process) and the baseline ERA (Steps 3 through 8 of the ERA process). A baseline ERA will be conducted at an individual site only if the results of the screening ERA warrant (US Navy 1999).

5.5.2.1 Screening ERA

The screening ERA will include site descriptions, nature and extent of contamination, contaminant fate and transport mechanisms, mechanisms of toxicity, exposure pathway evaluation, preliminary conceptual model (including endpoints and potential receptors), exposure estimates (food chain), and screening-level risk calculations. A discussion of the uncertainties associated with the screening ERA will also be included in the screening ERA report as will site-specific conclusions based on the results of the screening ERA.

General Objectives of the Screening ERA

The general objectives of the screening ERA are:

- To screen individual sites to determine if additional ecological risk assessment is warranted (beyond Steps 1 and 2 of the USEPA ERA guidance) or to eliminate specific sites from further consideration.
- To screen the receptors, media, and chemicals at individual sites to determine if additional evaluation is warranted or to eliminate them from further consideration.
- To identify any data gaps that may require the collection of additional data.

General Methodology for the Screening ERA

The proposed approach to achieve these objectives is as follows:

- Individual sites will be evaluated in separate screening ERA documents which will be performed concurrently. The screening ERAs for individual sites will be consolidated for reporting purposes; any additional data collection deemed necessary will also be coordinated among sites as appropriate. However, individual sites may follow different schedules after completion of the screening ERA as appropriate to the results and recommendations of each screening ERA and the resulting risk management decisions.
- Data to be evaluated in the site assessments will be site-specific and based upon the conceptual site model developed for each specific site. Fate and transport of contaminants will be considered in the conceptual site model, as necessary for the appropriate site-specific media. Preliminary sampling results may indicate the need to revise the conceptual site model to evaluate additional downgradient contaminant migration and/or contaminant concentration trend analysis.
- Sites may be considered collectively in later stages of the assessment if they are sources to similar downgradient areas. This will be decided on a case-by-case basis.
- The data table will include reporting limit range, frequency of detection, maximum contaminant detected, sample ID of maximum concentration detected, arithmetic mean, standard deviation, screening values, frequency of exceedance, and maximum hazard quotient. This table will be formatted similar to the tables developed for the Tier II Ecological Workshop.

Media and Existing Analytical Data Considered in the Screening ERA

The media and analytical data to be considered in the screening ERA are described in the following subsections.

Media

- The media to be included in the assessment are surface soil (0 – 6 inches), groundwater, surface water, and surface sediment.

Analytical Data

- Analytical data are expected to be available for each site and all of the media noted above. TCL / TAL metals data will be available for all environmental samples. Dioxin data is also available for representative samples collected in areas where

burning activities occurred historically. All of this data will be used in the screening ERA.

- All data to be used in the screening ERA are validated. Where warranted, unvalidated data may be considered on a qualitative basis.
- In general, only data from the remedial investigation sampling conducted at a site for each chemical group will be considered. For groundwater and surface water, samples from the most recent one-year period will be considered to account for potential seasonal variation. Data from geoprobe sampling and temporary groundwater wells will not be considered.
- Surface soil or sediment data collected prior to any major physical disturbance (such as capping or dredging) will not be used in the screening ERA.
- For surface soil, samples collected from depths up to 6 inches will be used preferentially. Data from deeper depths (e.g., 0 to 12 inches) will be considered if surface soil data are limited.
- For sediment, samples from depths of 0 to 6 inches are preferred. Samples from depths of 0 to 12 inches will be considered if shallower data are unavailable or limited.
- For surface water and groundwater, total (unfiltered) metal concentrations will be used during the initial screening.
- The rationale for selecting the specific samples used in the assessment of each site will be provided. The locations of the selected samples will be shown on figures included in the draft screening ERA report.
- Data gaps will be identified on a site-by-site basis and additional data collection activities will be proposed where data gaps exist.

Step 1 Screening Values

The screening values proposed for use in Step 1 of the screening ERA are described below.

- Medium-specific screening values will be used during Step 1 of the screening ERA based on the following hierarchy:
  - LANTOPS Alternate Screening Values developed as part of the Norfolk Naval Ship Yard (NNSY) assessment, as tentatively approved by the EPA Region III BTAG, will be used as part of the screening ERA. BTAG approval of these values will be confirmed prior to their use.
  - LANTOPS Alternate Screening Values developed for this assessment as replacements for a specific BTAG Region III Screening Level or for chemicals for which BTAG Region III Screening Levels are unavailable. The rationale for the use of the alternate screening values will be provided.
  - BTAG Region III Screening Levels will be considered where available for specific media and analytes.

- If available prior to the beginning of the screening ERA, the revised set of BTAG Screening Levels (currently under development by USEPA) will be considered for use.
- All screening values that differ from Region III BTAG Screening Levels and which have not been previously approved by the regulators will be submitted (along with the rationale for their use) to the regulators for concurrence prior to their use in the screening ERA.
- Screening values will be adjusted, where appropriate, based on modifying factors such as hardness or total organic carbon.
- Where appropriate, total undiluted groundwater concentrations in perimeter wells will be compared to surface water screening values to provide a conservative assessment; the surface water screening values to be used (freshwater or marine) will be matched to the type of water body to which the groundwater would likely discharge to. Dilution factors and dissolved concentrations (for metals) may be considered in subsequent steps of the ERA to provide a more realistic estimate of exposure.

Step 2 (Food Chain Model) Considerations

- Not all detected chemicals will be evaluated in Step 2 of the ERA (food chain exposures). Only chemicals which exceeded the Step 1 screening values will be evaluated in this step. A separate technical memo will be provided outlining this "Step 2" list of chemicals and the rationale for its derivation.
- Exposure estimates for Step 2 (food chain) will be based on conservative bioaccumulation factors developed from the literature. A default factor of 1.0 will be used when data are unavailable for a chemical in the literature.
- The receptor species used in the screening ERA will be selected to represent only complete exposure pathways identified in the conceptual model. No effort will be made to evaluate all possible pathways.
- Only conservative assumptions will be used (i.e., area use factor of one, maximum ingestion rate, minimum body weight, maximum media concentration).

Results of the Screening Process

The results of the screening ERA will be used to evaluate the status of each individual site in terms of potential ecological risk. Following the screening ERA, possible decision points are (1) no further action is warranted; (2) further action is warranted; (3) further data are required; or (4) take remedial action. These possible decision points are described in more detail below.

- **No further action is warranted.** This decision is appropriate if the screening ERA indicates that sufficient data are available on which to base a conclusion of no unacceptable risk.
- **Further evaluation is warranted.** This decision is appropriate if the screening ERA indicates that there is the potential for unacceptable risks for some pathways, receptors, and chemicals. In this instance, the ERA would progress to Step 3 wherein the risk estimates would be refined based on more realistic and site-specific assumptions and data.

- **Further data are required.** This decision is appropriate if the screening ERA indicates that there are insufficient data on which to base a risk estimate. This decision may also be appropriate if the potential for unacceptable risks is identified following the screening ERA and additional data to refine these estimates (e.g., additional analytical data, measures of bioavailability, etc.) are needed for Step 3.
- **Take remedial action.** This decision may be appropriate for sites in which the potential for unacceptable risks was identified following the screening ERA but these potential risks could best be addressed through remedial action (e.g., presumptive remedy, soil removal) rather than additional study.

Recommendations pertaining to these possible decisions will be made for each site as part of the draft screening ERA report.

5.5.2.2 Baseline ERA

If the results of the screening ERA suggest that further ecological risk evaluation or data collection is warranted for a particular site, the ERA process would proceed to the baseline ERA which is a more detailed phase of the ERA process (Steps 3 through 8).

General Methodology for the Baseline ERA

The first activity of the Baseline ERA is the refinement of the risk estimates from the screening ERA (Step 3a). Potential risk estimates will be refined using a focused conceptual model based on more realistic and site-specific exposure assumptions, site-specific data, and/or detailed literature review. The focused conceptual model will include refined assessment endpoints, exposure pathways, and risk questions or hypotheses. The Step 3a evaluation may also include considerations of background and sample detection frequency. At the conclusion of Step 3a, data are evaluated for each assessment endpoint to determine if the uncertainties associated with the refined risk estimates for the site are acceptable to proceed to risk characterization (Step 7) or whether the uncertainties are unacceptable and require site-specific studies (Steps 4 through 6).

The specific actions that would need to be taken to continue the development of the baseline ERA based on the refined risk estimate will not be known until the completion of the refined assessment. If it is decided that site-specific studies are required, these studies will be identified during the completion of Step 3 (Step 3b), the project planning and study design / verification phase of the Baseline ERA. During this phase the required elements of Steps 4 through 6 will be developed.

Step 7 (Risk Analysis, Characterization, and Conclusions) consists of the documentation and synthesis of the information and data identified in Steps 1 through 6. In this step, risk is evaluated and characterized using both quantitative and qualitative methods. Conclusions are made on whether or not there is a reasonable potential for unacceptable ecological risk at the site, and if there is a potential for ecological risk, the magnitude of that risk.

Results of the Baseline ERA Process

Possible decision points based on the results of the baseline ERA are evaluated in Step 8 of the process and involve risk management decisions. Possible decision points include:

- **No further action is warranted.** This decision is appropriate if the baseline ERA indicates that there is no reasonable potential for unacceptable ecological risk within acceptable uncertainty.

- **Evaluate the need for remedial action.** This decision is appropriate if the baseline ERA indicates that there is a reasonable likelihood for unacceptable ecological risks within acceptable uncertainty. Whether or not remedial actions are taken will depend upon a number of risk management factors such as the results of any human health risk assessments and the potential impact of the remedial action itself on the habitats and biota present on the site.

Recommendations pertaining to these possible decision points will be made for each site as part of the draft baseline ERA report for those sites for which a baseline ERA is warranted.

5.6 Task 6: RI Report

RI reports will be prepared for each site or group of sites as deemed necessary. The RI reports will include, as appropriate, site maps with sampling locations, boring logs, cross sections, validated analytical data, and figures that depict the extent of soil and groundwater contamination. The reports will document recommendations and supporting information to justify the recommendations. The information collected and presented in the RI reports will be used to prepare FS documents. RI reports will include the following sections:

- Executive Summary
- Introduction and Site Background
- Geology and hydrogeology
- RI Activities
- Sampling and Analytical Methods
- Presentation and Evaluation of Analytical Data
- Nature and Extent of Contamination
- Contaminant Fate and Transport
- Risk Assessment
- Conclusion

5.6.1 Executive Summary

The executive summary should provide a brief overview of the findings of the RI. This information will inform decision-makers up front of the contaminants detected at the site and whether contamination is moving, how fast, and in what direction. The summary will also discuss whether the contaminants detected are consistent with the suspected source of contamination. These pieces of information will help decision makers to determine how well the site has been characterized and whether the data are sufficient for use in the baseline risk assessment and feasibility studies. As such, the RI report directly feeds the baseline risk assessment, the feasibility study, and risk management decision-making.

5.6.2 Introduction and Site Background

The introduction will present the objectives of the RI and introduce the information to be found in the report. Information concerning the site background will include a brief description of the site's history and a discussion of the results of previous investigations.

5.6.3 Geology and Hydrogeology

This section will include a description of both regional and site-specific geology, including detailed discussions of the site's soil and bedrock. Information obtained during the RI field activities and from previous investigations will be addressed.

The discussion of hydrogeology will include a detailed description of the site's aquifers. Aquifer test and groundwater sampling results will also be discussed. This Section will also include information regarding local and/or state well records (to include domestic wells).

5.6.4 RI Activities

This section will document, in detail, the events and activities that occur on site during the RI. Objectives of the investigation, investigative techniques, sampling locations, and sampling methods will be addressed.

5.6.5 Sampling and Analytical Methods

Details of the RI's sampling program will be presented in this section. The objectives and rationale for the types and locations of sampling and for the analytical methods used will be discussed.

5.6.6 Presentation and Evaluation of Analytical Data

The RI analytical results will be presented in this section. An evaluation of site contamination will be made and discussed in detail.

5.6.7 Nature and Extent of Contamination

The nature and extent of contamination at the site will be discussed in this section. The discussion will focus on the contamination in the different types of media at the site, such as soil, groundwater, surface water, and sediment. Scaled maps indicating the contaminant concentrations in each media will be provided.

5.6.8 Contamination Fate and Transport

This section will combine interpretations of the geology, hydrogeology, hydrology, and nature and extent of contamination at the site into conceptual site models. Each conceptual model will provide a qualitative description of the fate and transport of various contaminants through the media adjacent to the site. Chemical and physical properties of contaminants will be discussed in addition to how these properties affect the fate and transport of the contaminants in soil, groundwater, surface water, and sediment.

5.6.9 Risk Assessment

The Risk Assessment section will consist of a Human Health Risk Assessment and an Ecological Risk Assessment. This section will identify the existing or potential risks to human health and/or the environment and, if appropriate, will include information regarding current and potential use of groundwater as a drinking water source (including local ordinances and information from local water authorities). The RI report will contain a Step 3a Ecological Risk Assessment. Step 3a is the refinement of the risk estimates from the screening ERA. Potential risk estimates will be refined using a focused conceptual model based on more realistic and site-specific exposure assumptions, site-specific data, and/or detailed literature review. The focused conceptual model will include refined assessment endpoints, exposure pathways, and

risk questions or hypotheses. The Step 3a evaluation may also include considerations of background and sample detection frequency. At the conclusion of Step 3a, data are evaluated for each assessment endpoint to determine if the uncertainties associated with the refined risk estimates for the site are acceptable to proceed to risk characterization (Step 7) or whether the uncertainties are unacceptable and require site-specific studies (Steps 4 through 6). If a baseline ERA is required, it will be conducted prior to the initiation of the Feasibility Study.

This Risk Assessment Section will provide valuable input to the development and evaluation of remedial alternatives to the FS.

5.6.10 Conclusion

The conclusion section will consist of the findings of the RI and summarize the information discussed in the report.

5.7 Task 7: Evaluation of Site Screening Areas

SSAs will be addressed separately from the RI/FS sites. SSAs are newly discovered areas at which little or no information is currently available regarding potential media contamination. Each SSA will undergo the Site Screening Process (SSP) including the collection of environmental media samples to be documented in the site-specific addenda to the Master WP. Sections 4.1 through 4.3 of this document present the general information pertaining to field activities that may be performed. The results of the screening evaluation will identify the area as 1) requiring additional investigation, at which time the SSA will become an RI/FS site,or 2) requiring no further study/remediation, or 3) requiring a limited removal action with no further investigation.

Data collected from investigative efforts will be analyzed and validated using NFESC guidelines. Validated data will be entered into a relational database and queried according to media. The maximum concentration detected for each constituent in each media sampled will be used to perform the risk screening as a means of evaluating the potential risks to human health and the environment.

5.7.1 Human Health Risk Screening

The risk screening includes an evaluation of available analytical data and the selection of COPCs.

The maximum concentration detected in each media will be screened to determine the COPC. Screening criteria in USEPA Region III, Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening, EPA/903/R-93-001, January 1993, and USEPA Risk Assessment Guidance for Superfund, Vol. 1, Part A, 1989, will be used to select the COPC. The criteria that will be used for COPC selection are presented below:

- Comparison with Health-based Criteria: The maximum detected chemical concentrations will be compared with risk-based concentrations (RBCs) developed in accordance with USEPA Region III guidance (USEPA Region III, Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening, EPA/903/R-93-001, January 1993). The RBCs will be based on a target hazard index of 0.1 and a target cancer risk of 1x10-6. For soils, saturation concentrations will be calculated and used as the screening value if they are smaller than the RBCs. Chemicals with maximum detected concentrations below the RBC or soil saturation values will not be considered COPC.

- Frequency of Detection: Contaminants that are detected in less than five percent of the samples in a given medium where at least 20 samples have been collected will not be considered COPC.
- Comparison with Background Samples: Constituents present at or below background concentrations will not be selected as COPC. The maximum detected concentration will be compared to the 95 percent upper confidence limit (95% UCL) of background data set. If the 95% UCL of the background data set is greater than the maximum background concentration, the maximum concentration will be used for the comparison.
- Blank Contamination: Common laboratory contaminants that are detected in site samples will only be selected as COPC if their concentration exceeds ten times the maximum concentration in any blank. Constituents that are not common laboratory contaminants that are detected in site samples will only be considered detected and selected as COPC if their concentration exceeds five times the amount detected in any blank. COPC found in blank samples will be considered in the Risk Assessment, as long as the contaminants are associated with past site activities or the suspected source of contamination.
- Comparison with Recommended Dietary Allowances (RDAs): Chemicals which are human nutrients, present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and toxic only at very high doses will be eliminated from the quantitative risk analysis.
- Tentatively Identified Compounds: When only a few tentatively identified compounds (TICs) are present compared to the target analyte list and target compound list chemicals, and no site information indicates that either a particular TIC may be present at the site or that the estimated concentration may be very high, then TICs will not be included in the risk assessment. The rationale for excluding TICs will be included in the risk assessment document.

Constituents that exceed the screen and are selected as COPCs will require additional evaluation.

5.7.2 Ecological Risk Screening

The overall purpose of an ecological risk assessment is to evaluate the likelihood that adverse ecological effects would occur or are occurring as a result of exposure to one or more physical or chemical stressors. This assessment evaluates the potential effects of contaminants on sensitive or critical habitats or environments and protected species. The assessment employs a phased approach to determine potential adverse effects of contamination on the terrestrial and aquatic receptors (e.g., flora and fauna) on or adjacent to each site at St. Juliens Creek. Phase I consists of a comparison of analytical results for soils, surface water, or sediments to available ecological standards or criteria. The Phase I approach is intended to provide an evaluation of the potential ecological effects associated with site contamination. If contaminant concentrations in environmental media exceed appropriate standards or criteria, additional phases of evaluation may be necessary to fully characterize potential ecological effects at a site.

The risk assessment methodologies will be consistent with EPA guidelines for ecological risk assessments. Current guidance includes the following:

- Interim Ecological Risk Assessment Guidelines (USEPA III, Biological Technical Advisory Group 1994)

- Framework for Ecological Risk Assessment (USEPA, 1992)
- Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (USEPA, 1989a)
- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (USEPA, 1989b)
- Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish (USEPA, 1989c)
- Screen contaminants in media at St. Juliens Creek Annex

5.7.2.1 Hazard Screening

The selection of chemical stressors or COPCs is based on frequency of detection, background comparison, calculation of environmental effects quotients, persistence of the contaminant, bioaccumulation potential, and the toxicity of the contaminant. Because of the differential toxicity of some contaminants to ecological verses human receptors, the COPCs for ecological receptors may differ from those selected for the human health risk assessment. Physical stressors including temperature and hydrologic changes and habitat alteration will also be taken into consideration.

Maximum detected concentrations in each media will be screened to determine the COPC. The screening process will use criteria provided in EPA III's screening level guidance. This process uses a determination of environmental effects quotients (EEQs) for screening. EEQs are determined by dividing the criteria into the concentration for that contaminant. Where values exceed 1.0, a potential for risk exists. The higher the EEQ, the greater the potential for risk. In addition to the criteria, comparisons can be made with background data from non-impacted areas near the site being evaluated. To evaluate COPCs during the screening phase, the frequency of detection also will be evaluated. If contaminants are detected in less than 5 percent of the samples for that medium, where at least 20 samples were collected, the contaminants will not be considered as COPCs.

SECTION 6.0

Feasibility Study Tasks

At the conclusion of the RI and BRA, an FS will be conducted in accordance with CERCLA, as amended by SARA. Many of the provisions under CERCLA having the greatest impact on the RI/FS process are contained in Section 121 (Cleanup Standards and State Involvement), Section 104 (Response Authorities), Section 117 (Public Participation), Section 110 (Worker Protection Standards), and Section 113 (Civil Proceedings).

Background information and data gathered during the RI will be used to evaluate various remedial alternatives. The alternatives that provide the most appropriate, cost-effective solutions for site remediation will then be identified. In accordance with CERCLA, remedial alternatives that reduce the toxicity, mobility, or volume of wastes and contaminated materials will be emphasized.

The FS report documents the analyses and evaluations used to develop remedial action alternatives for a site. The information presented in the FS report will be used to select a cost-effective remedial alternative that complies with the requirements of the NCP. The NCP states that a remedy is cost effective if its costs are proportional al to its overall effectiveness [40 CFR 300.430(e)]. The FS Report will include the following information.

6.1 Introduction

The first section of a FS report includes information on the purpose and organization of the report. The FS report is not intended to be a design document; rather, it gives a conceptual overview of remedial alternatives to evaluate their feasibility. The report discusses criteria used to evaluate remedial technologies and to determine the effects of implementing them.

The introduction section will also discuss the site background, geology, hydrogeology, nature and extent of contamination, and human-health and environmental risk assessments for the site.

6.2 Remedial Action Objectives and Technology Screening

This section will present general and site-specific remedial action objectives (RAOs) and identify corresponding ARARs for the site.

General RAOs are defined by the NCP and CERCLA (as amended by SARA), which are applicable to all Superfund sites. CERCLA defines the statutory requirements for developing remedies.

Site-specific RAOs relate to specific contaminated media and to potential exposure routes. Site-specific objectives, which require an understanding of the contaminants and the physical properties in the respective media, are based on an evaluation of the risks to public health and to the environment and the ARARs. The future protection of environmental resources and the means of minimizing long-term disruption of existing facility operations are also considered.

Cleanup goals are established using the results of the baseline risk assessment and established standards or guidelines. The first step in setting cleanup goals is to establish preliminary remediation goals (PRGs) for each media. PRGs are established from RBCs identified in the baseline risk assessment and from frequently used standards (chemical-specific ARARs).

6.3 Development and Screening of Remedial Action Alternatives

In the following section, general response actions are developed to address the RAOs established in the previous section. General response actions are broad classes of responses or remedies developed to meet site specific RAOs. Potential remedial technologies and specific process options are then identified for each response action.

Remedial technologies are the general categories of technologies such as chemical treatment, thermal destruction, or immobilization. Process options are specific process within each technology type. For example, the chemical treatment remedial technology would include such process options as precipitation, ion exchange, and oxidation/reduction.

Technologies and process options that potentially apply are screened initially based on their suitability for specific site characteristics. Site characteristics that generally influence initial screening are the contaminant types, quantities, and concentrations, the physical site conditions.

The remedial technologies that are best suited for further consideration are defined in this section of the FS. Innovative technologies will be considered in accordance with the requirements of CERCLA. Based on information obtained in the RI, the screening process eliminates technologies that are not feasible. Technologies that are difficult to implement or have severe limitations that would prevent achievement of remedial objectives are considered not feasible. The technologies are evaluated according to their effectiveness and implementability in relation to site and waste characteristics. The costs of implementing a particular technology is considered on relative and qualitative bases. Based on these considerations, a recommendation is made to retain or eliminate the technology from further consideration.

Technologies retained for further consideration in the screening stage are combined to form a range of remedial alternatives. According to CERCLA, the following alternatives should be developed to the extent practicable:

- A number of treatment alternatives, ranging from one that would eliminate or minimize, to the extent feasible, the need for long-term management including monitoring, to one that would use, as a primary component of the alternative, treatment to address the principal threats.
- One or more alternatives that involve containment of waste with little or no treatment, but protect human health and the environment by preventing potential exposure and/or reducing mobility of contaminants.
- A no action alternative.

Depending on the number of alternatives developed, additional screening may take place based on each alternative's effectiveness, implementability, and cost.

Many alternatives often meet several, but not all, of the necessary criteria. For example, an alternative may be very effective and implementable, but too expensive, while another may be economical to implement, but not sufficiently effective. Some identified remedial options may have merit, but cannot be effectively screened until site-specific bench or pilot treatability tests are conducted. Where a particular option clearly fails one of the criteria (i.e., effectiveness, implementability or cost), it will be eliminated. Alternatives that appear to have merit are retained for further consideration.

6.4 Detailed Analysis of Alternatives

Additional data from site characterization and/or treatability testing are then used to further define and perform a detailed analysis of alternatives. The detailed analysis of alternatives is performed to provide decision-makers with sufficient information for selecting the optimum alternative for each site. The analysis involves assessment of each alternative with respect to the nine evaluation criteria as identified in CERCLA. These are:

- Short-term effectiveness
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility or volume
- Implementability
- Cost
- Compliance with ARARs
- Overall protection of human health and the environment
- Regulatory agency acceptance
- Community acceptance.

Once the site-wide alternatives have been subjected to a detailed analysis, they are summarized and compared to the evaluation criteria listed above. From this comparative analysis the relative advantages and disadvantages of each alternative are discussed.

SECTION 7.0

References

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APPENDIX A

Norfolk Partnering Team Human Health Risk Assessment Consensus Agreements

NAVAL BASE NORFOLK PARTNERSHIP
HUMAN HEALTH RISK ASSESSMENT
CONSENSUS AGREEMENT #6.A

TOPIC: Methodology Used for the Identification of Chemicals of Potential Concern

SUMMARY AND BASIS OF AGREEMENT:

The identification of Chemicals of Potential Concern (COPCs) is the first component, following data evaluation, in all human health risk assessments. For sites at Naval Base Norfolk, COPC selection shall be completed separately for each environmental medium and area of concern (if applicable) using analytical data obtained during sampling and analyitical investigations. The analytical data to be used to select COPCs in risk assessments for Naval Base Norfolk will always undergo formal third party data validation in accordance with the most recent publications of USEPA's National Functional Guidelines, in order to determine data quality and usability.

Prior to continuing summarization and discussions of the basis of this agreement, it should be noted here that the acronym *COPC* should not be confused with the acronym *COC* (which will appear later in text). The former is an acronym for the term used in Naval Base Norfolk risk assessments; the latter acronym is used in discussing USEPA Region III-established COC (contaminants of concern) screening levels, which is used as a COPC selection criterion in Naval Base Norfolk risk assessments. USEPA Region III COC screening values will be discussed in later text.

The methodology used to identify COPCs for sites at Naval Base Norfolk, which is not completely described in available regulatory guidance documents, is discussed in this consensus agreement as a hierarchal application system of selection criteria, i.e., a system consisting of distinct, hierarchal levels of selection criteria designated as (in order of significance): *Primary Criteria, Secondary Criteria and Re-Inclusion Criteria.* The application of all appropriate criteria will always be agreed upon, prior to the commencement of any risk assessment, among the Tier 1 members of the Norfolk Naval Base partnership and involved parties of risk assessment/toxicology personnel. The consensus agreements in this series describes the agreed-upon COPC identification methodology that has been adopted for sites at the Naval Base. The first of these agreements describes this COPC identification methodology in terms of the hierarchal levels of selection criteria. It should be noted that this methodology applies only to individual chemical constituents, and does not apply to the evaluation of parameters such as TPH, TOC, TOX, etc. Adopted approaches and procedures to be followed in all human health risk assessments for special-circumstances related to this overall topic, which warrant further individual consideration, are presented in the following sub-agreements:

- Consensus Agreement #6.A.1: Hierarchy of COPC Selection Criteria
- Consensus Agreement #6.A.2: Derivation of Updated Region III Risk-Based COC Screening Values
- Consensus Agreement #6.A.3: Application of Residential versus Industrial Region III Risk-Based Soil COC Screening Values
- Consensus Agreement #6.A.4: Derivation of Human Health Risk-Based COPC Selection Criteria for Chemicals Detected in Sediment Samples

NAVAL BASE NORFOLK PARTNERSHIP
HUMAN HEALTH RISK ASSESSMENT
CONSENSUS AGREEMENT #6.A.1

TOPIC: Hierarchy of Chemicals of Potential Concern (COPC) Selection Criteria

SUMMARY AND BASIS OF AGREEMENT:

A hierarchal application system of selection criteria, i.e., a system consisting of distinct, hierarchal levels of selection criteria designated as (in order of significance): *Primary Criteria, Secondary Criteria and Re-Inclusion Criteria* is the first COPC identification methodology. As previously noted in consensus agreement #6.A, this methodology applies only to individual chemical constituents, and does not apply to the evaluation of parameters such as TPH, TOC, TOX, etc.

Primary Selection Criteria:

Since Naval Base Norfolk is located in the Commonwealth of Virginia, all environmental investigations and activities are conducted in accordance with guidance established by USEPA Region III (Region III) and the Commonwealth of Virginia Department of Environmental Quality (VADEQ). Therefore, the primary selection criteria to be used for identifying COPCs in environmental media being investigated at sites at Naval Base Norfolk will be the comparative analyses described in the following technical guidance, and updates, established by Region III: Selecting Exposure Routes and Contaminants of Concern, by Risk-Based Screening (SCCRBS), dated January 1993. This guidance document, which also serves as the accepted guidance recommended by VADEQ, establishes the primary COPC selection criteria as a direct comparison of maximum site-measured concentrations with Region III-derived risk-based COC (contaminants of concern) screening levels. Region III COC screening levels have been established for soil, tap water, ambient air, and fish consumption, and must be updated periodically to reflect the on-going changes in USEPA's toxicological database. The derivation of updated COC screening concentrations, which is not described in current Region III guidance, is discussed in Consensus Agreement No. 6.A.2. Other primary selection criteria have been designated for surface water and sediment media, as discussed later in this agreement. At least one exceedence of a primary comparison criterion by a site-measured chemical concentration will result in the identification of that chemical as a COPC for that environmental medium.

Region III COC screening values have been established to be health protective against both direct and indirect contact exposures to contaminated environmental media. At a minimum, it is agreed that all human health risk assessments conducted for sites at Naval Base Norfolk will consider direct contact exposures to environmental media on concern. When identifying COPCs based on direct contact exposures, it is agreed that the Region III COC screening values derived for soil, tap water, (regardless of classification), ambient air, and fish will be compared to site-measured concentrations in the manner descrined in the following items.

- Region III soil COC screening values established for industrial and/or residential land use will be compared to surface and subsurface soil data (please refer to Consensus Agreement No. 6.A.3 for use of the most appropriate values based on land use considerations).

- Region III COC screening values established for tap water will be applied to the selection of groundwater COPCs, regardless of groundwater depth or classification.

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site-specific modifications to numerical water quality standards (WQSs). These regulations might be considered as an alternative to using the non-site-specific, established WQSs; however, the procedures for any demonstration for a site-specific WQS are restricted to a reevaluation of the bioconcentration or bioaccumulation properties of the pollutant.

- If the established Federal and State human health AWQCs and WQSs are used, the absence of an established numerical value for any constituent can be addressed by the derivation of a value by the risk assessor. However the new value must be derived using the same equations and exposure assumption used to derive the published values.

- Human health risk-based sediment screening criteria, derived specifically for Norfolk Naval Base, by the risk assessor, using the agreed-upon equations and exposure assumptions discussed in Consensus Agreement No. 6.A.4, will be compared directly to site-measured sediment concentrations.

Region III has also established risk-based concentrations, referred to as soil screening levels (SSLs), that consider indirect contact exposures to soil via air and groundwater. The Region III derivations of these criteria are currently based on the following USEPA proposed document: Soil Screening Guidance. December 1994. Office of Solid Waste and Emergency Response (available from the NTIS as document numbers 9355.4-1, PB95-965530, or EPA540/R-94/105). Recently, a 1996 version of this document has been released; however, it is agreed that the most recent versions of this document will always serve as the basis for the Region III SSLs to be used in risk assessments conducted for sites at Naval Base Norfolk. The SSLs are risk-based values that are derived using the same exposure assumptions as COC screening values, plus additional assumptions necessary for inter-media extrapolation. Although SSLs may be more applicable to the Feasibility Study (FS) process, as well as fate and transport assessments, they may be applied to the risk assessment process when indirect exposures to soil via air and groundwater exposure pathways are being considered. The SSLs will be compared to site-measured soil concentrations in the following manner (regardless of residential or industrial land use):

- SSLs protective of transfers from soil to air will be compared to site-measured surface soil concentrations in all human health risk assessments, since the inhalation of fugitive dusts emanating from soil is considered in virtually all risk assessments, provided there is little to no vegative cover or pavement. SSLs protective of transfers from soil to air will be compared to subsurface soil concentrations when a future excavation scenario is being evaluated in the risk assessment.

- SSLs protective of transfers from soil to groundwater will be compared to site-measured surface and/or subsurface soil concentrations, provided the measured depths to groundwater indicate that the groundwater is close to the ground surface (i.e., shallow), and/or soil-to-groundwater modeling is being done as part of the risk assessment. SSLs protective of transfers from soil to groundwater will be compared to site-measured subsurface soil concentrations only (and not surface soil concentrations) when the measured depths to groundwater indicate that the groundwater is far below the ground surface (i.e., deep).

NAVAL BASE NORFOLK PARTNERSHIP
HUMAN HEALTH RISK ASSESSMENT
CONSENSUS AGREEMENT #6.A.1
(Continued)

- A site-related toxic chemical that persists in the environment and exhibits the tendency to bioaccumulate will be further considered for re-inclusion as a COPC in the risk assessment.

SIGNATORIES TO THE AGREEMENT:

We the undersigned have reached the above agreement on this 7th day of August 1997.

James T Harris
Devlin Harris
Randy M Jackson
Timothy A Resich
Harry S. Harbold
Jack R Robinson

NAVAL BASE NORFOLK PARTNERSHIP
HUMAN HEALTH RISK ASSESSMENT
CONSENSUS AGREEMENT #6.A.3

TOPIC: Application of Residential versus Industrial Region III Risk-Based Soil COC Screening Values

SUMMARY AND BASIS OF AGREEMENT:

Since risk-based soil COC screening values have been established by Region III for the protection of potentially exposed populations under both residential and industrial land use situations, the COPC selection process in a site-specific risk assessment should consider and incorporate the knowledge of land use, both at the site being evaluated, as well as in the vicinity of that site. Therefore, it is agreed upon that prior to the commencement of the human health risk assessment, the Tier 1 members of the Norfolk Naval Base partnership and involved parties of risk assessment/toxicology personnel will reach an understanding of current and future land use patterns at both the site, and in areas immediately surrounding the site. This understanding will be reached under the terms of Consensus Agreement No. 6.B: Current and Future Land Use of Sites at Naval Base Norfolk. Upon reaching this agreed-upon understanding of land use (well in advance of the commencement of the risk assessment), the aforementioned parties will then decide upon the appropriate use (or non-use) of the Region III risk-based residential versus industrial soil COC screening values as primary, site-specific selection criteria in the identification of soil (surface and/or subsurface) COPCs. The following items will serve as a basis in the process of deciding the appropriate use of residential versus industrial soil COC screening values in a site-specific risk assessment.

- Only residential soil COC values will be compared to site-measured soil concentrations if certainty exists that the future land use of the site will be residential, regardless of the known current and future land use of the surrounding areas.

- Only industrial soil COC values will be compared to site-measured soil concentrations if certainty exists that the current and future land use of the site and surrounding areas is industrial/commercial.

- Both residential and industrial soil COC values will be compared to site-measured soil concentrations if the current and/or future land use is understood to be described as anything other than the first two items presented above, or, if there is uncertainty with regard to future land use of the site and surrounding areas, even though the current land use is known. In these situations, even though both the residential and industrial soil COC values are compared to site-measured soil concentrations, the former are more health conservative than the latter, and will therefore, actually determine the soil COPCs to be evaluated in the human health risk assessment. It should be noted though that in this situation, even though both sets of soil COC values are utilized, risks will only be estimated for COPCs identified based on comparisons with the residential values.

SIGNATORIES TO THE AGREEMENT:

We the undersigned have reached the above agreement on this 7th day of August 1997.

Dewin Harris

Randy M Jackson

Harry S. Harbold

NAVAL BASE NORFOLK PARTNERSHIP
HUMAN HEALTH RISK ASSESSMENT
CONSENSUS AGREEMENT #6.A.4

SIGNATORIES TO THE AGREEMENT:

We the undersigned have reached the above agreement on this 7th day of August 1997.

NAVAL BASE NORFOLK PARTNERSHIP
HUMAN HEALTH RISK ASSESSMENT
CONSENSUS AGREEMENT #6.A.6

TOPIC: Evaluation of Lead as a COPC in Soil, Groundwater and Sediment

SUMMARY AND BASIS OF AGREEMENT:

Currently, no risk-based COC screening values are established, or can be established for comparison with lead concentrations detected in soil, groundwater and sediment, due to the inavailability of applicable toxicity criteria (i.e., cancer slope factors and reference doses). Therefore, until the establishment of such criteria, it is agreed that the following will serve as primary COPC selection criteria for lead in those media:

- Groundwater - USEPA's drinking water action level of 15 µg/L
- Soil and sediment - USEPA's residential soil criterion of 400 mg/kg.

Also, until the establishment of USEPA-approved toxicity criteria, the identification of lead as a COPC will result in the evaluation of the potential for the occurrence of adverse health effects in exposed individuals by use of the most recent version of USEPA's Lead Bio-Uptake Model (please refer to Consensus Agreement No. 6.G: Risk Characterization Issues).

SIGNATORIES TO THE AGREEMENT:

We the undersigned have reached the above agreement on this 7th day of August 1997.

[illegible]

Dealin Hanna

Randy M Jackson

Timothy A. Perkins

Harry S. Harbold

Jack L Bedonovich

NAVAL BASE NORFOLK PARTNERSHIP
HUMAN HEALTH RISK ASSESSMENT
CONSENSUS AGREEMENT #6.B

Any decisions reached pertaining to future land use are predicated on Naval Base assurance through appropriate policies and guidance provided to the Partnership that land use patterns to which sites will be remediated cannot be altered without review of the future protectiveness of the newly designated land use by the Naval Base and the regulators (USEPA Region III, the VADEQ and other appropriate agencies). When sites are assessed for or remediated to concentrations that are protective of individuals under any land use scenario other than unrestricted use (i.e., residential use), and the Naval Base proposes a change in land use at that site, or property adjacent to that site, the Naval Base will immediately notify the regulators. The Naval Base will assess any proposed change in land use for protectiveness against the original or planned cleanup goals and will consult with the regulators regarding such an evaluation. No change in land use will be implemented without regulator concurrence that the original or planned remedy will remain human health protective, or unless the Naval Base first remediates site contaminants to lower concentrations corresponding to the proposed change.

SIGNATORIES TO THE AGREEMENT:

We the undersigned have reached the above agreement on this day of September 1997.

ATTACHMENT A

Checklists for Site-Specific Plans

Site-Specific Investigation-Derived Waste Plan Checklist

This checklist supplements the Master IDW Plan with site-specific information. Once completed for a specific project, it provides necessary IDW information for each investigation. It is to be taken into the field with the Master IDW Plan.

Site: _____

1. IDW Media: _____Soil cuttings
   _____Well development or purge water
   _____Decontamination residual soil and wastewater
   _____PPE or disposable equipment
   _____Other _____

2. Expected Regulatory Status: _____Hazardous
   _____Solid Waste
   _____Unknown
   _____Other _____

3. Site Location: _____

4. Nature of Contaminants Expected:

_____Petroleum contamination
_____Polyaromatic hydrocarbon
_____Pesticides
_____Other _____
_____Herbicides
_____PCBs
_____Metals

5. Volume of IDW Expected: _____Drums
   _____Cubic Yards
   _____Tons
   _____Gallons

6. Compositing Strategy for Sample Collection:_____

7. IDW Storage
   _____As per Master IDW Plan _____Other_____

8. Waste Disposal
   _____As per Master IDW Plan _____Other_____

Site-Specific Quality Assurance Project Plan Checklist

This checklist supplements the Master QAPP with site-specific information. Once completed for a specific project, it provides necessary quality assurance information for each investigation. It is to be taken into the field with the Master QAPP.

Site: _____

1. List sampling tasks:

2. List data quality objectives:

3. Organization:

LANTDIV IR Section Head	_____
LANTDIV Navy Technical Representative	_____
USEPA Remedial Project Manager	_____
VDEQ Federal Facilities Project Manager	_____
CH2M HILL Activity Manager	_____
CDM Federal Project Manager	_____
Quality Control Senior Review	_____
Technical Project Manager	_____
Field Team Leader	_____

4. Table of samples with analyses to be performed and associated QC samples (attached):

5. Analytical Quantitation Limits:
   _____As per Table 8-2 of Master QAPP _____Other (attached)

6. QA/QC Acceptance Criteria (e.g., precision, accuracy)
   _____As per Table 4-1 of Master QAPP _____Other (attached)

7. Data reduction, validation, and reporting:
   _____As per Section 9 of Master QAPP _____Other (attached)

8. Internal QC Procedures (field and laboratory):
   _____As per Section 10 of Master QAPP _____Other (attached)

9. Corrective Action:
   _____As per Section 14 of Master QAPP _____Other (attached)

10. Other deviations from Master QAPP _____

Site-Specific Field Sampling Plan Checklist

This checklist supplements the Master Field Sampling Plan with site-specific information. Once completed for a specific project, it provides necessary field sampling information for each investigation. It is to be taken into the field with the Master FSP.

Site:_____

1. Tasks to be performed:

_____Geophysical surveys
_____Soil gas surveys
_____Surface water and sediment sampling
_____Surface soil sampling
_____Soil boring installation
_____Subsurface soil sampling
_____Monitoring well installation and development
_____Monitoring well abandonment
_____Groundwater sampling
_____In-situ groundwater sampling
_____Aquifer testing
_____Hydrogeologic measurements
_____Biota sampling
_____Trenching
_____Land surveying
_____Investigation derived waste sampling
_____Decontamination
_____Other_____

2. Field measurements to be taken:

_____temperature
_____pH
_____dissolved oxygen
_____turbidity
_____specific conductance
_____organic vapor monitoring
_____geophysical parameters (list):
_____electromagnetic induction
_____ground-penetrating radar
_____surveying
_____magnetometry
_____global positioning system
_____soil gas parameters (list):
_____combustible gases
_____water-level measurements
_____pumping rate
_____other_____

3. Sampling program (nomenclature, etc.):

_____As per Section 3.1 of Master FSP
_____Other _____

4. Map of boring and sampling locations (attach to checklist):

5. Table of field samples to be collected:

6. Applicable SOPs (attach to checklist) or references to specific pages in Master FSP:

7. Site-specific procedures or updates to protocols established in the Master FSP:

_____

Site-Specific Health and Safety Plan

This checklist must be used in conjunction with the Master HASP. This checklist is intended for use by CDM Federal and CH2M HILL employees only. All CDM Federal and CH2M HILL employees performing tasks under this checklist must read and sign both this checklist and the Master HASP and agree to abide by their provisions (see EMPLOYEE SIGNOFF attached to the checklist).

Site:_____

Location(s)_____(reference attached map)

This document shall be maintained on site with the Master Health and Safety Plan. It will include as attachments from the Work Plan a site map and the site characterization and objectives for this site.

The procedures described in the Master Health and Safety Plan will be followed unless otherwise specified in this Site-Specific Health and Safety Plan.

1. HAZWOPER-Regulated Tasks

_____Test pit and excavation
_____Soil boring installation
_____Geoprobe boring
_____Geophysical surveys
_____Hand augering
_____Subsurface soil sampling
_____Surface soil sampling
_____Soil gas surveys
_____Sediment sampling
_____Monitoring well/drive point installation
_____Monitoring well abandonment
_____Groundwater sampling
_____Aquifer testing
_____Hydrologic measurements
_____Surface water sampling
_____Biota sampling
_____Investigation-derived waste (drum) sampling and disposal
_____Observation of loading of material for offsite disposal
_____Oversight of remediation and construction
_____Other_____

2. Hazards of Concern: (Check as many as are applicable. Refer to Section 3 of Master H&S Plan for control measures):

_____Heat stress
_____Cold stress
_____Buried utilities, drums, tanks
_____Inadequate illumination
_____Drilling
_____Heavy equipment
_____Working near water
_____Flying debris
_____Gas cylinders
_____Noise
_____Slip, trip, or fall hazards
_____Back injury
_____Confined space entry
_____Trenches, excavations
_____Protruding objects
_____Vehicle traffic
_____Ladders, scaffolds
_____Fire
_____Working on water
_____Snakes or insects
_____Poison ivy, oak, sumac
_____Ticks

_____Radiological _____Other_____

3. Contaminants of Concern (List if known. Reduce Table 3.8 of the Master HASP to site-specific contaminants, add additional chemicals if necessary, and attach to this checklist):

_____ _____ _____

_____ _____ _____

4. Personnel (List CH2M HILL field team members and telephone numbers):

Field team leader(s) _____ _____

Site safety coordinator(s) _____ _____

Field team members _____ _____

_____ _____

5. Contractors/Subcontractors

_____Procedures as per Master HASP

_____Other_____

Name: _____ _____ _____

Contact:_____ _____ _____

Telephone:_____ _____ _____

6. Level of personal protective equipment (PPE) required:_____
Refer to Table 5.1 of Master HASP, SOPs, and Respiratory Protection, Section 2 of the Site Safety Notebook.

7. Air monitoring instruments to be used:

_____PID _____FID

_____CGI _____Dust monitor

_____O_2

8. Decontamination procedures:

_____As per Section 7 of Master HASP

_____Other _____

9. List any other deviations or variations from the Master HASP:

10. Emergency Response (Check that all names and numbers are correct on page 47 of Master HASP and attach corrected page to this checklist)

11. Map to hospital (Highlight route to hospital from site and attach to this checklist)

12. Emergency Contacts (Check that all names and numbers are correct on page 49 of Master HASP and attach corrected page to this checklist)

13. Approval. This prepared site-specific checklist must be approved Chuck Myers/CDM Federal or other authorized representative

    Name_____Title_____Date_____

14. Employee Signoff. All CDM Federal and CH2M HILL employees working at the site must sign the attached Employee Signoff for the checklist as well as for the Master HASP.

_____Site

HASP Checklist Employee Signoff

The employees listed below have been given a copy of this health and safety plan checklist, have read and understood it, and agree to abide by its provisions.

EMPLOYEE NAME	EMPLOYEE SIGNATURE AND DATE

Final

Master Sampling and Analysis Plan

St. Juliens Creek Annex
Chesapeake, Virginia

Contract Task Order 15

July 2000

Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Under the

LANTDIV CLEAN II Program
Contract N62470-95-D-6007

Prepared by

CDM Federal Programs Corporation

Submitted by

CH2MHILL

Herndon, Virginia

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Master Sampling and Analysis Plan

Master Field Sampling Plan
Master Quality Assurance Project Plan
Master Investigation Derived Waste Management Plan

Preface

This document presents the Master Sampling and Analysis Plan (SAP) for the activities to be performed at Remedial Investigation/Feasibility Study (RI/FS) sites and potentially Site Screening Areas (SSAs) located at St. Juliens Creek Annex to Naval Base, Norfolk (St. Juliens Creek Annex), Chesapeake, Virginia. This master plan (MP) has been developed to encompass the anticipated sampling and analysis activities at all RI/FS sites and SSAs, as defined in the Federal Facilities Agreement (FFA). The U. S. Navy Facilities Engineering Command, Atlantic Division (LANTDIV), in conjunction with the United States Environmental Protection Agency (USEPA), Region III, and the Virginia Department of Environmental Quality (VDEQ) has agreed that one set of Master Plans (MP) s, including a Master Work Plan (WP), a Master SAP, and a Master Health and Safety Plan (HASP), will provide the background information needed to understand base-wide site conditions, the approach to be used for the RI/FS and site screening processes (SSPs), and the general types of activities to be completed.

The Master SAP consists of three documents: The Master Field Sampling Plan (FSP), the Master Quality Assurance Project Plan (QAPP), and the Master Investigation-Derived Waste Management Plan (IDWMP). These MPs will be updated by LANTDIV or the environmental contractor as necessary, and reviewed at least once every three years by USEPA and VDEQ personnel to ensure that the information contained therein is accurate and reflects current procedures and guidance. Any updates or necessary changes will be incorporated through addenda to the MPs.

Site-specific details, such as sampling locations, numbers of samples, and analytical parameters, will be provided in separate site-specific plans. The site-specific plans will supplement each MP and will present information specific to each new area of investigation. Checklists that outline the information to be included in each site-specific plan are provided in Attachment A of the Master WP. Environmental contractors performing field investigations on St. Juliens Creek Annex will be able reference general material, such as sampling and analytical methodologies, from one master set of documents. General information will not have to be reproduced for every SSA and RI/FS site.

Final

Master Field Sampling Plan

St. Juliens Creek Annex
Chesapeake, Virginia

Contract Task Order 15

July 2000

Prepared for

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Herndon, Virginia

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SOPs

Abbreviations and Acronyms

ASTM	American Society of Testing and Materials
ATV	All-Terrain Vehicle
bgs	below ground surface
CLP	Contract Laboratory Program
CoC	Chain of Custody
DO	Dissolved Oxygen
°C	Degrees Centigrade
EM	Electromagnetic Induction
FID	Flame Ionization Detector
FSP	Field Sampling Plan
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HASP	Health and Safety Plan
HCl	hydrochloric acid
HNO_3	nitric acid
H_2SO_4	sulfuric acid
IDW	Investigation-Derived Waste
IDWMP	Investigation-Derived Waste Management Plan
MHz	megahertz
ml	milliliter
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	mean sea level
NaOH	sodium hydroxide
NTU	nephelometric turbidity unit
OVM	Organic Vapor Monitor
PAH	Polycyclic Aromatic Hydrocarbon
PC	Personal Computer
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PVC	Polyvinyl Chloride

QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedures
SSA	Site Screening Area
SSP	Site Screening Process
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristics Leaching Procedure
TNT	Trinitrotoluene
TSS	Total Suspended Solids
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VDOH	Virginia Department of Health
VOC	Volatile Organic Compound
WP	Work Plan
XRF	X-Ray Fluorescence

SECTION 1.0

Introduction

This Master Field Sampling Plan (FSP) is a compilation of the anticipated field activities which may be performed to support Remedial Investigation/Feasibility Study (RI/FS) and Site-Screening Process (SSP) activities at one or more of the sites at the St. Juliens Creek Annex to Naval Base, Norfolk (St. Juliens Creek Annex) in Chesapeake, Virginia. The purpose of the Master FSP is to describe the types of field procedures which may be performed during the course of field activities and how these procedures will be completed. This Master FSP does not include site-specific information regarding past activities, nor does it include potential sample locations or the number of samples to be collected. The specific information regarding field activities at any RI/FS site or Site Screening Area (SSA) will be provided in separate Site-Specific Work Plans. These work plans will reference this Master FSP, rather than repeat the information contained in this plan. Information to be provided in each site specific FSP is outlined on the FSP site-specific checklist, located in Attachment A of the Master Work Plan (WP).

This Master FSP describes field investigation procedures and practices to be followed at St. Juliens Creek Annex and is organized in three sections. Section 1 is a general introduction. Section 2 addresses analytical services and describes the different field activities which may be performed at the base. Section 3 provides protocol for sample documentation and custody. All analyses will be performed in accordance with standard U. S. Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) protocol or USEPA Test Methods for Evaluating Solid Waste (SW-846) Third Edition. Tests conducted in the field, such as water quality measurements and tests for soil characteristics, will be performed according to the Standard Operating Procedures (SOPs), located this Master Plan. Standard operating procedures (SOPs) referenced in Section 2 are included as Appendix C of the Master WP. The potential field activities that may be conducted at the base include:

- Geophysical surveys
- Soil gas surveys
- Surface water and sediment sampling
- Surface soil sampling
- Soil boring installation
- Subsurface soil sampling
- Monitoring well installation and development
- Monitoring well abandonment
- Groundwater sampling
- In-situ groundwater sampling
- Aquifer testing
- Hydrogeologic measurements
- Biota sampling
- Trenching
- Land surveying
- Investigation derived waste sampling

- Decontamination

The background and setting for St. Juliens Creek Annex are described in the Master WP and are not repeated here. Site-specific information regarding individual sites or SSAs will be included in Site-Specific Work Plans.

SECTION 2.0

Field Activities

This section describes analytical field sampling analytical/quality control protocol and field activities which may be performed at St. Juliens Creek Annex. Not all of these activities will be conducted at all sites or SSAs. The field activities discussion is general; details of the procedures are provided in the SOPs which are included as attachments to this Master Field Sampling Plan.

The sampling activities at St. Juliens Creek Annex will conform to U.S. Navy specifications and guidelines.

2.1 Analytical Services

Analytical services include the measurement of field parameters, routine analyses of environmental samples, and data validation.

2.1.1 Field Measurements

The measurement of the field parameters temperature, pH, dissolved oxygen, turbidity, and specific conductance are screening tools. These parameters will be used to evaluate groundwater and surface water conditions prior to sample collection. These parameters will also be used to estimate the effectiveness of well development activities.

Field screening also includes the use of an organic vapor monitoring instrument to measure organic vapors in air. These data will be used for the following:

- Evaluation of ambient air conditions during field activities to meet the requirements of the Health and Safety Plan.
- Assist in the gross screening of soil samples.

Field screening procedures are discussed in more detail in Section 4 of the Master Quality Assurance Project Plan (QAPP) and in the SOPs.

2.1.2 Routine Sample Analysis

The routine analysis of environmental samples will be requested for Total Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), and Target Analyte List (TAL) metals and cyanide.

These data will be used for the following:

- Risk assessment
- Characterization of the native soil, fill, and sediment
- Characterization of groundwater and surface water

The methods and procedures to be followed during routine sample analyses are discussed in more detail in Section 8 of the Master QAPP.

2.1.3 Data Validation

Data validation requirements are discussed in more detail in Section 9 of the Master QAPP.

2.2 Field QC Procedures

Quality Control (QC) duplicate samples and blanks are used to provide a measure of the internal consistency of the samples and to provide an estimate of the components of variance and the bias in the analytical process. Table 10-1 in the QAPP is a summary of the collection frequencies of the field QC samples.

2.2.1 Blanks

Blanks provide a measure of cross-contamination sources, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. American Society of Testing Materials (ASTM) Type II water will be used for blanks. Three types of blanks will be generated during sampling activities: trip blanks, field blanks, and equipment blanks.

One trip blank will be included each day for each cooler containing samples for VOC analysis. The trip blanks will be prepared before each sampling event, shipped or transported to the field with the sampling bottles, and sent to the laboratory unopened for analysis. Trip blanks will not be prepared or handled in the field. Trip blanks will indicate whether contamination is introduced during shipment to the field, storage in the field, or shipment from the field to the analytical laboratory.

One field blank will be collected each week of sampling. The field blanks will indicate whether contamination has been introduced by handling the sample bottle in the field or in the laboratory. The pre-preserved sample container will be filled with ASTM Type II water in the field at the time of sampling.

One equipment blank will be collected each day during sampling. The equipment blanks will indicate the completeness of equipment decontamination procedures.

EPA has recently requested that a temperature blank be included in each cooler containing samples for CLP analyses so that the laboratory can record the temperature without disturbing the samples. The temperature blank will not be given a sample number nor listed as a sample on the Chain of Custody (CoC).

2.2.2 Duplicates

Field duplicate samples will be collected at a frequency of 1 per 10 field samples per matrix. The locations from which the duplicates are taken will be selected with a bias for locations where contamination is expected. The duplicate sample will be submitted for analysis as two independent samples with different sample numbers. Data validators will use these results to evaluate the accuracy of the analytical data.

2.2.3 Matrix Spike//Matrix Spike Duplicate (MS/MSD)

Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at a frequency of 1 per 20 field samples. Analytical results from these samples indicate the effect that the matrix (water, soil, sediment) has on extracting the analyte for analysis. Data validators will use the results to evaluate the accuracy of the analytical data.

2.3 Geophysical Surveys

Geophysical survey methods that may be used include electromagnetic induction (EM), ground penetrating radar (GPR), magnetometry, and downhole geophysical surveys. Appropriate survey methods will be selected to delineate potential areas of buried wastes and utilities at the areas under investigation. Utility clearance will be performed St. Juliens Creek Annex and/or its subcontractors prior to any soil disturbance. The results from these surveys will be used to determine the locations of subsequent soil borings and monitoring wells and to characterize the condition of the subsurface.

In general, grids will be established in the field at areas to be evaluated at an appropriate spacing (e.g., 15 to 20 feet), depending on the geophysical method being used and the size of the site. Smaller grid spacings may be used in areas where greater subsurface definition is required (e.g., locating an underground storage tank). The grid spacings will be tied to existing permanent structures (e.g., buildings, monitoring wells) so they can be referenced to later land surveys. In some areas, brush and tree clearing may be required for the geophysical surveying operations. The criteria used to determine grid spacing will be further defined in the Site-Specific Work Plans.

2.3.1 Electromagnetic Induction

EM terrain conductivity profiling is a non-invasive method used to identify lateral changes in subsurface conductivity through inductive electric measurements made at the ground surface. The EM survey is a rapid, cost-effective reconnaissance tool. Areas of higher-than-background conductivity may be associated with surficial and buried wastes, contaminants, or metals objects (i.e., buried drums and storage tanks, product lines, utility lines). EM may also be used for contaminant plume mapping, locating abandoned trenches and lagoons, and locating lateral anomalies such as pockets or pits of different materials.

EM data will be digitally recorded and downloaded to a personal computer (PC) for processing and analysis. Data will be profiled and contoured over the area of investigation to determine inordinately high and low conductivity values. Areas interpreted to represent buried waste, contaminants, or metals will be delineated.

2.3.2 Ground Penetrating Radar

GPR is an active geophysical system which transmits high frequency EM waves into the ground and detects the energy reflected back to the surface. The GPR transmits electromagnetic waves of radio and microwave frequencies (e.g., 80 megahertz [MHz] to 1,000 MHz). Reflections typically occur at lithologic changes, subsurface discontinuities, and internal soil structures. GPR is useful for determining the presence of underground utilities and buried metallic objects, and for further characterizing buried wastes by

producing a graphic cross section of the subsurface. Other applications include locating concrete foundations, buried archaeological artifacts, excavations, filled pits, and lagoons.

2.3.3 Magnetometry

Magnetometry measures local perturbations in the earth's magnetic field. Both naturally-occurring and man-made magnetic materials can modify the ambient field. Buried ferrous objects, such as drums, tanks, and product lines, usually produce a detectable magnetic anomaly.

Magnetic data will be digitally recorded and downloaded to a PC for processing and analysis. Data will be profiled and contoured over the area of investigation to facilitate identification of anomalous magnetic intensities. Areas interpreted to represent buried waste, contaminants, or metals will be delineated.

2.3.4 Downhole Geophysics

Downhole geophysical methods are used to characterize or log the stratigraphy, geology, morphology, and hydrology of a well or open bore hole. Methods that are commonly utilized and what is recorded are summarized below:

- Caliper log - measures changes in the diameter of the borehole.
- Fluid resistivity log - records natural variations in electrical resistivity (resistance)of borehole and interstitial fluids.
- Electrical resistivity log - records natural variations in electrical resistivity (resistance) between contrasting lithologic types and interstitial fluids.
- Spontaneous potential log - records natural variations in electrical potential (voltages) between contrasting lithologic types.
- Gamma log - records natural variations in gamma radiation between contrasting lithologic types.
- Acoustic (sonic) log - records natural variations in density (porosity) between contrasting lithologic types.
- Neutron logs - records natural variations in neutron emission between contrasting lithologic types.
- Temperature log - records variations in water temperature within a borehole.
- Fluid movement (flow) log - records variations in borehole groundwater flow through.

2.4 Soil Gas Survey

Soil gas surveys are expected to be used in areas where materials containing petroleum-based compounds, VOCs, or other hydrocarbon compounds were used, spilled, or stored. Soil gas survey results will be used to help delineate the extent and concentration of organic vapors in the vadose zone which may be indications of soil and/or groundwater

contamination. The results may also be used to determine the need for and locations of confirmatory soil borings and monitoring wells.

Soil gas samples will be collected in-situ and analyzed on-site. Samples may be analyzed for hydrocarbon compounds and/or selected chlorinated compounds (i.e., trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane) using gas chromatographic techniques. Samples can also be analyzed for combustible gases using a portable combustible gas indicator.

2.5 Surface Water and Sediment Sampling

Surface water and sediment samples will be collected from drainage ditches, wetlands areas, creeks, lagoons, ponds, and estuaries across the site. Sampling will proceed from downstream to upstream locations to reduce the amount of turbidity and potential cross-contamination of downstream samples. Sampling will be conducted at low tides, where appropriate, and low flow to minimize dilution of possible contaminants. Sampling activities will not occur after periods of heavy rainfall.

2.5.1 Surface Water Sampling

Field parameters (e.g., dissolved oxygen [D.O.], temperature, specific conductance, pH) will be measured prior to sample collection. Surface water samples will then be collected by submersing the sampling container directly into the surface water body or by using a "thief" type sampler and then transferring the sample to the sample container. The body of the immersed sampling container will face downstream so that any sediment disturbed during the immersion of the container does not enter the sampling vessel. If the volume of surface water encountered is insufficient to allow the direct submersion of the sampling containers, a glass interim vessel will be used to transfer the surface water sample to the sample containers. The glass interim vessel will be laboratory cleaned to the same specifications as the sample containers.

Table 2-1 presents the required containers, preservatives, and holding times for water samples. All appropriate preservatives will be added to the sample containers by the contracted laboratory before shipment to the environmental contractor's field team. All samples will be kept cool in the field at 4°C, using bagged ice.

For VOC samples, the bottles will be filled to minimize aeration of the samples. During the collection of surface water samples, care will be taken to ensure that any pre-added preservative is not rinsed from the sampling container during sample collection. Sample vials will be filled completely and capped to prevent the entrapment of any air bubbles in the vial.

2.5.2 Sediment Sampling

Sediment samples will typically be collected with surface water samples. At locations where both sediment and surface water samples are being collected, the surface water sample will be collected first. This will ensure that any sediment disturbed during the sediment sampling does not enter the surface water sampling container.

Table 2-1
Required Containers, Preservatives, and Holding Times for Water Samples

Analysis	Number of Containers	Sample Container	Preservative	Holding Time	Volume of Sample Collected
VOCs	3	Three 40-ml glass vials w/Teflon-lined cap	HCl to pH <2; Cool to 4°C	14 days	Fill completely; no air bubbles
SVOCs	2	Two 1-liter bottles	Cool to 4°C	7 days	Fill to shoulder
Pesticides/PCBs	2	Two 1-liter bottles	Cool to 4°C	7 days	Fill to shoulder
TAL Metals	1	1-liter polyethylene bottle	HNO_3 to pH <2; Cool to 4°C	6 months (28 days for mercury)	Fill to shoulder
Cyanide	1	1-liter polyethylene bottle	NaOH to pH >12; Cool to 4°C	14 days	Fill to shoulder
Chlorinated Herbicides	2	Two 1-liter bottles	Cool to 4°C	7 days	Fill to shoulder
Organophosphorus Pesticides	2	Two 1-liter bottles	Cool to 4°C	7 days	Fill to shoulder
Lead and Arsenic	1	1-liter polyethylene bottle	HNO_3 to pH <2; Cool to 4°C	6 months	Fill to shoulder
Total Organic Carbon	1	500-ml amber glass	H_2SO_4 or HNO_3 to pH<2; Cool to 4°C	28 Days	Fill completely, no air bubbles
TCLP VOCs	3	40-ml glass vials w/Teflon-lined cap	HCl to pH <2; Cool to 4°C	14 days	Fill completely; no air bubbles
TCLP SVOCs	2	1-liter bottles	Cool to 4°C	7 days	Fill to shoulder
TCLP Pesticides	2	1-liter bottles	Cool to 4°C	7 days	Fill to shoulder
TCLP Metals	1	1-liter polyethylene bottle	HNO_3 to pH <2; Cool to 4°C	6 months (28 days for mercury)	Fill to shoulder
TSS	1	1-liter bottle	Cool to 4°C	7 days	Fill to shoulder
TDS	1	250 ml bottle	Cool to 4°C	7 days	Fill to shoulder
Alkalinity	1	250 ml bottle	Cool to 4°C	14 days	Fill to shoulder
Hardness	1	250 ml bottle	HNO_3 to pH <2; Cool to 4°C	6 months	Fill to shoulder

VOC = Volatile organic compound
SVOC = Semivolatile organic compound
PCB = Polychlorinated biphenyl
TAL = Target Analyte List
TCLP = Toxicity Characteristics Leaching Procedure
°C = degrees Centigrade
ml = milliliters
TSS = Total Suspended Solids
TDS = Total Dissolved Solids
HCl = Hydrochloric acid
HNO3 = Nitric acid
NaOH = Sodium hydroxide
H2SO4 = Sulfuric acid

Several different techniques may be used to collect sediment samples, including stainless-steel trowel sampling, stainless-steel hand auger sampling, and grab sampling with a Ponar Dredge. The method selected will typically depend on the flow and depth of water at the sampling location. A brief description of these sampling techniques and their applicability is provided below. Table 2-2 lists required containers, preservatives, and holding times for sediment samples.

Table 2-2
Required Containers, Preservatives, and Holding Times for Soil and Sediment

Analysis	Number of Containers	Sample Container	Preservative	Holding Time	Volume of Sample
TCL VOCs	2	2-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
TCL SVOCs	1	8-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
TCL Pest/PCBs	1	8-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
TCL Pesticides	1	8-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
TAL Metals	1	8-oz plastic or glass bottle	Cool to 4°C	6 months	Fill to shoulder
Cyanide	1	8-oz plastic or glass bottle	Cool to 4°C	14 days	Fill completely
Chlorinated Herbicides	1	8-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
Organophosphorus Pesticides	1	8-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
Lead/Arsenic	1	8-oz plastic or glass bottle	Cool to 4°C	14 days	Fill to shoulder
TOC	1	8-oz plastic or glass bottle	Cool to 4°C	28 days	Fill completely
Grain Size	1	Quart size plastic bag	Cool to 4°C	--	Approximately 1/3 rd full
TCLP VOCs	2	2-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
TCLP SVOCs	1	8-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
TCLP Pesticides	1	8-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
TCLP Metals	1	8-oz plastic or glass bottle	Cool to 4°C	14 days	Fill completely
Reactivity	1	8-oz plastic or glass bottle	Cool to 4°C	28 days	Fill completely
Corrosivity	1	8-oz plastic or glass bottle	Cool to 4°C	28 days	Fill completely
Ignitability	1	8-oz plastic or glass bottle	Cool to 4°C	--	Fill completely

VOC = Volatile organic compound
SVOC = Semivolatile organic compound
PCB = Polychlorinated biphenyl
TAL = Target Analyte List
TCLP = Toxicity Characteristics Leaching Procedure
°C = degrees Centigrade
ml = milliliters
TSS = Total Suspended Solids
TDS = Total Dissolved Solids
HCl = Hydrochloric acid
HNO3 = Nitric acid
NaOH = Sodium hydroxide
H2SO4 = Sulfuric acid

During sediment sample collection, the VOC sample containers will be filled first. The sample will be placed directly into the VOC sample container to minimize the volatilization of organic compounds. The remaining sample volume will be placed into a stainless-steel bowl and mixed thoroughly. After mixing, all other sample containers will be filled.

2.5.2.1 Stainless-Steel Trowel

A stainless-steel trowel will be used to collect sediment samples in areas where there is minimal water flow across the sampling location and depth specific characterization is not required. The trowel will be used to transfer the sediment from the sampling location into the sample containers.

2.5.2.2 Stainless-Steel Hand Auger

For depth-discrete sediment sampling, a clean stainless steel, hand-held coring instrument with a disposable plastic liner tube, fitted with an eggshell catcher to prevent sample loss, will be used. The coring device will be pushed through the thickness of the sediments. The core will either be extruded into a stainless-steel bowl or directly into the appropriate sample bottles. The sample recovery will be noted, and the discreet interval (e.g., 0 to 4 inches, 4 to 8 inches, 8 to 12 inches, or deeper if needed) will be placed in a stainless steel mixing bowl.

2.5.2.3 Ponar Dredge Sampling

A Ponar Dredge will be used to collect sediment samples from beneath any surface water greater than 1-foot in depth. The ponar dredge is a "clamshell" type sampling device consisting of the bucket/jaws and the sampler arms. During sampling activities, a length of rope is attached to a ring on the top of the sampler arms. The sampler arms are then pushed towards the bucket to open the sampler jaws. The jaws are locked in the open position by inserting a spring-loaded steel pin through a small hole in the arms. The sampler is lifted by the rope, with the samplers weight creating the tension which holds the locking pin in place. The sampler is lowered until the sediments are encountered, pulled up approximately 6-inches, and allowed to free fall. With the tension relieved, the spring on the locking pin forces the pin out of the hole in the arms. As the sampler is retrieved, the jaws close trapping the sediment sample inside. Any surface water entrapped in the sampler is slowly decanted through a screened port on the top of the ponar.

2.6 Surface Soil Sampling

Sampling techniques that may be employed for surface soil sampling include, stainless-steel trowel sampling and stainless-steel hand auger sampling, depending on the nature of the material to be sampled. A stainless-steel trowel will typically be used to collect samples of loosely packed materials and a stainless-steel hand auger for densely packed materials. Surface soil samples will be obtained from a depth of 0 to 6 inches below ground surface (bgs) and typically be used to investigate leaks and spills on the ground surface. Samples collected from beneath paved or gravel surfaces are not considered surface samples. Table 2-2 lists the required containers, preservatives, and holding times for soil samples.

2.7 Soil Borings

Before soil borings (or well borings) are initiated, utility clearances will be obtained from the Navy. Borings will be advanced by utilizing either direct-push technology (DPT) or by a drill rig. If physical access to areas is restricted, soil borings may also be advanced using a hand auger or a tripod-mounted sampling device. The locations and total depth of hand-

augered boreholes will be determined in the field based upon subsurface soil conditions and site specific sampling objectives.

2.7.2 Soil Borings Performed by Direct Push Technology (DPT)

Direct push technology (DPT) may be used to collect soil samples. Shallow borings will be performed using a DPT rig and a 4-ft long Macro Core sampling device or equivalent (See DPT SOP). The borings will extend to the desired depth defined by the site-specific work plans. If field evidence (e.g., screening readings above ambient on a photoionization detector) indicates possible contamination, or if layers of waste are identified, a sample will be collected from that material. If there is no visual or other field evidence of waste material, a sample will be collected from a depth interval from 2 feet above the water table to the water table. Boreholes resulting from subsurface soil sampling activities will be sealed with hydrated bentonite powder or pellets.

2.7.2 Soil Borings Performed by Drilling

Subsurface soil sampling by drilling can be performed using a tripod, truck-mounted, or all-terrain vehicle (ATV) drill rig, using a split-spoon sampler. The sampler is driven into unconsolidated materials using a falling weight connected to the drill rig. The soil borings performed under these investigations will typically be sampled continuously (every 2-feet) or periodically (every 5-feet) to depth, as necessary, for lithologic and/or chemical characterization. A geologist will observe the drilling and sampling operations. The soil will be classified according to the Unified Soil Classification System (USCS). Field observations of lithology, moisture content, discoloration's, odors, and other visible features will be described and recorded in the field logbook. During advancement of the boring, a photoionization detector will be used to measure volatile organic contamination in the soil cuttings and split spoon samples. Subsurface soil samples may be analyzed from all or selected boreholes.

Upon completion, each boring will be backfilled with a bentonite-cement grout mixture. A labeled stake will be placed at the ground surface near the borehole for future reference. Asphalt or other surface material will be patched. Auger cuttings will be containerized in a roll-off or steel drums. If significant contamination is present, either visually or by measurement from a photoionization detector (PID), the soil will be drummed separately, labeled with the appropriate boring number, and placed on a wooden pallet at the site. Soil cuttings from background locations will be spread on the ground near the borehole and not containerized.

2.8 Subsurface Soil Sampling

Split spoon sampling techniques will typically be used at locations where samples are being collected from depths greater than 3-5 feet, discreet sampling intervals, from beneath asphalt, or where compaction of the soil has made sample collection using manual augers or trowels impossible.

A drill rig will be used to advance hollow stem augers to the top of the desired sampling interval. The inner diameter of the augers will be based on the use of the borehole and specified in site-specific Sampling and Analysis Plans (SAPs). A stainless-steel split-spoon

sampling device will be attached to the proper length of drilling rod and inserted through the hollow stem augers. A 150-pound hammer will be used to advance the split-spoon sampling device up to 2-feet below the auger or until refusal as required for sample collection. The split spoon sampler will then be retrieved and the sample handled in accordance with site specific SAPs.

2.9 Monitoring Well Installation

Monitoring wells will be installed in selected boreholes. Boreholes drilled for monitoring well installation will be lithologically logged by the Field Geologist as described in Section 2.7. Well locations will be determined based upon previous analytical results, or other pertinent field data, as described in the site specific work plans.

Monitoring well borings will usually be installed using hollow stem augers, unless field conditions require the use of a rotary method. The rotary method will utilize the addition of drilling water, not drilling mud. Well screens will be placed within the zone of interest. Specific well screen placement will be discussed in the Site-Specific Work Plans.

At locations where permanent wells are not required or well installation cannot be completed using a truck-mounted or ATV drilling rig, drive points may be installed. Drive points are 2-inch diameter, stainless steel monitoring wells with short screens which are installed by driving the well point into the ground. These will be installed in wet areas where the weight of a drilling rig cannot be supported, or because of steep slopes or dense forest. Drive points may also be installed in an open borehole.

2.9.1 Monitoring Well Construction

Monitoring wells will generally be constructed of 2 or 4-inch I.D., Schedule 40 polyvinyl chloride (PVC) risers and screen, with flush joint threads. Wells will typically have 10 to 15-feet screen lengths, depending upon aquifer thickness. Samples of aquifer material for grain size analysis may be collected from selected well borings. From this information, screen slot size and sand pack particle size will be determined. Wells will have a 2 to 3-foot sump, below the screen to catch small particles which may move through the sand pack. Wells may also be constructed of stainless steel rather than PVC in areas where high concentrations of solvents are present in the groundwater that could degrade a PVC well.

A sand pack will be placed around the screened interval to one to two feet above the top of the screen. A minimum of two feet of bentonite will be placed above the sand pack. If above the water table, bentonite will be hydrated with potable water prior to grouting. Grout will be placed via a side-discharging tremie pipe above the bentonite pellets to within one foot of the ground surface.

Drive points may be constructed in one of two ways. If the drive point is hammered into place, no other well construction will be necessary, and the well assembly is fabricated from 2-inch diameter stainless steel and includes a screen (anticipated to be 2-3 feet in length), casing, and a hardened point. If a hand augered borehole is used, the procedure will consist of:

- Advancing a 4-inch diameter hand auger to the desired depth below the water table.

- Installing a temporary casing if the borehole collapses using PVC pipe hammered into the collapsing borehole and reaugered to clean out the soils until final depth is achieved.
- Placing a 2-inch diameter drive point in the open borehole.
- Placing sand pack around the drive point to a depth that is approximately 1 foot above the screened interval.
- Placing a bentonite seal above the sand pack to the top of the borehole.
- Grouting will not be used in drive points.

In high traffic areas, wells will be completed with a flush mounted protective casing with locking cap. A 2-foot x 2-foot x 4-inch concrete pad will be installed in the asphalt or concrete to reinforce the shallow wells. This will be sloped away from the well to prevent surface water infiltration.

Wells completed where there is no vehicular traffic will have 2- to 3-feet of "stickup" above ground surface. A steel protective casing will be placed over the riser and cemented into a 4-foot x 4-foot x 4-inch concrete pad. Steel guard posts will be placed around the protective casing to prevent accidental damage. The pad will be sloped away from the well to prevent surface water infiltration.

2.9.2 Monitoring Well Development

Monitoring wells will be developed prior to sampling by removing water from each well using a disposable polyethylene bailer and clean rope, submersible pump, or bladder pump. The development water will be discharged into 55 gallon drums or other storage containers (e.g., tankers). A surge block also will be used to aid in development. If dedicated sampling equipment is not used, equipment will be decontaminated between wells.

Well development will be performed after the grout used to construct the well has been allowed to adequately set (at least 48 hours). The groundwater levels will be measured to the nearest 0.01 foot from the top of the PVC casing. Development will consist of removing at least three well volumes of water, plus the amount of water added during the drilling or installation process. Development will continue until the water clears, or until 6 hours of development has passed, whichever comes first. Water clarity will be measured with a nephelometric turbidity unit (NTU) meter. Development information, including water clarity, pH, specific conductivity, and temperature, will be recorded in the field logbook.

Wells installed as part of previous investigations will be evaluated in the field to determine if redevelopment is required. Redevelopment will be considered necessary if 10 percent or more of the screen length has been "silted in," that is, filled in by soil particles; this soil matter leads to turbid samples and possibly incorrect conclusions about groundwater analytical results. If redevelopment is necessary, it will follow similar procedures as for newly installed wells; however, additional time and volume of water removed may be needed to remove the fine sediment from the well.

After installation of drive points, the inside of each drive point screen will be scrubbed with a 2-inch diameter round steel brush to clean out any mud or sediment that might clog the screen slots. The water in the drive point will then be bailed out. If necessary, distilled

water may be added and the screens scrubbed again to facilitate water flow through the screen. This procedure may be repeated two or three times to clean the screen.

2.10 Monitoring Well Abandonment

Well abandonment will be performed on monitoring wells which are no longer in use or which are improperly constructed. The well abandonment procedures are in accordance with the Virginia Department of Health (VDOH). The objective of this procedure is to prevent contamination from reaching groundwater through the well (VDOH, April 1992). The well will be overdrilled using hollow stem augers and, if possible, the casing will be removed. The casing will be decontaminated, cut into small sections approximately 3 feet long, and disposed as regular trash. The well will be filled with grout by a tremie pipe which will extend to the bottom of the well. As the grout fills the well, the pipe will be raised.

2.11 Groundwater Sampling from Monitoring Wells

Monitoring wells will not be sampled for at least two weeks after the well has been developed. This will allow an adequate amount of time for the well to recover. Prior to sampling, groundwater will be purged from each well. Purging will be performed until at least three borehole volumes have been removed and the temperature, specific conductance, and pH have stabilized to within 10 percent for three consecutive readings. The borehole volume will be calculated using values for the depth of the well, the depth to water, and the well diameter. Purging will be accomplished using low flow pumps or bailers. Well purging data will be recorded in the field logbook. The Investigation-Derived Waste Management Plan (IDWMP) discusses treatment and disposal of purge water.

Samples will be collected after the field parameter measurements have stabilized. Wells that are pumped dry during purging will be allowed to recover before sampling; the sample will be obtained as soon as a sufficient volume of groundwater to fill all sample containers has entered the well.

Groundwater samples will be collected from the well using a clean, double check valve bailer or low-flow sampling pump. The sample will be transferred from the bailer or the pump into properly-labeled, laboratory-prepared sampling containers filled and/or preserved as appropriate; cooled to approximately 4 degrees Celsius (°C); and shipped to the analytical laboratory under appropriate CoC documentation procedures. If needed, samples will be field filtered prior to preservation using a 0.45 micron filter. The filter will be prepared prior to use by rinsing with distilled water or otherwise following the manufacturer's instructions. Table 2-1 shows the required containers, preservatives, and holding times for water samples.

2.12 In-Situ Groundwater Sampling

Groundwater samples may be collected using a Geoprobe® hydraulic sampler or a HydroPunch® hydraulic sampler mounted on a 4-wheel-drive truck where permanent wells are not installed and the extent of groundwater contamination needs to be defined. Prior to

sampling activities, utility clearances will be performed. The borehole will be advanced using a drill rig and hollow stem auger techniques to reach the depth of interest in the aquifer. At that depth, the drill rods will be removed and the Geoprobe® or HydroPunch® samplers hydraulically pushed to the zone of interest. The cover will then be retracted, allowing water to flow into the device. Groundwater samples will either be retrieved using a double check valve sampling tool or a "mini" bailer. Samples will be collected directly into sample containers that have been precleaned and preserved by the analytical laboratory to EPA specifications. Table 2-1 shows the required containers, preservatives, and holding times for water samples.

2.13 Aquifer Testing

Aquifer testing that might be completed include slug tests, step-drawdown pumping tests, and constant-rate pumping tests.

2.13.1 Slug Tests

Rising and falling head slug tests may be performed in monitoring wells to evaluate aquifer hydraulic conductivity in the vicinity of the well. Slug tests will be performed after groundwater sampling using solid PVC slugs with clean bailer rope. A pressure transducer attached to an electronic recording device, such as an In-Situ Hermit™, will be used to record changes in pressure associated with water level recovery. Tests will be repeated three times to verify reproducibility.

2.13.2 Step-Drawdown Pumping Tests

Step-drawdown pumping tests might be performed to ascertain the efficiency (specific capacity) of a well and to determine an appropriate pumping rate for conducting a constant-rate pumping test. Methodology will be described in site-specific work plans and field sampling plans.

2.13.3 Constant-Rate Pumping Tests

A constant-rate pumping test might be performed on a well to ascertain the transmissivity and storage coefficient or storativity of the aquifer for use in modeling and capture zone analyses. Methodology will be described in site-specific work plans and field sampling plans.

2.14 Hydrologic Measurements

Groundwater or surface water hydrologic measurements may be collected at St. Juliens Creek Annex. Measurement procedures are described below.

2.14.1 Groundwater Level Measurements

Groundwater level measurements will be measured in monitoring wells and drive points. Fluid level measurements will be used to evaluate the movement of groundwater, the horizontal hydraulic gradient, the vertical hydraulic gradient, and the thickness of any free product, if present. This information, when combined with other site-specific information

such as hydraulic conductivity, extent of contamination, and product density, may be used to estimate contaminant movement or source areas. Fluid levels will be measured with a water level indicator or oil/water interface probe, as appropriate. The depth from the top of casing to fluid level will be recorded to the nearest 0.01 foot.

2.14.2 Surface Water Level Measurements

Surface water level measurements may be read from surveyed staff gauges placed in surface water bodies. Surface water level measurements will be used with groundwater measurements to help determine communication between surface water and groundwater. Depth of surface water bodies may be measured using a graduated weighted tape or similar device. Average width of the water body may be measured using a tape measure or a rangefinder, relative velocity of a water body will be estimated if the velocity cannot be measured with a flow meter.

2.15 Biota Sampling

Aquatic biota sampling for surface water may include collecting aquatic macroinvertebrate and fish. The biota samples will be located to represent upstream, adjacent, and downstream conditions when possible. In selecting the station locations in tidal areas, the presence of a salt wedge and the magnitude of tidal influence upstream of the site will be considered. Site-specific conditions, such as headwater systems, may preclude the establishment of an upstream station.

Qualitative terrestrial vegetation sampling, qualitative mammalian species surveying, qualitative herpetofauna community surveying, and avian community surveying may be performed.

2.15.1 Aquatic Macroinvertebrate Sampling

Benthic macroinvertebrates will be collected using a Ponar bottom grab sampler or hand-held coring device. A minimum of three replicate grab samples will be collected at each sampling location because of the precision of macroinvertebrate sampling. Sampling precision is affected by the substrate area encompassed by the sampling device and the distribution of the organisms. Three replicate random sampling units at each sampling location generally are considered a minimum based on guidance in *Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters* (USEPA, 1990). The invertebrate taxa will be identified to genus and species level with the exception of fragmented and juvenile specimens and for those species with known taxonomic difficulties.

2.15.2 Fish Sampling

Fish will be collected from surface water bodies using electrofishing, gill nets, seining, trot lines, or other fish collection techniques. The fish collection method used will depend on whether freshwater or estuarine systems are being evaluated. Electrofishing will be used in freshwater systems. Gill nets, trap nets, and trot lines will be used in estuarine and large stream and riverine systems. Seines will be deployed in small stream systems and from the shore of large estuarine and riverine systems.

Sampling will be conducted in areas within the designated reach that will ensure adequate representation of the fish community. Fish will be held in fish boxes with an adequate air supply until taxonomic identification and field processing. Species will be identified, measured, and weighed. Fish with disease, tumors, fin damage, and skeletal anomalies will be noted. One representative fish from each species will be preserved for taxonomic verification. All remaining fish will be returned to the surface water body.

In addition to fish community sampling, fish tissue sampling may be conducted to determine bioconcentration of selected contaminants in fish.

2.16 Test Pits/Trenching

Test pits or trenches may be completed in areas where characterization of fill or other waste materials is required or the extent of contamination needs to be determined. Test pits/trenches may be excavated up to 15 feet in length and to a maximum depth of ten feet. Samples of materials excavated from the trench will be collected from the bucket of the backhoe or the pile of excavated material using a stainless steel trowel or spoon. Test pits/trenches will not be entered by any member of the sampling team.

The position of the test pit/trench will be determined in the field by the Project Geologist/Scientist. Utility clearance will be obtained from the Navy prior to excavation. Excavation equipment will be decontaminated prior to and after each test pit/trench excavation. Excavation will proceed by removing lifts of no more than about 6 to 12 inches, until an assessment of the material can be made. The material removed from the trench will be placed on plastic sheeting. A geologist will log the test pit materials. The cross section will be sketched or described and notable features will be identified in the field log book. Depths will be measured from the ground surface. The length and width of the test pit will also be measured. The test pits/trenches will be backfilled with the material removed from the excavation immediately after completed to reduce site hazards and minimize the potential for rainwater accumulation and subsequent contaminant migration.

2.17 Land Surveying

Surveying activities will be conducted by a qualified surveying subcontractor licensed in the Commonwealth of Virginia. The following land surveying activities may be conducted at the Base:

- Obtaining elevations of groundwater monitoring wells, piezometers, soil borings, and drive points, to an accuracy of 0.01 feet, referenced to mean sea level (msl). Elevations will be determined from a United States Geological Survey (USGS) benchmark located at the Base. Benchmarks may not be readily accessible to the survey sites.
- Establishing the elevation reference point for wells at the top of the inner PVC well casing, and a permanent mark designating the elevation point. The ground surface elevation for each well and boring will be established to an accuracy of 0.01 feet. Horizontal control shall be established to the 0.1 foot.

- The location of each well, boring, and test pit will be tied into permanent land monuments (e.g. building corners). Horizontal control shall be established to the 0.1 foot.
- Grid intersections (for soil gas or geotechnical surveys) will be marked with wooden stakes and will be numbered by the surveyor with a unique location number.
- Surveying of surface water/sediment sampling stations may be difficult, especially because of the steep terrain around streams and drainage areas. The field team will estimate these locations in the field and mark them on a field map during sampling.

Portable Global Positioning Satellite (GPS) systems may also used to determine horizontal coordinates for points, such as sampling locations and grid points. Horizontal control varies with different GPS systems.

2.18 Investigation-Derived Waste Sampling

Investigation derived wastes (IDW) include disposable materials used in the normal course of field operations, such as health and safety equipment and sampling equipment. IDW also includes materials generated from drilling and sampling activities, such as drill cuttings, development and purge water, and decontamination water. Base wide IDW management is addressed in the Master IDWMP.

2.19 Decontamination

Temporary decontamination pads will be placed at strategic locations throughout the base prior to field activities generating large quantities of water. The decontamination pads will be constructed of high density polyethylene and wood with elevated sides and a sump to collect fluids. These fluids will be pumped into a tank or drums designated for that site. The location of the decontamination pads will be finalized during mobilization, as directed by the Base, and will be based upon areas/sites that are under investigation. Specific elements of decontamination are described below.

2.19.1 Sampling Equipment Decontamination

Sampling equipment (i.e., split-spoons, sampling trowels, bucket augers, bailers, etc.) will be decontaminated prior to sampling and between samples. Waters generated during decontamination of sampling equipment at each site or SSA will be contained in 55-gallon drums, pending receipt of analytical results and final disposition recommended to the Base. Decontamination water will be segregated from all other water because of solvents and acids that are introduced into the water.

All heavy equipment, including the drilling rig, rods and augers, and other downhole equipment used during site investigation activities will be decontaminated prior to use and between locations using a high-pressure steam wash at a decontamination pad located on or near the site. The steam-cleaning water will be from a potable source. The decontamination water will be pumped into drums with a sump pump and the drums will be immediately emptied into a tank that is centrally located at each site. Monitoring well

casings and screens will also be steam-cleaned using the same procedure, unless they are certified by the manufacturer as clean and plastic seals are intact.

2.19.2 Personnel Decontamination

Personnel decontamination is discussed in the Master Health and Safety Plan (HASP).

2.20 Field Tests

Various field tests may be performed during sampling activities. Field tests are commonly used to measure water quality parameters of groundwater and surface water and to assess the chemical properties of soil.

Water quality parameters that may be measured during field activities include pH, Eh, specific conductance, dissolved oxygen, temperature, alkalinity, and turbidity. Measurement of these parameters will be performed in accordance with SOPs and site-specific WPs, and FSPs.

Field tests used to assess the chemical properties of site soils include, but are not limited to, X-ray fluorescence (XRF) field screening - to identify soil containing concentrated amounts of heavy metals; immunoassay screening - to determine the presence of PCBs, polycyclic aromatic hydrocarbons (PAHs), benzene, or trinitrotoluene (TNT) above certain concentrations; flame ionization detector (FID) and PID headspace screening - to detect the presence of organic and inorganic vapors being emitted from soil. All soil field tests will be performed in accordance with site-specific WPs, FSPs, and SOPs.

SECTION 3.0

Documentation

3.1 Sample Designation

Each sample will be designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Site-specific procedures are elaborated below.

Location types will be identified by a two-letter code. Each sampling location will be identified with a two-digit number corresponding to the well or sampling location.

The following is a general guide for sample identification:

First Segment of Sample Number	Second Segment of Sample Number	Third Segment of Sample Number	
Naval Installation Abbreviation	Site Number	Sample Type	Sample Location
AA	AAA	AA	AAAAA

Symbol Definition:

A = Alphanumeric

Site Abbreviation:

AA = Two letter abbreviation identifying the Naval Installation where the sample was collected. St. Juliens Creek = SJ

Site Number:

AA = One letter and two numbers identifying the site on the Naval installation where the sample was collected (i.e. S21 = Site 21 and U2 = SWMU 2

Sample Type:

SS = Soil Sample
SB = Soil Boring (subsurface soil) Sample
SD = Sediment Sample
SW = Surface Water Sample
GP = Geoprobe® Groundwater Sample
GW = Groundwater Sample
DR = Drum Sample
PZ = Piezometer Sample
SG = Soil Gas Sample
TR = Trench Sample

IS	=	IDW Soil Sample
IW	=	IDW Water Sample

Sample Location

AAAAA	=	Unique sample number and qualifiers.

Qualifiers

P	=	Duplicate Sample
L	=	Diluted for laboratory analysis
R	=	Rerun of laboratory analysis

Numbering Format for QA/QC Samples

QA/QC samples will follow the following pattern:

AA-AAAAAA

where the two digits before the hyphen will be alphabetic, by QA/QC type, and the six digits after the hyphen will designate the date on which the samples were collected. Eligible QA/QC sample types are:

FB	Field blank
TB	Trip blank
EQ	Equipment blank

The date designation will always have six digits in a DDMMYY format. Examples of this numbering approach for QA/QC samples are:

FB-100196	Field blank collected on October 1, 1996
TB-072997	Trip blank collected on July 29, 1997
EQ-080198	Equipment blank collected on August 1, 1998

3.2 Sample Shipping Procedures

All field-sampling activities will be documented through the use of field logs and chain-of-custody procedures. Sample containers will be clean first-quality containers provided by the laboratory. An identification label, indicating the sample number, station number, analysis to be performed, preservative used, date and time of sample collection, and the name of the responsible sampling team member, will be attached to each sample container.

After being collected, samples will be packed in coolers with vermiculite and ice for delivery to the laboratory. Chain-of-custody forms will be taped to the inside of the lid of each cooler. Chain-of-custody forms contain general information about the location of the activity and the members of the sampling team, as well as specific information about type of sample, sample location, number of sample containers from each station, and analyses to be performed. Each time the sample is relinquished or received, the party involved signs the form and notes the time and date.

The coolers used to deliver the samples will be sealed with strapping tape. Evidence tape will be placed across the front and back of each lid to control tampering. The samples will be delivered to the laboratory at the end of each day of sampling to ensure that holding times are not exceeded.

Standard Operating Procedures

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STANDARD OPERATING PROCEDURE

Field Measurement of pH

I. Purpose

To provide a general guideline for field measurement of pH of groundwater samples.

II. Scope

The following general discussion applies to most commonly used pH meters but may differ between specific brands. The operator's manual should be consulted for specific calibration and operating procedures.

III. Equipment and Materials

- pH buffer solution for pH 4, 7, and 10
- Deionized water in squirt bottle
- pH meter
- Combination electrodes
- Beakers
- Glassware that has been washed with soap and water, rinsed twice with hot water, and rinsed twice with deionized water

IV. Procedures and Guidelines

A. Calibration

Calibrate unit prior to initial daily use and at least once every 4 hours or every five samples, whichever is less. Calibrate with at least two solutions. Clean probe according to manufacturer's recommendations. Duplicate samples should be run once every 10 samples or every 4 hours which ever is more frequent.

1. Place electrode in pH 7 buffer solution.
2. Allow meter to stabilize and then turn calibration dial until a reading of 7.0 is obtained.
3. Rinse electrode with deionized water and place it in a pH 4 or pH 10

buffer solution.

4. Allow meter to stabilize again and then turn slope adjustment dial until a reading of 4.0 is obtained for the pH 4 buffer solution or 10.0 for the pH 10 buffer solution.

5. Rinse electrode with deionized water and place in pH 7 buffer. If meter reading is not 7.0, repeat sequence.

B. Procedure

1. Before going out into the field:

   a) Check batteries.
   b) Do a quick calibration at pH 7 and 4 to check electrode.
   c) Obtain fresh solutions.

2. Calibrate meter using calibration procedure in the operators manual.

3. Pour the sample into a clean beaker.

4. Rinse electrode with deionized water between samples.

5. Immerse electrode in solution. Make sure the white KCl junction on the side of the electrode is in the solution. The level of electrode solution should be one inch above sample to be measured.

6. Recheck calibration with pH 7 buffer solution after every five samples.

C. General

1. When calibrating the meter, use pH buffers 4 and 7 for samples with pH < 8, and buffers 7 and 10 for samples with pH > 8. If meter will not read pH 4 or 10, something may be wrong with the electrode.

2. Measurement of pH is temperature dependent. Therefore, buffers temperatures should be within about 2 degrees C of sample temperatures. For refrigerated or cool samples, use refrigerated buffers to calibrate the pH meter.

3. Weak organic and inorganic salts and oil and grease interfere with pH measurements. If oil and grease are visible, note it on the data sheet. Clean electrode with soap and water and rinse with distilled water. Then recalibrate meter.

4. Following field measurements:

   a) Report any problems.
   b) Compare with previous data.
   c) Clean all dirt off meter and inside case.
   d) Store electrode in pH 4 buffer.

5. Accuracy and precision are dependent on the instrument used; refer

to manufacturer's manual. Expected accuracy and precision are +/- 0.1 pH unit.

V. Key Checks and Items

- Check batteries
- Calibrate

VI. Preventive Maintenance

- Refer to operation manual for recommended maintenance.
- Check batteries, have a replacement set on hand.

STANDARD OPERATING PROCEDURE

Field Measurement of pH and Eh

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for field measurement of pH and Eh.

II. Equipment and Materials

- pH buffer solution for pH 4, 7, and 10
- Deionized water in squirt bottle
- pH/Eh meter, calibration sheet, and instructions
- pH and redox electrodes
- Beakers
- Glassware that has been washed with soap and water, rinsed twice with hot water, and rinsed twice with deionized water
- 4 M KCl saturated with Ag/AgC1 solution, electrode filling solution.

III. Procedures and Guidelines

A. Calibration

Calibrate unit prior to initial daily use. There are no calibration procedures for the redox electrode. Calibrate with at least two solutions. Clean the probe according to the manufacturer's recommendations. Duplicate samples should be run once every 10 samples. The order of calibration solutions will be based on the instrument manufacturer's recommendation.

1. Place electrode in pH 7 buffer solution.
2. Allow meter to stabilize, and then turn calibration dial until a reading of 7.0 is obtained.
3. Rinse electrode with deionized water and place it in a pH 4 or pH 10 buffer solution.
4. Allow meter to stabilize again and then turn slope adjustment dial until a reading of 4.0 is obtained for the pH 4 buffer solution or 10.0 for the pH 10 buffer solution.

5. Rinse electrode with deionized water and place in pH 7 buffer. If meter reading is not 7.0, repeat sequence.

B. Procedure

1. Before going out into the field:

   a. Check batteries.
   b. Do a quick calibration at pH 7 and 4 to check electrode.
   c. Obtain fresh calibration solutions.
   d. Fill electrodes.

2. Calibrate meter using calibration procedure.

3. Pour the sample into a clean beaker.

4. Rinse electrode with deionized water between samples.

5. Immerse electrode in solution. Make sure the white KCl junction on the side of the electrode is in the solution. The level of electrode solution should be one inch above sample to be measured.

6. Recheck calibration with pH 7 buffer solution after every five samples.

C. General

1. When calibrating the meter, use pH buffers 4 and 7 for samples with pH <8, and buffers 7 and 10 for samples with pH >8. If meter will not read pH 4 or 10, something may be wrong with the electrode.

2. Measurement of pH is temperature dependent. Therefore, buffers temperatures should be within about 2 degrees C of sample temperatures. For refrigerated or cool samples, use refrigerated buffers to calibrate the pH meter.

3. Weak organic and inorganic salts and oil and grease interfere with pH measurements. If oil and grease are visible, note it on the data sheet. Clean electrode with soap and water and rinse with distilled water. Then recalibrate meter.

4. Following field measurements, report problems and compare with previous data. Clean dirt off meter and inside case and store electrode in pH 4 buffer.

5. Accuracy and precision are dependent on the instrument used; refer to manufacturer's manual. Expected accuracy and precision are +/- 0.1 pH unit.

6. The redox electrode should be checked prior to beginning site work and when anomalous readings suggest that the probe is malfunctioning. The procedure for checking the redox electrode is as below:

a. Prepare solution A (0.1 M potassium ferrocyanide and 0.005 M potassium ferricyanide): weigh out 4.22 g reagent-grade $K_4Fe(CN)_6 \cdot 3H_2O$ and 1.65 g reagent-grade $K_3Fe(CN)_6$. Place in a 100 ml volumetric flask. Add about 50 ml distilled water and swirl to dissolve solids. Dilute to volume with distilled water.

b. Prepare solution B (0.01 M potassium ferrocyanide, 0.05 M potassium ferricyanide, and 0.36 M potassium fluoride): Weigh out 0.42 g reagent-grade $K_4Fe(CN)_6 \bullet 3H_2O$ 1.65 g reagent-grade $K_3Fe(CN)_6$, and 3.39 g reagent-grade $KF \bullet 2H_2O$. Place in a 100 ml volumetric flask. Add 50 ml distilled water, and swirl to dissolve solids. Dilute to volume with distilled water.

c. Transfer solution A to a 150 ml beaker. Place electrode in the solution and wait until the reading stabilizes. The potential should be about 234 mV.

d. Rinse electrode and repeat the measurement with solution B. The potential should be about 66 mV greater in solution B than in solution A.

IV. Key Checks and Preventive Maintenance

- Check batteries, have a replacement set on hand.
- Calibrate meter.
- Refer to operation manual for recommended maintenance.

STANDARD OPERATING PROCEDURE

Field Measurement of Specific Conductance and Temperature

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for field measurement of specific conductivity and temperature of groundwater samples. The following general discussion applies to most commonly used meters but may differ between specific brands. The operator's manual should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Conductivity meter and electrode
- Distilled water in squirt bottle
- Standard potassium chloride (KCl) solution (0.01 N)

III. Procedures and Guidelines

A. Technical:

Detection limit = 1 μmho/cm @ 25°C; range = 0.1 to 100,000 μmho/cm

B. Calibration:

Calibrate prior to initial daily use with standard solution. The standards should have different orders of conductance. Clean probe according to manufacturer's recommendations. Duplicates should be run once every 10 samples. Calibration procedure:

1. With mode switch in OFF position, check meter zero. If not zeroed, set with zero adjust.

2. Plug probe into meter.

3. Turn mode switch to red line and turn red line knob until needle aligns with red line on dial. If they cannot be aligned, change the batteries.

4. Immerse probe in 0.01 N standard KCl solution. Do not allow the probe to touch the sample container.

5. Set the mode control to TEMPERATURE. Record the temperature on the bottom scale of the meter in degrees C.

6. Turn the mode switch to appropriate conductivity scale (i.e., x100, x10, or x1). Use a scale that will give a midrange output on the meter.

7. Wait for the needle to stabilize. Multiply reading by scale setting and record the conductivity.

8. If the conductivity meter does not perform an automatic temperature adjustment, the conductivity may be adjusted to 25°C using the formula:

$$G_{25} = G_T / [1 + 0.02 (T - 25)]$$

Where:

G_{25} = conductivity at 25°C, µmho/cm

T = temperature of sample, degrees C

G_T = conductivity of sample at temperature T, µmho/cm

The table below lists the values of conductivity that the calibration solution would have if the distilled water were totally nonconductive; however, even water of high purity will possess a small amount of conductivity.

Temperature °C	Conductivity (µmho/cm)
15	1,141.5
16	1,167.5
17	1,193.6
18	1,219.9
19	1,246.4
20	1,273.0
21	1,299.7
22	1,326.6
23	1,353.6
24	1,380.8
25	1,408.1
26	1,436.5
27	1,463.2
28	1,490.9

29	1,518.7
30	1,546.7

9. Rinse the probe with deionized water.

C. Sample Measurement:

Pour the sample into a small beaker and place the probe in the sample. Note and record the reading. Rinse the probe with deionized water when done.

IV. Attachments

- Conductivity meter calibration sheet

V. Key Checks and Preventive Maintenance

- Check battery.
- Calibrate meter.
- Clean probe with deionized water when done.
- When reading results, note sensitivity settings.
- Refer to operations manual for recommended maintenance.
- Check batteries, and have a replacement set on hand.

CONDUCTIVITY METER CALIBRATION SHEET

Date	Time	Analyst Initials	Instrument Readings: Uncalibrated @ EC=225	Instrument Readings: Calibrated @ EC=225	Comments

STANDARD OPERATING PROCEDURE

Field Measurement of Dissolved Oxygen

I. Purpose

To provide general guidelines for the calibration and use of the Dissolved Oxygen (DO) meter.

II. Scope

The following general discussion applies to more commonly used meters but may differ between specific brands. The operator's manual should be consulted for specific calibration and operation procedures.

III. Equipment and Materials

- Operations manual
- A DO probe and readout/control unit with batteries
- Electrolyte solution (KCl dissolved in deionized water) and probe membrane

IV. Procedures and Guidelines

A. Calibration

Calibrate prior to initial daily use before any readings are taken. Clean probe according to manufacturer's recommendations.

1. Prepare DO probe according to manufacturer's recommended procedures using electrolyte solution.
2. In the off position, set the pointer to zero using the screw in the center of the meter panel.
3. Turn function switch to red line and adjust using red line knob until the meter needle aligns with red mark at the 31 degrees C position.
4. Turn function switch to zero and adjust to zero using the zero control knob.
5. Attach prepared probe and adjust retaining ring finger tight.
6. Allow 15 minutes for optimum probe stabilization (when meter is off or during disconnection of the probe).
7. For YSI meters, place probe in hollow stopper that is supplied for use with the YSI Calibration Chamber.

8. Place approximately 1/2 inch of deionized water into a 4-ounce, wide mouth screw cap bottle. Keep this bottle capped and with the DO meter.

9. Just before use, shake the bottle to saturate the water with air.

10. Remove cap, place probe in bottle keeping an air-tight seal around the rubber stopper. Swirl water around in the bottle while waiting for conditions to reach equilibrium.

11. Shield chamber from sun and wind to avoid temperature fluctuations during calibration.

12. Turn function switch to temperature and record temperature reading. Determine calibration factor for that temperature and altitude correction factor from tables supplied by manufacturer.

13. Multiply the calibration factor by the correction factor to get a corrected calibration value.

14. Turn function switch to appropriate ppm range and adjust the calibrate knob until the meter reads the corrected calibration value. Wait two minutes to verify calibration value. Re-adjust as necessary.

B. Procedure

1. Before going out into the field:

   a) Check batteries
   b) Obtain fresh electrolyte solution
   c) Prepare DO probe

2. Calibrate meter using calibration procedure.

3. Place probe in water to be measured. The probe should be moved through the water at 1 ft/sec or use a probe with a built-in stirrer.

4. Allow sufficient time for probe to stabilize to water temperature and DO. Record DO meter reading.

V. Attachments

DO Meter Calibration Sheet.

VI. Key Checks and Items

- Battery check
- Calibration

VII. Preventive Maintenance

- Refer to operation manual for recommended maintenance.
- Check batteries, have replacement set on hand.

DO METER
CALIBRATION SHEET

Date	Time	Analyst's Signature	Temp (C)	Alt. (ft)	Predict (ppm 0_2)	Actual (ppm 0_2)	Comment

STANDARD OPERATING PROCEDURE

Volatiles Monitoring by OVM

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for the calibration and use of an OVM Organic Vapor Monitor. This is a broad guideline for field use of an OVM; for specific instruction, refer to the operators manual.

II. Equipment and Materials

- Operations manual
- An OVM hand readout unit and side pack assembly
- 100 ppm isobutylene as calibration gas
- T-type feeder tube with 1.5 liter/min. regulator

III. Procedures and Guidelines

ONLY PROPERLY TRAINED PERSONNEL SHOULD USE THIS INSTRUMENT. FOR SPECIFIC INSTRUCTIONS, SEE OPERATIONS MANUAL.

OVM, Organic Vapor Monitor

1. Introduction

   The OVM Organic Vapor Monitor is designed to detect organic materials in air. It uses a photo-ionization detector (PID) as its detection principle. This detector allows the monitor to respond to a wide variety of organic compounds.

2. Operational Checks

   - See basic operating instructions in operations manual.

3. Calibration

   - See basic operating instructions in operations manual.

IV. Key Checks and Preventive Maintenance

- Check battery.
- Zero and calibrate.
- Verify sensor probe is working.
- Recharge unit after use.

A complete preventive maintenance program is beyond the scope of this document. For specific instructions, refer to the operations manual. Some key issues are discussed below:

- A complete spare instrument should be available whenever field operations require volatiles monitoring.
- Spare parts should be on hand so minor repairs may be made in the field.
- Batteries should be charged daily.
- Occasionally allow the batteries to totally discharge before recharging to prevent battery memory from occurring.

STANDARD OPERATING PROCEDURE

Close Support Laboratory Method for Analysis of Chlorinated Volatiles in Soil

I. Scope and Application

This method is proposed for field screening of soil and solid samples for chlorinated volatile hydrocarbons. It is presented as a means to rapidly characterize contamination in soil samples.

Application of this method is limited to screening analysis of soil for the target constituents listed in the field sampling plan. The chromatographic record produced in the analyses allows the site investigation team to examine the relative degree of soil contamination associated with other nontargeted compounds in the sample extracts. Positive identification and quantification of specific constituents will be supported by analyses of duplicate and other composited samples at a remote CLP laboratory employing EPA approved testing protocols.

Preliminary method validation data indicates analysis recoveries of upwards of 80 percent.

The method detection limits (MDL) for the target constituents are estimated to be 10 ug/kg. These estimates are the result of previous method development work.

II. Summary of Method

The methods presented here are loosely based on EPA Method 3550, sonification extraction, found in the EPA SW846, *Test Methods for Evaluating Solid Waste*, 3rd ed., November 1986. In brief, pentane is used in conjunction with sonification to effect extraction of the target constituents from the sample matrix. The extract is subsequently analyzed on a capillary gas chromatograph using an electron capture detector (ECD).

III. Interferences

Samples containing compounds that co-elute with the target constituents may cause a positive bias in the results.

The presence of compounds that closely match the retention times of the target constituents may result in false identifications.

The MDLs for the target constituents may be suppressed by baseline noise

associated with samples having high levels of background organics or other interferences.

The response factors for uncalibrated peaks that are significantly different than those of the target constituents may produce errors in the estimation of the total target constituent contamination.

IV. Safety

The target constituents are either identified as or suspected of being carcinogens. All samples are assumed to be hazardous. All stock and working calibration standards, as well as all samples, shall be handled with the utmost care using good laboratory techniques in order to avoid harmful exposure.

Lab analysts shall wear lab coats, safety glasses, and surgical gloves at all times when preparing and handling standards and field and lab samples.

Standards and samples shall be prepared in a fume hood.

Pentane (C_5H_{12}) is regulated by NIOSH. The suggested permissible exposure level (PEL) is 120 ppm with a ceiling level of 610 ppm. Exposure pathways are oral, dermal, and airway. Effects of short term exposure are drowsiness and irritation of eyes and nose, large doses may cause unconsciousness. Prolonged overexposure may cause irritation of the skin. The odor threshold of n-pentane is reported as 2.2 ppm. Pentane is highly flammable and is incompatible with strong oxidizing agents.

Sample extracts and standards prepared in flammable solvents shall be stored in a cooler (outside the laboratory).

All of the target compounds are reported in the NIOSH manual as having "good warning properties." Any situation which leads to or causes noticeable odors or produces any physical symptoms in the workers shall be investigated immediately followed by appropriate corrective action.

The ultrasonic sonicator used for sample extraction emits a high frequency sound. When in use, the sonicator horn shall be inside the sound chamber with the door closed.

Safety equipment including a fire extinguisher, first aid kit, eye wash, and chemical spill cleanup kit shall be available for use at all times.

Lab wastes shall be separated and properly disposed. The wastes include: used sample aliquots initial wash water, chemical wastes generated in the analysis, and disposables used in the preparation of the samples. These wastes shall be collected and deposited in a drum clearly marked as "CSL Lab Wastes Only--Hazardous." Water used for final rinsing of glassware will be considered nonhazardous and will be released into a 50 gallon drum. These wastes will then be disposed of in accordance with the appropriate and relevant disposal method.

V. Apparatus and Materials

Soil sampling equipment as described in the Quality Assurance Project Plan.

Volatiles sample vials (i.e., 40 ml capacity with septum screw caps).

Balance--Sartorius top loading electronic with 1,500 gram capacity with 0.01 gram sensitivity.

Glassware--class A volumetric pipets and flasks, beakers, vials, pasteur pipets, and miscellaneous glassware as necessary for preparation and handling of samples and standards.

Labware--necessary for preparation and handling of samples and standards.

Syringes--Hamilton glass type as required for injection of sample extracts and standards, preparation of dilutions, and spiking of samples.

Sonifier--Heat Systems Ultrasonic Sonicator with variable control up to 375 watt output and watercooled cup horn.

Gas chromatograph (GC)--Hewlett-Packard Model 5890A; temperature programming, electronic integration, report annotation, automatic sampler, 30-meter megabore capillary column (DB-1, 1.50 micron film thickness), and ECD.

VI. Chemicals, Reagents, and Gases

Pentane-spectro grade, 99.9 percent.

Sodium sulfate-reagent grade, anhydrous powder form.

Stock standards-prepare or purchase stand materials at approximately 1,000 mg/L in methanol.

Working standards-prepared from stock standards by precise dilution in pentane.

Nitrogen-carrier gas, prepuried grade.

VII. Calibration

External calibration-four-level calibration at approximately 10.0, 1.0, 0.1, and 0.01 µg/ml for the target constituents in pentane.

Working calibration-working calibration shall be performed with the analysis of each working day's lot of samples or with each lot of 20 samples, whichever is more frequent. Working calibration shall be verified by use of a mid-range standard mix. If the response factors and retention times vary by more than ± 15 percent or ± 0.10 minutes from the initial calibration, then recalibration shall be performed on freshly prepared working standards.

VIII. Sample Preparation and Extraction

Place a labeled vial on the top loading balance and record its tare weight. Add an aliquot of soil, approximately 5 grams to the vial and accurately record the soil sample weight to the nearest 0.01 grams.

Sample treatment: If the sample is wet or a highly consolidated material (i.e, clay), then add about 2 grams of sodium sulfate and mix using a glass rod.

In a labeled VOA vial, volumetrically pipet 5.0 ml of pentane (Section 6.8) and record the volume added.

With the VOA vial cap tightly in place, sonicate at an output setting of 30 percent for approximately 5 minutes. The resulting sonicated sample should be dispersed throughout the pentane solvent and have a grain-like appearance. If not, then add an additional 1 gram of sodium sulfate and resonify. Repetitions of this process may be needed to properly extract some samples.

After sonication, let the VOA vial stand until the solids have settled. Using a pasteur pipet, transfer a suitable aliquot of the pentane solvent (extract) from the vial into a labeled GC auto-sampler vial and cap immediately with septum crimp seals. Refrigerate the sample extracts until analyzed.

IX. Analysis

Perform GC analysis on the extract.

If the analysis indicates that the results are more than 50 percent above the calibration range, dilute the sample extract such that concentrations fall within the calibration range.

Check the retention values for each of the target constituents against the expected (calibration) value. Flag those results where the retention time does not fall within ± 0.05 minutes of the expected value. Reject those results where the retention time does not fall with ± 0.10 minutes of the expected value.

Use the retention time marker as an indicator of the reliability of each sample injection and GC run. The retention time marker should fall within the same windows as the target constituents and should be within ± 15 percent area counts of its initial calibration value. If these criteria are not met, re-evaluate the data using relative retention times. Reruns should occur to resolve data suspicions.

X. Calculations

Quantification of the target compounds is based on the integrated areas of samples in comparison to the integrated areas of the calibration standards for each analyst. The integrator reports the concentrations in ug/ml in the extracts. Calculation of the concentration for each target constituent in the original sample on an as received basis is as follows:

conc. in ug/kg = ((A x Vt x DF)/Ws) x 1000

where:

A	=	amount of target constituent found in the extract in ug/ml
Vt	=	volume of solvent added to the VOA vial, 5.0 ml (Section 8.1)
DF	=	dilution factor, if required (Section 10.2)
1,000	=	dimensional correction factor
Ws	=	weight of the sample added to the VOA vial in grams (Section 8.1)

XI. Quality Assurance

Quality assurance measures shall include as a minimum:

- Daily mid-range calibration checks performed prior to the analysis of each day's lot of samples or with each lot of 20 samples, whichever is more frequent.
- Analysis of field blank samples at a frequency of 1 in 20 samples analyzed or 1/day, whichever is more frequent.
- Analysis of laboratory blank samples at the same frequency. Should the results of the laboratory blanks show contamination, the cause of the contamination should be investigated and corrective action taken.
- Analysis of field duplicate samples at a frequency of 1 in 20 samples or 1/day, whichever is more frequent.
- Analysis of a mid-range matrix spike samples and a matrix spike duplicate at a frequency of 1 in 20 samples analyzed or 1/day, whichever is more frequent.
- Use of the retention time marker during the analysis of all samples and standards.

STANDARD OPERATING PROCEDURE

Close Support Laboratory Method for Analysis of Semivolatile Organics in Soil

I. Scope and Application

This method is proposed for field screening of soil and solid samples for volatile hydrocarbon parameters that are indicative of contamination at the site. It is presented as a means to rapidly characterize contamination in soil samples.

Application of this method is limited to screening analysis of soil for the target constituents listed in the field sampling plan. The chromatographic record produced in the analyses allows the site investigation team to examine the relative degree of soil contamination associated with other nontargeted compounds in the sample extracts. Positive identification and quantification of specific constituents, such as these constituents and other priority pollutants, will be supported by analyses of duplicate and other composited samples at a remote CLP laboratory employing EPA approved testing protocols.

Preliminary method validation data indicates analysis recoveries of upwards of 80 percent.

The method detection limits (MDL) for the target constituents are estimated to be 1 ug/gm. These estimates are the result of previous method development work.

II. Summary of Method

The methods presented here are loosely based on EPA Method 3550, sonification extraction, found in the EPA SW846, *Test Methods for Evaluating Solid Waste*, 3rd ed., November 1986 and "Screening of Semivolatile Organic Extracts" found in the *CLP Statement of Work (2/88)*. In brief, methylene chloride is used in conjunction with sonification to effect extraction of the target constituents from the sample matrix. The extract is subsequently analyzed on a capillary gas chromatograph using a flame ionization detector (FID).

III. Interferences

Samples containing compounds that co-elute with the target constituents may cause a positive bias in the results.

The presence of compounds that closely match the retention times of the target constituents may result in false identifications.

The MDLs for the target constituents may be suppressed by baseline noise associated with samples having high levels of background organics or other interferences.

The response factors for uncalibrated peaks that are significantly different than those of the target constituents may produce errors in the estimation of the total target constituent contamination.

IV. Safety

The target constituents are either identified as or suspected of being carcinogens. All samples are assumed to be hazardous. All stock and working calibration standards, as well as all samples, shall be handled with the utmost care using good laboratory techniques in order to avoid harmful exposure.

Lab analysts shall wear lab coats, safety glasses, and surgical gloves at all times when preparing and handling standards and field and lab samples.

Standards and samples shall be prepared in a fume hood.

Methylene chloride ($MeCl_2$), used in the preparation of sample extracts, is regulated by OSHA and described in NIOSH/OSHA manual, Occupational Health Guidelines for Chemical Hazards, 1981. The $MeCl_2$ permissible exposure level (PEL) is 500 ppm in air over an 8 hour period. Its odor threshold is between 25 and 50 ppm. Exposure pathways are oral, dermal, and airway. Effects of short term exposure are reported to be mental confusion, light headedness, nausea, vomiting, and headaches. High concentrations may cause irritation of the eyes and respiratory tract. Prolonged exposure may cause skin burns. $MeCl_2$ is nonflammable.

Sample extracts and standards prepared in flammable solvents shall be stored in a cooler (outside the laboratory).

The ultrasonic sonicator used for sample extraction emits a high frequency sound. When in use, the sonicator horn shall be inside the sound chamber with the door closed.

Safety equipment including a fire extinguisher, first aid kit, eye wash, and chemical spill cleanup kit shall be available for use at all times.

Lab wastes shall be separated and properly disposed. The wastes include: used sample aliquots initial wash water, chemical wastes generated in the analysis, and disposables used in the preparation of the samples. These wastes shall be collected and deposited in a drum clearly marked as "CSL Lab Wastes Only-Hazardous." Water used for final rinsing of glassware will be considered nonhazardous and will be released into a 50 gallon drum. These wastes will then be disposed of in accordance with the appropriate and relevant disposal method.

V. Apparatus and Materials

Soil sampling equipment as described in the Quality Assurance Project Plan.

Volatiles sample vials (i.e., 40 ml capacity with septum screw caps); precleaned as purchased from a vender.

Balance–Sartorius top loading electronic with 1,500 gram capacity with 0.01 gram sensitivity.

Glassware–class A volumetric pipets and flasks, beakers, vials, pasteur pipets, and miscellaneous glassware as necessary for preparation and handling of samples and standards.

Labware–necessary for preparation and handling of samples and standards.

Syringes–Hamilton glass type as required for injection of sample extracts and standards, preparation of dilutions, and spiking of samples.

Sonifier–Heat Systems Ultrasonic Sonicator with variable control up to 375 watt output and water cooled cup horn.

Gas chromatograph (GC)–temperature programming, electronic integration, report annotation, automatic sampler, 30-meter megabore capillary column (DB-1, 1.50 micron film thickness), and FID.

Refrigerator/freezer–complete with locks as needed for storage and controlled access to samples and sample extracts.

VI. Chemicals, Reagents, and Gases

Methylene chloride–spectro grade, 99.9 percent.

Sodium sulfate–reagent grade, anhydrous powder form.

Stock standards–prepare or purchase stand materials at approximately 1,000 mg/L in $MeCl_2$.

Working standards–prepared from stock standards by precise dilution in pentane.

Nitrogen–carrier gas, prepurified grade.

Hydrogen–FID gas, pre-purified grade.

Air–FID gas, zero grade.

VII. Calibration

External calibration–four-level calibration at approximately 100, 10, and 1 ug/gm for the target constituents.

Working calibration–working calibration shall be performed with the analysis of each working day's lot of samples or with each lot of 20 samples, whichever is more frequent. Working calibration shall be verified by use of a mid-range standard mix. If the response factors and retention times vary by more than 15 percent or 0.10 minutes from the initial calibration, then recalibration shall be performed on freshly prepared working standards.

VIII. Sample Preparation and Extraction

In a labeled VOA vial, accurately weigh out approximately 5 grams of soil recording the weight to the nearest 0.01 gram. This should be done immediately after weighing to avoid potential losses of analytes.

Sample treatment: If the sample is wet or a highly consolidated material (i.e, clay), then add about 2 grams of sodium sulfate and mix using a glass rod.

To the sample vial, volumetrically pipet 5.0 ml of methylene chloride (Section 6.8) and record the volume added.

With the VOA vial cap tightly in place, sonicate at an output setting of 30 percent for approximately 5 minutes. The resulting sonified sample should be dispersed throughout the pentane solvent and have a grain-like appearance. If not, then add an additional 1 gram of sodium sulfate and resonify. Repetitions of this process may be needed to properly extract some samples.

After sonification, let the VOA vial stand until the solids have settled. Using a pasteur pipet, transfer a suitable aliquot of the pentane solvent (extract) from the vial into a labeled GC auto-sampler vial and cap immediately with septum crimp seals. Refrigerate the sample extracts until use.

IX. Analysis

Perform GC analysis on the extract.

If the analysis indicates that the results are more than 50 percent above the calibration range, dilute the sample extract such that concentrations fall within the calibration range.

Check the retention values for each of the target constituents against the expected (calibration) value. Flag those results where the retention time does not fall within 0.05 minutes of the expected value. Reject those results where the retention time does not fall with 0.10 minutes of the expected value.

Use the retention time marker as an indicator of the reliability of each sample injection and GC run. The retention time marker should fall within the same windows as the target constituents and should be within 15 percent area counts of its initial calibration value. If these criteria are not met, re-evaluate the data using relative retention times. Reruns should occur to resolve data suspicions.

X. Calculations

Quantification of the target compounds is based on the integrated areas of samples in comparison to the integrated areas of the calibration standards for each analyst. The integrator reports the concentrations in

ug/ml in the extracts. Calculation of the concentration for each target constituent in the original sample on an as received basis is as follows:

conc. in ug/gm = (A x Vt x DF)/Ws)

where:

A	=	amount of target constituent found in the extract in ug/ml
Vt	=	volume of solvent added to the VOA vial, 5.0 ml (Section 8.1)
DF	=	dilution faction, if required (Section 9.2)
Ws	=	weight of the sample added to the VOA vial in grams (section 8.1)

XI. Quality Assurance

Quality assurance measures shall include as a minimum:

- Daily mid-range calibration checks performed prior to the analysis of each day's lot of samples or with each lot of 20 samples, whichever is more frequent.
- Analysis of field blank samples at a frequency of 1 in 20 samples analyzed or 1/day, whichever is more frequent.
- Analysis of laboratory blank samples at the same frequency. Should the results of the laboratory blanks show contamination, the cause of the contamination should be investigated and corrective action taken.
- Analysis of field duplicate samples at a frequency of 1 in 20 samples or 1/day, whichever is more frequent.
- Analysis of a mid-range matrix spike samples and a matrix spike duplicate at a frequency of 1 in 20 samples analyzed or 1/day, whichever is more frequent.
- Use of the retention time marker during the analysis of all samples and standards.

STANDARD OPERATING PROCEDURE

Close Support Laboratory Method for Analysis of PCBs in Soil Using a GC-ECD

Target Constituents

Polychlorinatedbiphenyls (PCBs)

Sample Matrix

Soil

Sample Preparation

Hexane Extraction/Perchlorination

Instrumental/Physical Method

Automated Sampler/Gas Chromatography

Method of Detection

Electron Capture Detector

Detection Level

The method detection limits (MDL) for PCBs are estimated to be 100 ug/kg. In general, the detection level is a function of sample matrix, sample preparation, and instrument performance.

I. Scope and Application

This procedure may be used for screening soil samples for polychlorinated biphenyls (PCBs). This procedure is applicable to samples containing PCBs as single congeners or as complex mixtures such as weathered, intact, or mixtures of commercial Aroclors. The procedure is incapable of identifying the parent PCBs because the original PCBs are chemically converted to a common product, decachlorobiphenyl (DCB).

This method is prone to false positive interferences. Positive identification and quantification of specific constituents, such as individual Arochlors, should be supported by analyses of duplicate and other composited samples at a laboratory employing agency-approved or published testing protocols.

Preliminary method validation data indicate analysis recoveries of 90 percent.

The method detection limit (MDL) is estimated to be 100 ug/kg for PCBs.

II. Summary of Method

The soil extraction and analysis is based on EPA Method 508A, Screening for Polychlorinated Biphenyls by Perchlorination and Gas Chromatography.

III. Interferences

In addition to PCBs, several compounds (biphenyl, polyhalogenated biphenyls, hydrogenated biphenyls) will form DCB with varying yields when extracted and perchlorinated according to this procedure. If such compounds are present in the extract, false positive or positively biased data could be generated.

Samples containing compounds that co-elute with the target constituent may cause a positive bias in the results.

The presence of compounds that closely match the retention times of the target constituent may result in false identifications.

The MDLs for the target constituent may be suppressed by baseline noise associated with samples having high levels of background organics or other interferences.

IV. Safety

All stock and working calibration standards, as well as all samples, shall be handled with the utmost care using good laboratory techniques in order to avoid harmful exposure.

$SbCl_5$ is a corrosive reagent that reacts violently with water. This compound must be used with extreme caution. All operations involving the pure reagent must be performed in a hood.

Lab analysts shall wear lab coats, safety glasses, and vinyl gloves at all times when preparing and handling standards, field samples, and lab samples.

Standards and samples shall be prepared in a fume hood.

n-Hexane (C_6H_{14}) is regulated by NIOSH. The suggested Threshold Limit Value (TLV) is 50 ppm, and the Permissible Exposure Level (8-hour PEL) is 50 ppm. Exposure pathways are oral, dermal, and airway. Exposure is harmful and may be fatal. Overexposure may be irritating to the respiratory tract and, in high concentrations, narcotic. Hexane has a faint, peculiar odor. Hexane is highly flammable and is incompatible with active metals and strong alkaline solutions.

Safety equipment including a fire extinguisher, first aid kit, and eye wash shall be available for use at all times.

Lab wastes shall be separated and properly disposed. The wastes include: unused soil samples, sample extracts, unused reagents, small quantities of alcohol waste generated by standard preparations and syringe rinsing, and water for cleaning glassware. Unused soil samples are placed in CSL waste drums labeled specifically for soil jars. Unused samples are held by the CSL for seven days before disposal. Sample extracts will be combined in a carboy labeled waste solvents, the solvent volume will be reduced under nitrogen, and finally disposed with the other site-related organic solvents. Unused reagents will be properly labeled and landfilled. Water used for final rinsing of glassware will be considered nonhazardous and will be either be disposed at the facility, or drummed and disposed with the decon water.

V. Apparatus and Materials

Soil sampling equipment–described in "Field Sampling Plan."

Glassware–class A volumetric pipets and flasks; beakers, vials, pasteur pipets, and miscellaneous glassware as necessary for preparation and handling of samples and standards.

Labware–necessary for preparation and handling of samples and standards.

Syringes–Hamilton glass type as required for injection of sample extracts and standards, preparation of dilutions, and spiking of samples.

Gas chromatograph (GC)–a temperature programmable oven operated from 150°C to 280°C with a 530uM 30M SPB-5 1.5uM capillary column, split/splitless inlet, and ECD.

Autosampler

Computer System–at least 486 25 MHZ, with accompanying monitor and printer. The computer must contain the following software: HP Chemstation, Windows, and Excel.

Laboratory fume hood, absorbing type is acceptable.

Top-loading analytical balance with 10 mg resolution and 200 gram capacity.

VI. Chemicals, Reagents, and Gases

Stock standards–Purchase standard materials at a concentration of approximately 2 mg/ml in methanol.

Working standards–prepared from stock standards by precise dilution in water.

Ultra Pure Carrier Grade Nitrogen–for use as makeup gas.

Ultra Pure Carrier Grade Helium–for use as carrier gas.

Antimony pentachloride–perchlorination reagent (>98%), distilled under vacuum.

Hexane-pesticide grade

Iron Power-analytical grade, ≥99.1% pure.

Sodium sulfate–ACS granular, anhydrous.

Hydrochloric Acid–reagent grade.

VII. Calibration and Standard Verification

Initial calibration–Five-level calibration at approximately 2, 4, 10, 25 and 60 mg/L for decachlorobiphenyl. These concentrations define the linear calibration range of the instrument.

The calibration curve should be validated by the analysis of a laboratory control sample (LCS). The LCS must be obtained from an independent, EPA authorized, second source. The LCS will verify the concentration of the standards used to obtain the initial calibration.

Continuing calibration–The continuing calibration standard (CCV) should be selected from the initial calibration standards, and it should be the standard that is closest to the mid point of the calibration range. The working calibration curve for each analyte must be verified daily by the analysis of a continuing calibration standard. The ongoing daily continuing calibration must be compared to the initial calibration curve to verify that the operation of the measurement system is in control. A day is defined as 24 hours from the start run time of the last valid continuing calibration.

For each analyte, calculate the percent difference of the continuing calibration from the initial curve using the following equation:

$$\% \ D = \frac{[\ RRF_m - RRF\ ] \ \_ \ 100}{RRF_m}$$

Where:

RRF_m = the mean response from the initial calibration curve

RRF = the daily response from the continuing calibration standard

The acceptance criterion for this screening method's continuing calibration is 40 percent D. If one of the target analytes that exceeded the 40 percent D criteria is detected in a sample, then a new calibration of the instrument must be performed for that target analyte, and the sample must be reanalyzed after a valid initial calibration is achieved. If the acceptance criteria are achieved, the calibration curve can be used to calculate the results of sample analyses.

Sample results for any target analyte can **only** be reported if the initial and continuing calibrations are valid.

Surrogate Recovery–Hexabromobiphenyl (HCB) shall be used as a surrogate. The surrogate compound shall be used as a retention marker. Retention time shifts greater than 0.2 minutes shall require corrective action.

Prepare secondary dilutions of the surrogate compound. This spiking solution must be added to all standards, blanks (except the instrument blanks), and samples. The surrogates must be at a concentration which provides a response similar to the response of the target analytes in the mid point standard used for continuing calibration.

Laboratory check standard (LCS)–The LCSs are to be obtained from the EPA or an EPA approved vendor. The LCSs must be prepared independently from the standards used for initial and continuing calibration standards.

Prepare and analyze a LCS at the beginning of each work day. For each parameter, calculate the percent recovery. All parameters in the LCS should be recovered within the precision requirements of the project (50 to 150 percent). If any parameter exceeds this criterion, then a new calibration curve should be established. Sample results for a target analyte can only be reported if the initial calibration of the instrument is valid.

VIII. Sample Preparation and Extraction

A. General

1. Log balance calibration with 0.10 gram, 1 gram and 10 gram standards.
2. Enter the samples to be prepared into the sample prep logbook.
3. Prelabel all sample vials using a permanent marker.
4. Record preparation for all BLKs, LCSs, CCVs, and samples in sample prep log book. Each page of the log book should contain the following columns; Lab #, sample wt. (gram), final volume (mL), dilution, Prep by, and Prep date.

B. Instrument blank preparation procedure

1. Prelabel an autosampler vial "IBLK-dateseq" (i.e., IBLK-082801). Assure from sample preparation log and standards log that the seq # is unique (i.e., If IBLK 0828-01 is already used name it IBLK 0828-02). Fill the autosampler vial three-quarters full with hexane, do not add the surrogate, cap, and inject onto the GC system as would occur with a field sample. NOTE: This sample is not passed through the extraction procedure.

C. Reagent blank preparation procedure

1. Prelabel centrifuge vial "RBLK-dateseq." Add 10 mL of hexane to the vial, add 10 µL of the surrogate solution (200 ug/mL HCB in hexane) with a syringe under the hexane surface and quickly cap the vial.

   Pass this sample through the entire procedure as if it was a field sample.

D. Laboratory control sample (LCS) preparation procedure

1. Prelabel a centrifuge vial "LCS-dateseq." Weigh approximately 1 gram of control sample matrix into the vial, add 5 uL of LCS solution by placing syringe needle under soil and dispensing solution. Quickly add 10 mL hexane and 10 uL of surrogate. Quickly cap vial.

   Pass this sample the entire procedure as if it was a field sample.

E. Continuing calibration verification standard preparation procedure

1. Prelabel a centrifuge vial "CCV-dateseq." Add 10 mL hexane, 10 uL surrogate, and quickly add 20 uL of the spiking standard (a 50 ug/mL mixture of PCB 1254 and 1260 in hexane). Quickly cap vial.

   Pass this sample through the entire procedure as if it was a field sample.

F. Method blank preparation procedure

1. Prelabel HS vial "MBLK-dateseq." Weigh 1 gram of control soil sample into a centrifuge vial. Add 10 mL of hexane to vial, add 1 gram of sodium sulfate, add 10 uL of surrogate solution (200 ug/mL HCB in hexane) with syringe under the hexane surface. Quickly cap.

   Pass this sample the entire procedure as if it was a field sample.

G. Matrix spike/matrix spike duplicate preparation procedure

1. Weigh approximately 1 gram of sample into a prelabeled centrifuge vial. Attempt to use the same weight of sample as used for the non-spiked sample.

2. Add 20 ul of the spiking standard solution by placing syringe needle under the soil surface and dispensing solution. Quickly add 10 mL of hexane and 10 uL surrogate. Quickly cap vial.

   Pass this sample through the entire procedure as if it was a field sample.

H. Field Sample

1. Accurately weigh approximately 1 g of soil into a centrifuge tube containing 1 g of sodium sulfate, conditioned at 400°C for 4 hours.

2. Add 10 ml of pesticide grade hexane 10 ul of surrogate solution, and shake/vortex for 1 minute. Allow the sodium sulfate and soil to settle to the bottom.

3. Transfer a 300 ul aliquot to a 13 mm x 100 mm tube and reduce under dry nitrogen to approximately 10-25 ul.

4. Immediately, and rapidly add 0.2 ml of distilled animony pentachloride and cap the tube. The sample should remain light yellow after this addition, but if the sample turms dark brown or black, it must be discarded and another aliquot of that sample used.

5. Place the samples in a 160°C sand bath for three hours. Remove from the bath and cool to room temperature.

6. To each sample add dropwise 0.5 ml of 20% hydrochloric acid. This mixture is then extracted 3 times with 3 ml of n-hexane. Each extract is passed through a funnel containing approximately 0.5 g of anhydrous sodium sulfate into a 10 ml volumetric flask.

7. If the sample is obviously contaminated and experience has shown similar extracts to contain high levels of contamination, it is recommended that a preliminary dilution be prepared to avoid grossly contaminating the gas chromatograph.

IX. Analysis

Perform GC analysis on the extract using the instrument conditions similar to those listed in Attachment 1.

If the analysis indicates that the results are more than 50 percent above the calibration range, prepare a dilution of the sample to yield concentrations that fall within the calibration range.

Check the retention times for decachlorobiphenyl against the expected (calibration) value. Reject those results where the retention time does not fall with 0.2 minutes of the expected value.

X. Calculations

Quantification of the target compounds is based on the integrated areas of the samples in comparison to the integrated areas of the calibration standards for each analysis. The integrator reports the concentrations in points per billion (ppb) in the extracts. Calculation of the concentration for total PBCs in the original sample is as follows:

$$\text{Conc. in ug/kg} = \frac{A \times Vt \times 33.33 \times DF}{Ws}$$

Where:

A = Amount of target constituent found in ug/l.

Vt	=	Volume of the hexane in liters.
Ws	=	Weight of the sample added in kilograms.
33.33	=	Dilution factor of 0.3 ml aliquot brought to 10 ml.
DF	=	Dilution Factor if required.

XI. Quality Assurance

Quality assurance measures shall include as a minimum:

- Daily continuing calibration performed before the analysis of each day's samples. The linear calibration range of the instrument must be determined before the analysis of any samples. The instrument must be calibrated using the same instrument conditions that are used to analyze the samples. Prepare groundwater calibration standards at a minimum of five concentration levels for each parameter analyzed. The concentrations of the standards should bracket the linear range of the instrument. The CCV recovery shall recover within 50% and 150% of known concentration. If these limits are exceeded the instrument shall be reinitial calibrated.

- Daily LCS performed before the analysis of each day's samples. The instrument calibration must be confirmed with a LCS before the analysis of any samples. This sample must be analyzed using the same instrument conditions that are used to analyze the samples. If the LCS recoveries are less than 50% or greater than 150%. If these limits are exceeded the instrument shall be reinitial calibrated.

- Daily analysis of an instrument blank, performed before the analysis of each day's samples. If the results of the instrument blank show contamination, the cause of the contamination should be investigated and corrective action taken.

- Daily analysis of a reagent blank, performed before the analysis of each day's samples. If the results of the reagent blank show contamination, the cause of the contamination should be investigated and corrective action taken.

- Analysis of a method blank. A method blank is to be performed at a frequency of one in 20 samples of the same matrix. A method blank must contain no greater than five times the stated MDL of blank contaminants. For all other volatile compounds, the method blank must contain less than the stated detection limit. If the method blank exceeds these criteria, the laboratory must consider the analytical system out-of-control. Appropriate corrective actions must be taken and documented before further sample analysis.

  Contamination by carryover can also occur when high-level and low-level samples are analyzed in sequence. To reduce the possibility of carryover, disposable headspace vials are used only once and only after being baked at 70-85°C and samples are weighed directly into the headspace vials. Also, frequent baking and purging of the entire system may be required. For

samples thought to contain high concentrations of any volatile analyte, an organic free water blank should be analyzed immediately afterwards to verify that the analytical system is clean before the analysis of other samples. All sample analytical results following a high level sample must be examined for the possibility of carryover. If target analytes are found in the samples that are common to a previously analyzed high sample, the samples may be re-analyzed after it is demonstrated that the analytical system is clear by analysis of blanks. Method blanks are tested immediately after matrix spikes to demonstrate that the system is not prone to carryover.

The results of blank analyses must be reviewed before results for samples are reported. The blank results should not be subtracted from the sample analytical results.

- Surrogate recoveries from every sample will be calculation, if surrogate recoveries are less than 50% or greater than 150% the sample will be reanalyzed.
- Analyses of mid-range matrix spike and matrix spike duplicate samples at a frequency of one in 20 samples of the same matrix. If MS/MSD recoveries are less than 50% or greater than 150% the samples associated with this data set will be qualified as estimated and flagged with a "J" on the results spreadsheet.

STANDARD OPERATING PROCEDURE

Volatiles Monitoring with an OVA

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for the calibration and use of an OVA Organic Vapor Analyzer.

II. Equipment and Materials

- Operations manual
- An OVA hand readout unit and side pack assembly
- 100 ppm methane as calibration gas
- T-type feeder tube with 1.5 liter/min. regulator

III. Procedures and Guidelines

ONLY PROPERLY TRAINED PERSONNEL SHOULD USE THIS INSTRUMENT. FOR SPECIFIC INSTRUCTIONS, SEE OPERATIONS MANUAL.

OVA, Organic Vapor Analyzer

1. Introduction

   The OVA Organic Vapor Analyzer is designed to detect organic materials in air. It uses a flame-ionization detector (FID) as its detection principle. This detector allows the monitor to respond to a wide variety of organic compounds.

2. Operational Checks

   - See OVA Operators Manual included with instrument.

3. Calibration

   - See OVM Operators Manual included with instrument.

IV. Key Checks and Preventative Maintenance

- Check battery.
- Zero and calibrate.
- Verify sensor probe is working.
- Recharge unit after use.

A complete preventative maintenance program is beyond the scope of this document. For specific instructions, refer to the operations manual.

- A complete spare instrument should be available whenever field operations require volatiles monitoring.
- Spare parts should be on hand so minor repairs may be made in the field.
- Batteries should be charged daily.
- Occasionally allow the batteries to totally discharge before recharging to prevent battery memory from occurring.

STANDARD OPERATING PROCEDURE

Field Measurement of Organic Vapors Using an HNU

I. Purpose

To provide general guidelines for the calibration and use of the HNU photoionization detector.

II. Scope

This is a broad guideline for the field use of an HNU. For specific instructions, refer to the operations manual.

III. Equipment and Materials

- Operations manual
- An HNU readout/control unit and photoionization probe (either 10.2 or 11.7 eV depending on requirements) with fully charged battery pack
- Charging unit
- A cylinder of calibration gas, typically 100 ppm isobutylene in air
- A regulator for the calibration gas cylinder
- A short length of 1/8th-inch tube to transfer calibration gas from the cylinder to the HNU probe (as short as possible)

IV. Procedures and Guidelines

ONLY PROPERLY TRAINED PERSONNEL SHOULD USE THIS INSTRUMENT. FOR SPECIFIC INSTRUCTIONS, SEE OPERATIONS MANUAL.

A. CALIBRATE THE HNU

1. Identify the probe by lamp model.
2. Connect the sensor/probe to the readout/control unit.
3. Perform a battery check by turning the function switch to "Batt."
4. Turn function switch to "Standby" and set the readout to zero by turning the zero knob.
5. Hold the sensor/probe to your ear to verify that it is powered. A faint humming sound will be heard.

6. Set the range to the appropriate setting.

7. Connect the tube from the calibration gas cylinder to the end of the probe and open the valve on the calibration gas cylinder.

8. Sample the calibration gas and adjust to the proper reading with the span control knob.

9. If calibration cannot be achieved, disassemble the sensor/probe assembly and clean lamp. If the span knob setting is at the end of the span range, unit must be serviced by qualified personnel.

B. SAMPLING WITH THE HNU

1. Once calibration is complete, unit is ready for sampling. When not in use, set function knob to ``Standby."

2. When done for the day, turn unit off and disconnect the sensor/probe.

3. Charge the battery overnight (complete recharge takes 14 hours).

4. For preventive maintenance, refer to instruction manual.

V. Attachments

HNU calibration sheet

VI. Key Checks and Items

- Check battery.
- Zero and calibrate.
- Verify sensor probe is working.
- Recharge unit after use
- Select the probe suitable for the monitoring required.

VII. Preventive Maintenance

A complete preventive maintenance program is beyond the scope of this document. For specific instructions, refer to the operations manual. Some key items are discussed below:

- A complete spare HNU should be available on site whenever field operations require this instrument.
- A spare lamp should be on hand so a defective unit can be changed without returning the unit.
- Occasional cleaning of the lamp should be performed as needed.
- Charge batteries daily.

- Occasionally allow the batteries to totally discharge before recharging to prevent battery memory from occurring.

HNU Calibration Sheet

Date	Time	Analyst Initials	Uncalibrated @ 10 ppm	Calibrated @ 10 ppm	Comments

STANDARD OPERATING PROCEDURE

Bacharach Combustible Gas/Oxygen Meter and Personal Gas Monitor

I. Purpose

The purpose of this SOP is to provide general reference information for using the Bacharach Sentinel 4 and Bacharach Sniffer® 503-A meters in the field. Calibration and operation, along with field maintenance, will be included in this SOP.

II. Scope

This procedure provides information into the field operation and general maintenance of the Sentinel 4 Sniffer and 503-A. Review of the information contained herein will ensure that this type of field monitoring equipment will be properly utilized. Review of the owner's instruction manuals is a necessity for more detailed descriptions.

III. Definitions

Carbon Monoxide Sensor - Expresses the Carbon Monoxide concentration in parts per million (ppm).

Combustible Gas - Combustible gas is expressed as a percent of the lower explosive limit (LEL).

Hydrogen Sulfide Sensor - Expresses the Hydrogen Sulfide concentration in parts per million (ppm).

Oxygen Sensor - Expresses the Oxygen concentration as a percentage.

ppm - parts per million: parts of vapor or gas per million parts of air by volume.

Sentinel 4 - Combustible Gas/Oxygen/Hydrogen Sulfide/Carbon Monoxide meter.

Sniffer 503-A - portable Combustible Gas and Oxygen Alarm instrument.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for selecting qualified individuals for the monitoring activities.

Health and Safety Coordinator - The Health and Safety Coordinator is responsible for developing a site-specific Health and Safety Plan (HASP) which specifies air monitoring requirements.

Field Team Leader - It is the responsibility of the Field Team Leader to implement these procedures in the field, and to ensure that the field team performing air monitoring activities have been briefed and trained to execute these procedures before the start of site operations.

Site Safety Coordinator (SSC) - The SSC is responsible for ensuring that the specified air monitoring equipment is on site, calibrated, and used correctly by the field ersonnel. The SSC will coordinate these activities with the Field Team Leader.

Field team - It is the responsibility of the field team to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader/Site Safety Coordinator. The field personnel are responsible for documenting all air monitoring results in the field logbook during each field investigation.

V. Procedures

The Sentinel 4 Personal Gas Monitor and Sniffer 503-A utilize the principle of detecting sensors. The following four paragraphs discuss theory of operation as it applies to each functional sensor.

The combustible gas sensor uses two elements that are wound with a platinum wire. One of the elements is impregnated with a catalyst to oxidize combustible gases. The other element is impregnated with material that will also oxidize combustible gases, but will respond to temperature and humidity conditions. When the meter is turned on, an electrical current is passed through the elements and wires. As a combustible gas enters the chamber, the elements will oxidize the combustible gas, thus increasing the heat and resistance of the element. This change in resistance causes a system imbalance, which produces a measurable signal proportional to the combustible gas concentration.

The percent oxygen is measured utilizing an electrochemical sensor. As atmospheric oxygen enters the meter it diffuses into the sensor which converts the amount of oxygen in the sensor to a voltage signal. This voltage is directly proportional to percent oxygen in the atmosphere.

The concentration of hydrogen sulfide is measured utilizing an electrochemical sensor. As atmospheric hydrogen sulfide enters the meter it diffuses into the sensor which converts the amount of hydrogen sulfide in the sensor to a voltage signal. This voltage is directly proportional to the atmospheric hydrogen sulfide concentration.

The concentration of carbon monoxide as measured utilizing an electrochemical sensor. As atmospheric carbon monoxide enters the meter it diffuses into the sensor which converts the amount of carbon monoxide in the sensor to a voltage signal.

This voltage is directly proportional to the atmospheric carbon monoxide concentration.

The Sentinel 4 Personal Gas Monitor and Sniffer 503-A are intrinsically safe for use in Class I, Division 1, Groups A, B, C and D hazard areas. One fact that needs to be expressed is that this type of monitoring equipment utilizes internal oxidation of combustibles, if the meter is placed in an oxygen deficient atmosphere, the combustible reading may be affected. Review of each of the instruction manuals will aid in determining the percentage of oxygen that affects the combustible gas readings.

The following subsections will discuss Sentinel 4 and Sniffer 503-A calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

A. Calibration

Sentinel 4

Due to the numerous steps involved in calibration, it is recommended that you follow the calibration procedures (on a daily basis) as outlined in the instruction manual from pages 5-12 to 501

NOTE: A calibration kit will be provided for each Sentinel 4. This kit contains a cylinder for the combustible gas sensor, one cylinder for the hydrogen sulfide sensor, and one cylinder for the carbon monoxide sensor. The oxygen sensor can be calibrated with (uncontaminated/fresh air environment) atmospheric air and does not need cylinder gas.

Note: When a single sensor doesn't zero, none of the sensors are zeroed.

Sniffer® 503-A

<u>Oxygen Detector</u>

1. Check battery charge by turning function switch to "BATTERY TEST," if battery is in recharge zone instrument will need to be charged.
2. To zero the oxygen detector, turn function switch to "BATTERY TEST" position and - press "TEST" switch and observe the 02 meter indication. If indicator is zero, no further adjustment is necessary. If not, follow procedures in Section 5.4.1 of the Operations Manual.
3. To calibrate the oxygen detector, turn function switch to "BATTERY TEST" position. Unlock the "OXYGEN CALIB" knob and adjust it for an 02 meter indication of 21 or at the CAL mark. Relock "OXYGEN CALIB" knob. If using zero calibration gas, follow procedures in Section 5.4.2 of the Operator's Manual.
4. Record on Calibration Sheet.

% LEL Detector

1. Check battery charge by turning function switch to "BATTERY TEST," if batter is in recharge zone, instrument will need to be charged. Allow 5 minutes for the instrument to warm up.

2. Turn function switch to the % LEL position.

Note: To eliminate the annoyance of the audible alarm, cover the alarm with a hand or duct tape during calibration. The tape must be removed, prior to operation!!

3. Connect calibration gas (typically 30% of the LEL) and allow gas to flow for 1 minute.

Note: If calibration gas has a concentration value, not a % LEL value, the % LEL can be calculated as follows:

% calibration gas (i.e., methane) x 20% LEL (meter alarm setting) = % LEL calibration setting

If meter indication is within ±5% of LEL calibration gas, no further adjustment is required. If not, follow procedures in Section 5.5.4 of Operator's Manual.

Sniffer® 503-A

1. Connect sample probe and tubing to the instrument's sample inlet (refer to Sections 8.4 and 8.5 for the Operator's Manual for available hoses and probes.

2. Check that battery is in Operational Range.

3. Turn instrument to % LEL range and allow to warm up for 1 minute.

4. Check in a fresh air environment that % LEL reads 0% and that 02 indicator reads 21% (calibration mark).

5. Sample air/gas from area to be tested, allow 30 seconds for readings to stabilize. When finished, allow at least 10 seconds (longer if extension line is used) to purge sample line.

6. B" instrument is operating erratically, refer to "TROUBLESHOOTING" Section (Table 5-2) in Operator's Manual.

B. Operation

Sentinel 4

Due to the Sentinel 4 having many functions in terms of operation, it is recommended that you follow the operational procedures as outlined in the instruction manual from pages 6-1 to 6-34.

NOTE: Since the Sentinel 4 is capable of measuring four different parameters, an understanding of the alarm, error, and fault messages must be obtained. This can be done ET reviewing the troubleshooting table found on pages 9-2 to 9-9.

C. Site Maintenance

After each use, the meters should be recharged and the outside of the instruments should be wiped clean with a soft cloth.

D. Scheduled Maintenance

Function	Frequency
Check alarm and settings	Monthly/before each use
Clean screens and gaskets around sensors	Monthly
Replace sensors	Biannually or when calibration is unsuccessful

VI. Quality Assurance Records

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the field logbook.

- Identification - Site name, date, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc), serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g, Sentinel 4 or Sniffer 503-A had wide range fluctuations during air monitoring activities.)

  NOTE: The "Toxic Gas Meter Calibration Form" will be completed daily, prior to performing any air monitoring.

VII. References

Bacharach Installation, Operation, Maintenance Manual Sentinel -1 Personal Gas Monitor, 1990.

Bacharach Installation, Operation, Maintenance Manual, Sniffer 503-A, Rev. 3 October-1990.

Standard Operating Procedure

Explosimeter

I. Purpose and Scope

This SOP provides a guideline for field measurements of the levels of combustible gas and oxygen in air. The following general discussion applies to most explosimeter but may differ between specific brands. The operator's manual should be consulted fo specific calibration and operating procedures.

II. Equipment and Materials

- Industrial Scientific (MX251) Combustible Gas and Oxygen Indicator, or equivalent meter, which can be field calibrated
- Flow-control regulator and hose
- Calibration gas (50 percent LEL pentane—0.75 percent pentane and 15 percent oxygen in nitrogen)
- Equipment calibration data sheet

III. Procedures and Guidelines

A. **Calibration:** The explosimeter must be calibrated before initial daily use. Record calibration information on equipment calibration data sheet. Calibration will be performed according to the following procedure:

1. Turn instrument on
   - Unscrew knurled nut on bottom
   - Rotate metal cover 180°
   - Tighten knurled nut
2. Check battery
   - Check for no ``LoBatt" display—do not use if LoBatt displayed
3. Calibrate instrument

- Observe that instrument reads 0 percent LEL and 21 percent Oxygen (OX) (record readings)
- Connect sampling pump onto top of instrument
- Connect .75 percent Pentane/15 percent oxygen gas (with 1.5 LPM Regulator and direct tubing)
- Turn pump ON
- Turn gas ON
- Record LEL and O_2 after stabilized; LEL must read 50 percent +/-5 percent; O_2 must read 15 percent +/- 5 percent
- Disconnect sample pump and return to charger

B. **Sample Measurement:** The instrument is then ready for air sampling. Note and record the readings for percent LEL and percent O_2.

IV. Attachments

- Equipment calibration data sheet

V. Key Checks and Preventive Maintenance

Check that the batteries be adequately charged. Certain materials such as silicone, silicates, and organic lead compounds tend to poison the catalyst in the instrument, thereby giving erroneously low readings; calibration checks should be made frequently if such materials are suspected to be present.

If the CGI does not cal-check within ±5 percent of 50 percent LEL, an internal calibration must be performed, or the instrument replaced.

EXPLOSIMETER CALIBRATION SHEET

Date	Time	Analyst Initials	Instrument Readings: Uncalibrated @LEL=0% O_2=21%	Instrument Readings: Calibrated @LEL=50%±5 O_2=15%±5	Comments

STANDARD OPERATING PROCEDURE

Operation of Dräger Gas Detector

I. Purpose

The purpose of this SOP is to provide general reference information for using the Dräger Gas Detector. Operation along with field maintenance will be included in this SOP. This monitoring is intended for health and safety purposes only, not for analytical characterization of air quality.

II. Scope

This procedure provides information as it applies to field operation and general maintenance of the Dräger Gas Detector. - Application of the information contained herein will ensure that this type of field air monitoring equipment will be operated properly. The various calorimetric detector tubes required for each specific site operation will be addressed in the respective Health and Safety Plan (HASP).

III. Definitions

Dräger Bellows Pump - A hand-operated bellows pump that draws in 100 cubic centimeters (cc's) of air through a detector tube with each pump stroke.

Detector Tube (Dräger Tube) - A glass tube impregnated with an indicating chemical resulting in a color change.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for selecting qualified individuals for the monitoring activities.

Health and Safety Officer - The Health and Safety Officer is responsible for developing a site-specific Health and Safety Plan (HASP) which specifies air monitoring requirements.

Field Team Leader - It is the responsibility of the Field Team Leader to implement these procedures in the field, and to ensure that the field team performing air monitoring activities, have been briefed and trained to execute these procedures before the start of site operations.

Site Safety Coordinator (SSC) - The SSC is responsible for ensuring that the specified air monitoring equipment is on site, calibrated, and used correctly by the field personnel. The SSC will coordinate these activities with the Field Team Leader.

Field team - It is the responsibility of the field team to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader/Health and Safety Officer. The field team is responsible for documenting all air monitoring results in the field logbook during each field investigation.

V. Procedures

The Dräger Gas Detector uses the principle of exposing a measured concentration of a reagent to a measured volume of air, to produce a proportional reaction of the contaminant in question. There are various types and styles of detector tubes with each being specific to air contaminants, reaction principal, reaction color and number of pump strokes. Care must be taken to follow the instructions provided with each box of tubes. Always note the expiration date on the box and refrigerate the tubes whenever possible to maintain tube life.

The following subsections will discuss the operation and maintenance of the Dräger Gas Detector. These sections, however, should not be used as a substitute for the manufacturer's operating procedures.

A. Operation

- Check the pump for leaks before each series of measurements (according to the Leak Test procedures outlined in Section B).
- Break off both tips of the Dräger Tube in the break-off eyelet.
- Tightly insert the Dräger Tube in the pump head with the arrow on the tube pointing towards the pump.
- Fully compress the bellows.
- Straighten the fingers. The suction process takes place automatically and is completed when the limit chain is taut (Model 31) or the white dot is completely visible (Accuro).
- Repeat the suction process as often as specified in the Tube Operating Instructions.

Evaluate the indication as described in the Tube Operating Instructions, paying special attention to interfering chemicals, etc. These instructions are supplied with the package of tubes.

B. Maintenance

- Leak testing: Check the pump for leaks prior to use. To do this, completely compress the bellows and seal the pump with an unopened Dräger Tube. The pump is sufficiently air-tight if the bellows has not completely expanded after 30 seconds, (i.e., the limit chain is not taut [Model 31] or the white dot is not visible [Accuro]). It will then deliver the volume required.
- Eliminating leaks: For Model 31, any leak can usually be eliminated by cleaning the valve. To do this, remove the front plate and unscrew the valve using the

special spanner. Raise the valve disc to prevent it from being damaged by the spanner. Clean the valve by blowing it through with air or by rinsing it with water. Dry the valve after cleaning. If the rubber of the valve disc is sticky, brittle, hard or cracked, it must be replaced. Remove the pin from the valve seat stem and push in the pin of the new valve disc until the disc lies flat against the valve seat. It is best to moisten the pin a little at first. When fitting the cover plate, ensure that the limit chain is not twisted and that the fixing hook lies in the longitudinal direction of the pump, so that it fits satisfactorily in the slot of the cover plate.

- Cleaning the metal screen: After prolonged use of the Bellows Pump, the wire mesh sieve under the rubber bung in the pump head may become blocked. Therefore, the sieve must be cleaned from time to time, about every four weeks, when the pump is used frequently. For Model 31, loosen the two-hole nut with the special spanner and remove the rubber bung. Take out the sieve and clean it with a brush under running water. When re-inserting the two-hole nut, tighten it only until the rubber bung is just under stress and the Dräger Tube can be inserted easily, but tightly.

- Flushing the pump with air: To prevent corrosion of the interior portions of the pump, flush out the pump with air by making a few strokes without a Dräger Tube after each time it has been used.

C. Limitations and Considerations

The chemical reactions involved in the use of the tubes are affected by temperature. Cold weather decreases the reactions and thus the response times. Therefore, it is recommended that the tubes (prior to use) be kept warm if the measurement is done in cold temperatures; or for hot temperatures (which can increase the reaction and can cause a problem by discoloring the indicator when a contaminant is not present), the tubes should be stored at a moderate temperature.

The chemical utilized in the tubes will deteriorate over time, and therefore the tubes are assigned a shelf life. This will vary from one to three years and should be checked prior to use.

An advantage that detector tubes have over some other instrument is that it is possible to select a tube that is specific to a chemical. However, some tubes will respond to interfering compounds. Fortunately, the manufacturers provide information in the tube package on interfering gases and vapors.

Due to these many considerations, it is very important to read the instructions that are provided with and are specific to a set of tubes. The information includes the number of pump strokes needed, time for each pump stroke, interfering gases and vapors, effects of humidity and temperature, shelf life, proper color change and whether the tube is reusable.

VI. Quality Assurance Records

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the field logbook.

- Identification - Site name, date, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc.), serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks - (e.g., the Dräger tube changed to a color representing an interference during air monitoring activities).

VII. References

National Dräger, Inc. 1992. Dräger Detector Tube Handbook. Lubeck, 8th Edition, Pittsburgh, Pennsylvania.

STANDARD OPERATING PROCEDURE

MINIRAM Personal Monitor

I. Purpose

The purpose of this SOP is to provide general reference information using the MINIRAM (Mini Real-time Aerosol Monitor) Model PDM-3 to monitor airborne particulates.

II. Scope

This procedure provides information regarding the field operation and general maintenance of the MINIRAM Model PDM-3. The information contained herein presents the operation procedures for this field monitoring equipment. Review of the owner's instruction manual is a necessity for more detailed descriptions pertaining to the operation and maintenance of the monitor.

III. Definitions

MINIRAM - Mini Real-time Aerosol Monitor (MINIRAM) Model PDM-3 used to monitor airborne particulates for preferential response to the particle size range of 0.1 to 10 micrometers.

Sun Shield -.An accessory to the MINIRAM that protects the sensing elements from excessive ambient light fluctuations.

Z-Bag kit - A calibration kit that consists of a one-way flow rubber bulb for manual air pumping, a filter cartridge, a zippered plastic container, and connecting hardware.

mg/m3 - milligrams per cubic meter of particulate (size range of 0.1 to 10 micrometers) in air, by volume

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed The Project Manager is responsible for selecting qualified individuals for the monitoring activities.

Health and Safety Officer - The Health and Safety Officer is responsible for developing a site-specific Health and Safety Plan (HASP) which specifies air monitoring requirements.

Field Team Leader - It is the responsibility of the Field Team Leader to implement these procedures in the field, and to ensure that the field team performing air monitoring activities, have been briefed and trained to execute these procedures before the start of site operations.

Site Safety Coordinator (SSC) - The SSC is responsible for ensuring that the specified air monitoring equipment is on site, calibrated, and used correctly by the field team. The SSC will coordinate these activities with the Field Team Leader.

Field team - It is the responsibility of the field team to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader/SSC. The field team is responsible for documenting the air monitoring results in the field logbook during field investigation.

V. Procedures

The following sections provide information on the operating principles, calibration, operation, and maintenance of the MINIRAM.

A. Principle of Operation

The MINIRAM Model PDA13 (MINIRAM) is an airborne particulate monitor whose operating principle is based on the detection of scattered electromagnetic radiation in the near infrared. The MINIRAM uses a pulsed light emitting source which generates a narrow-band emission centered at 880 manometers (=); it is a light scattering aerosol monitor of the nephelometric type, i.e., the instrument continuously senses the combined scattering from the population of particles present within its sensing volume (approximately 1 cm3) whose dimensions are large compared with the average separation between the individual airborne particles.

In the "Open Sensing Chamber Sampling Method", air surrounding the MINIRAM passes freely through the open aerosol sensing chamber as a result of air transport caused by convection, circulation, ventilation and personnel movement (i.e., a pump is not used). The scattering sensing parameters have been designed for preferential response to the particle size range of 0.1 to 10 micrometers, ensuring high correlation with standard gravimetric measurements of both the respirable and inhalable size fractions. The rate at which air passes through the sensor does not influence the indicated concentration because the detection is performed directly on every parcel of air traversing the fixed sensing volume. Therefore, flow velocity through a real-time sensor such as the MINIRAM influences only the response time.

The MINIRAM measures the concentration of any airborne particles, both solid and liquid, and the display indicates this level in the units of milligrams per cubic meter (mg/m3), based on its factory calibration. The MINIRAM should be operated in a vertical position and away from reflecting surfaces.

The MINIRAM comes with a sun shield accessory that protects the sensing elements from excessive ambient light fluctuations. The sun shield is used for outdoor use and under fluctuating bright light illumination. However, it is advisable to use the sun shield at all times.

B. Calibration

Calibration is achieved in the field using a Z-Bag TM Calibrator which will provide a clean-air environment inside a plastic bag into which the MINIRAM is placed for zeroing. The Z-Bag kit consists of a one-way flow rubber bulb for manual air pumping, a filter cartridge, a zippered plastic container, and connecting hardware.

Prior to calibration, ensure that the MINIRAM is clean before placing into Z-Bag. Do not expose Z-Bag to sub-zero freezing temperatures as the plastic zippered bag may crack.

The calibration procedure is as follows:

1. Place Z-Bag on flat surface with red flow fitting facing up. Flatten bag. Remove small plastic cap from flow fitting on bag.
2. Connect rubber bulb/filter assembly to red flow fitting of plastic bag, until flush with bottom of fitting.
3. MINIRAM should be in its OFF condition (check display). If display is blanked, or if MINIRAM is in another mode, press OFF.
4. Open Z-Bag and place MINIRAM inside at the center. Press ZERO* and immediately zip closed the bag and begin pumping the rubber bulb/filter assembly.
5. Inflate Z-Bag up to a height of about five inches, then maintain the bag pressure until the MINIRAM displays OFF again.
6. Record background reading displayed while zeroing, on calibration form.
7. Unzip Z-Bag and remove MINIRAM. Place rubber bulb/filter assembly inside Z-Bag, and plug small plastic cap into flow fitting to close it. Zip close while flattening Z-Bag to ensure cleanliness of the bag interior.
8. MINIRAM is ready for use.

The "zero value" is the background level and is automatically subtracted from all aerosol concentrations readings during the measurement mode. Therefore, the displayed readings depend only on the actual dust concentration present within the sensing chamber. It will increase somewhat as the chamber inner walls and windows become contaminated with dust. A **zero** value greater than 3 mg/m2 indicates excessive chamber contamination. For cleaning instructions, refer to manufacturer's operating manual.

C. Use and Applications

To use the MINIRAM, remove it from the case and observe the display. If the display is blank the MINIRAM is in the minimum power mode. An "OFF" display means that it has been in the off mode for less than 48 hours.

Depending on the mode of interest, refer to the subsections below for a brief explanation of the use and applications.

1. Measure (MEAS) Mode

With a blank display mode press OFF and wait until the display reads "OFF" (approximately 5 seconds), before pressing MEAS to initiate measurement cycle. - If the MINIRAM shows "OFF", press MEAS directly to initiate measurement cycle.

The first readout displayed is "GO" (or "CGO" if TIME is also pressed), followed by the last concentration reading or ".00". Approximately 36 seconds after pressing MEAS the first new 10 second averaged concentration reading is displayed. All subsequent readings are concentration values in milligrams per cubic meter, updated every 10 seconds. The MINIRAM will run in this mode for 500 minutes after which it will stop and display the OFF reading (retaining in storage the concentration average and elapsed time information).

Once the measurement cycle has started, the only way it will be stopped is by pressing OFF. The MINIRAM normally operates in the .00 to 9.99 mg/m3 range but whenever a 10-second concentration exceeds 9.99 mg/m3 it will automatically switch to a .0 to 99.9 mg/m3 range and remain their until the concentration drops to the lower range.

If both MEAS and TIME are pressed at the same moment (TIME then MEAS) the MINIRAM will display "CGO" (for Continuous Go) which will cause the instrument to measure continuously in 500 minute intervals. It will run continuously until OFF is engaged or the batteries are exhausted at which time "OFF" will be displayed. Concentration averages and timing information for the last seven 500 minutes intervals will remain in storage.

2. Time-Weighted Average (TWA) Mode

During the measurement mode, if TWA is pressed the display will indicate the average concentration in mg/m^3 up to that instant, from the start of the last run. The value of TWA is updated every 10 seconds. After releasing the TWA key the MINIRAM display returns to the 10-second concentration display.

3. Shift-Average (SA) Mode

During the measurement mode, if SA is pressed the display will provide the aerosol concentration up to that moment, averaged over an 8-hour shift period. This concentration corresponds to the exposure from the start of the measurement cycle and is updated every 10 seconds. After releasing the SA key the MINIRAM display returns to the 10-second concentration display.

4. Play Back (PBK) Mode

With the MINIRAM in the off mode, the stored information can be played back by pressing PBK for more than 1 second. The information will be played back in the following order:

- ID number
- Shift or run number
- Sampling time in minutes

- Off-time between the last and next run (in tens of minutes)
- Average in mg/m^3

This sequence is repeated seven times; an average reading of 9.99 mg/m^3 indicates that a significant overload condition occurred during that run. It will take approximately 70 seconds to run through this program.

5. ID Number Selection

In order to change the MINIRAM identification number, press the OFF key then the ID# key and the presently stored number (between 1 and 999) will be displayed. The raise the number press the up arrow key, and to lower the number press the down arrow key. Pressing the OFF key after this selection will lock-in that number.

D. Maintenance

After each use, the MINIRAM should be wiped clean with a soft cloth and connected to charger. The MINIRAM requires a minimum 8 hour charge for daily operation. When not in use it should be stored in the accompanying case to avoid particulate build up in the sensing chamber.

When the zero value exceeds 3 Mg/M3, the sensing chamber may need to be cleaned following the instructions provided in the manufacturer's operating manual.

VI. Quality Assurance Records

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the Field Logbook.

- Identification - Site name, date, location, CTO number, activity monitored (monitoring --well installation, etc.), serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g., the MINIRAM experienced a wide range of fluctuations).

VII. References

Monitoring Instruments for the Environment (MIE), INC., MINIRAM Personal Monitor

Model PDM-3 Operations Manual. March 1990.

STANDARD OPERATING PROCEDURE

Soil Sampling

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of surface and subsurface soils using hand and drilling-rig mounted equipment.

II. Equipment and Materials

- Stainless-steel trowel, shovel, scoopula, coring device, trier, hand auger, or other appropriate hand tool
- Stainless-steel, split-spoon samplers
- Drilling rig or soil-coring rig
- Stainless-steel pan or bowl
- Sample bottles

III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in SOP Deconrig (Decontamination of Drilling Rigs and Equipment). The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

A. Surface and Shallow Subsurface Sampling

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. A decontaminated sampling tool will be used to collect the sample when the desired sampling depth has been reached. Soil for semivolatile organic and inorganic analyses is placed in the bowl and mixed; soil for volatile organic analysis is not mixed or composited but is placed directly into the appropriate sample bottles. A stainless-steel or dedicated wooden tongue depressor is used to transfer the sample from the bowl to the container.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, photo-ionization device (PID) readings should be taken directly above the hole, and the hole is then backfilled.

B. Split-Spoon Sampling

Using a drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight ("hammer") dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon. Material for samples for all other parameters should be removed to a decontaminated stainless steel tray. The sample for semivolatile organic and inorganic analyses should be homogenized in the field by breaking the sample into small pieces and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the sample and compositing the sample for non-volatile parameters only.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used by the drilling rig.

IV. Attachments

ASTM D 1586.

V. Key Checks and Preventative Maintenance

Check that decontamination of equipment is thorough. Check that sample collection is swift to avoid loss of volatile organics during sampling.

Designation: D 1586 – 84

Standard Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

3. Descriptions of Terms Specific to This Standard

3.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.11 *sampling rods*—rods that connect the drive-weigh assembly to the sampler. Drill rods are often used for thi purpose.

3.12 *SPT*—abbreviation for Standard Penetration Test, term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This method provides a soil sample for identificatio purposes and for laboratory tests appropriate for soil ol tained from a sampler that may produce large shear stra disturbance in the sample.

4.2 This method is used extensively in a great variety geotechnical exploration projects. Many local correlatio and widely published correlations which relate SPT blo count, or *N*-value, and the engineering behavior of eart works and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment tl provides at the time of sampling a suitably clean open h before insertion of the sampler and ensures that the penet tion test is performed on undisturbed soil shall be acceptal The following pieces of equipment have proven to suitable for advancing a borehole in some subsurface cor tions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 (162 mm) and greater than 2.2 in. (56 mm) in diameter r be used in conjuction with open-hole rotary drilling casing-advancement drilling methods. To avoid disturba of the underlying soil, bottom discharge bits are not mitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) greater than 2.2 in. (56 mm) in diameter may be use

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 67 (1974).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

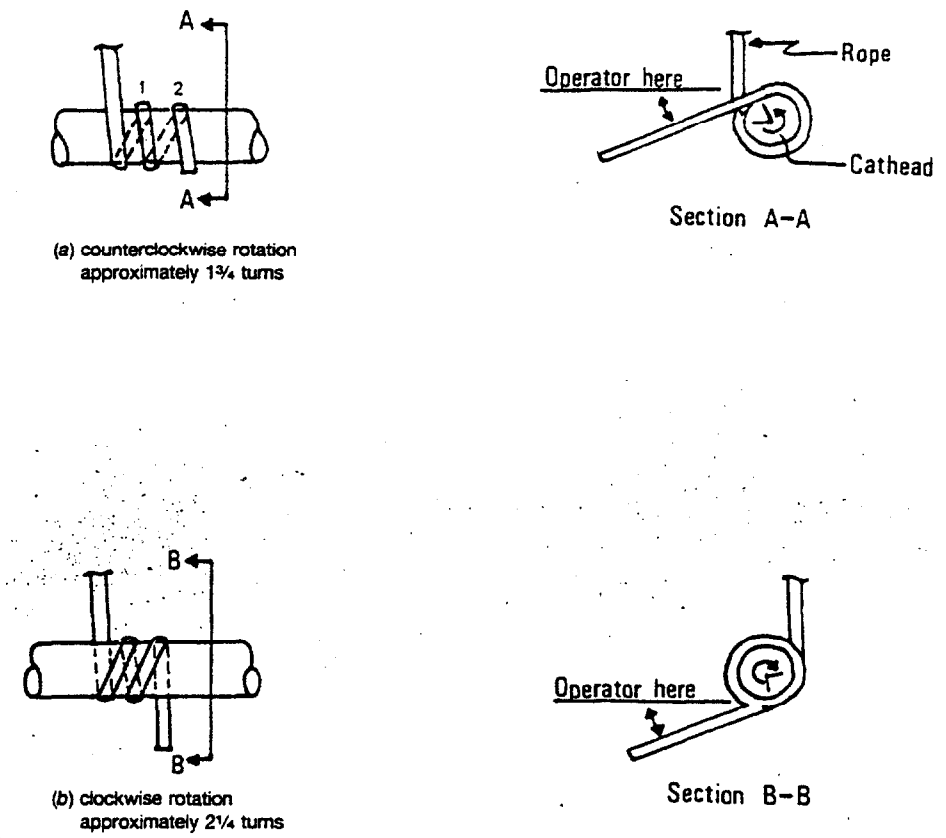


FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of Cathead

conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 2—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly:*

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

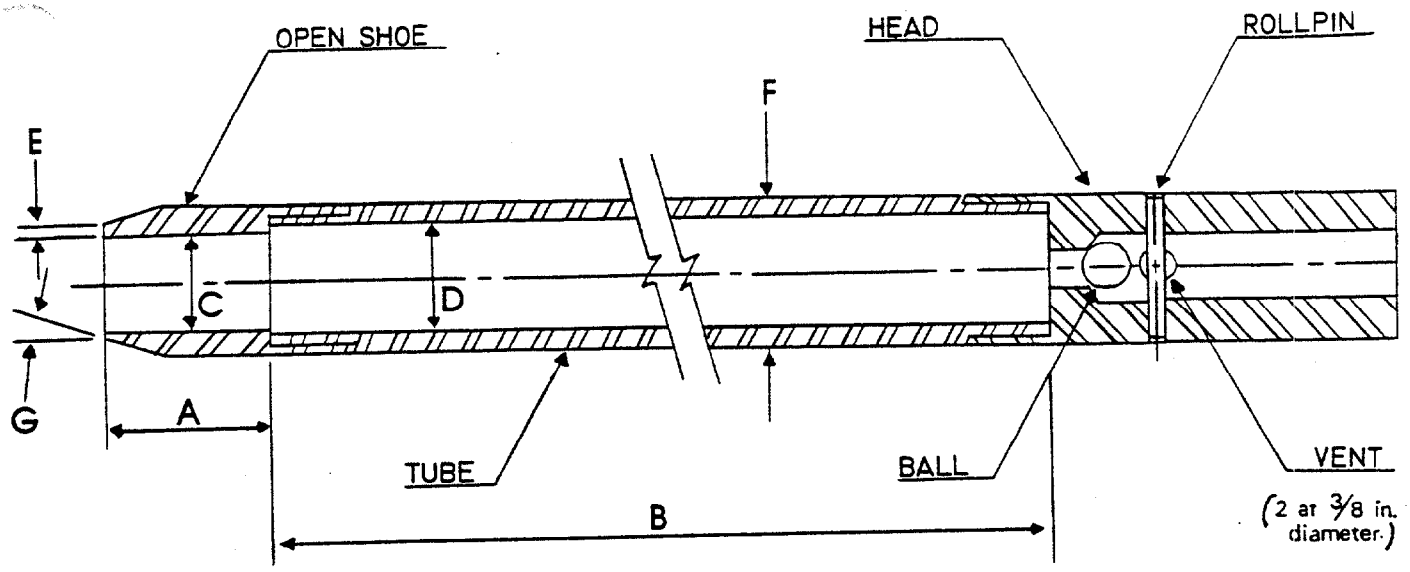
NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with requirements of the project and other ASTM standard

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is permissible. It is not permissible to advance the boring subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.3 The variability in *N*-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting *N* on the basis of comparative energies. A method for energy measurement and *N*-value adjustment is currently under development.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

STANDARD OPERATING PROCEDURE

Shallow Soil Sampling

I. Purpose

To provide general guidelines for the collection and handling of surface soil samples during field operations.

II. Scope

The method described for surface soil sampling is applicable for loosely packed earth and is used to collect disturbed-soil samples.

III. Equipment and Materials

- Sample jars.
- A hand auger or other device that can be used to remove the soil from the ground. Only stainless steel, teflon, or glass materials should be used. The only exception is split spoons, which are most commonly available in carbon steel; these are acceptable for use only if they are not rusty.
- A stainless steel spatula should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Vermiculite
- Fiberglass measuring tape (at least 200 feet in length)

IV. Procedures and Guidelines

A. Wear protective gear, as specified in the Health and Safety Plan.

B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

1. For samples on a grid:

   a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the logbook.

b. Proceed to sample the points on the grid line.

c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.

d. Proceed to sample the points on the grid line as described in Section C below.

e. Repeat 1c and 1d above until all samples are collected from the area.

2. For non-grid samples:

a. Use steel measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).

b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.

c. Proceed to sample as described in Section C below.

d. Repeat 2a through 2c above until all samples are collected from the area.

C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of rooves, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Supervisor (FTS). If the FTS concurs, the sampling point will be deleted from the program. The FTS will contact the CH2M HILL project manager (PM) immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

D. To collect samples:

1. Use a decontaminated stainless steel scoop/trowel to scrape away surficial organic material (grass, leaves, etc.) adjacent to the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

2. If sampling:

a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.

b. Subsurface soil. Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

3. Take an OVM reading of the sampled soil and record the response in the field notebook. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook.

4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan.

5. Repeat this procedure until sufficient soil is collected to meet volume requirements.

6. For TCL VOC and field GC aliquots, fill sample jars directly with the trowel/scoop and cap immediately upon filling. DO NOT HOMOGENIZE.

7. For TCL pesticides/PCBs and SVOCs, TAL metals, and field XRF aliquots, homogenize cuttings in the pan using a decontaminated stainless steel utensil in accordance with SOP Decon.

8. Transfer sample for analysis into appropriate containers with a decontaminated utensil.

9. Backfill the hole with vermiculite. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

V. Attachments

None.

VI. Key Checks and Items

- Phthalate-free latex or surgical gloves and other personal protective equipment.
- Transfer volatiles first, avoid mixing.
- Decontaminate utensils before reuse, or use dedicated, disposable utensils.

STANDARD OPERATING PROCEDURE

Soil Boring Drilling and Abandonment

I. Purpose and Scope

The purpose of this guideline is to describe methods to obtain samples of subsurface soil and then backfill boreholes to the surface.

II. Equipment and Materials

- Truck-mounted drilling rig, and a skid rig or barge-mounted tripod rig
- Hollow-stem augers (4¼-inch ID)
- Split-spoon samplers
- Downhole compacting tool (e.g., a pipe with a flat plate attached to the bottom)
- Cement
- Bentonite
- Hand augers, stainless steel

III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated according to the procedures identified in SOP Decontamination of Personnel and Equipment. The location to be sampled is cleared of debris and trash, and the location is noted in the logbook.

Continuous-fight hollow-stem augers with an inside diameter of at least 4.25 inches are used. The use of water or other fluid to assist in hollow-stem drilling will be avoided.

The bit of the auger is placed on the ground at the location to be drilled and then turned with the drilling or soil-coring rig. For split-spoon sampling, the auger is advanced to a depth just above the top of the interval to be sampled.

While advancing the augers to the full borehole depth, the soils removed from the boring will be screened using a portable volatile organics detector. The borehole will be grouted to the surface with bentonite-cement grout. The soil cuttings are to be drummed and managed as described in SOP Disposal of Waste Fluids and Soils.

The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface. When installing grout in soil borings, the grout will be installed through a tremie pipe that is placed inside the augers. The grouting will be completed before the augers are removed.

Samples will be collected from the soil borings at 2-foot intervals. The soil samples will be collected from the surface continuously to the water table. Because some of the

soil samples are being collected for chemical analysis, decontaminated stainless steel split-spoon samplers will be used for sample collection. The split-spoon samplers will be decontaminated according to the procedures outlined in SOP Decontamination of Personnel and Equipment. Sample collection will follow the general procedures outlined in SOP Soil Boring Sampling-Split Spoon.

A tripod drilling rig or skid rig will be required for boring installation in the lagoons. A tripod drilling rig is generally a tripod equipped to collect continuous samples using a hammer-driven sampler. The soil sample collection will be the same as that outlined above, except that hollow-stem augers are not used to advance the borehole. Borehole collapse due to soft sediments may occur when collecting samples using a tripod drilling rig.

Soil samples will be collected at 1-foot intervals. The soil samples will be placed in clean jars and a headspace measurement of the volatile organics in each of the samples determined. The headspace measurements will be used to identify the potentially most-contaminated samples which will be submitted for analysis through the CLP.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

Check that the drilling rig or soil-coring rig is in working order. Check that the borehole is grouted to the ground surface at the completion of drilling and sampling.

V. Attachments

None.

VI. Key Checks and Items

- Latex or surgical gloves.
- Decontaminate split spoon and transfer tools before next sample.
- Sample volatiles first, then semivolatiles. Avoid mixing.

STANDARD OPERATING PROCEDURE

Soil Boring Sampling–Split Spoon

I. Purpose

To provide a general procedure for sampling subsurface soil produced from a split spoon.

II. Scope

The scope of this procedure is to cover the sample team's responsibility beginning with the opening of the split spoon.

III. Equipment and Materials

- Latex or surgical gloves
- Stainless steel tray or pan
- Field notebook
- Stainless steel spoon or spatula
- Sampling jars
- Decontamination solutions and equipment

IV. Procedures and Guidelines

1. Field team personnel will wear latex or surgical inner gloves and nitrile or neoprene outer gloves to protect from potential dermal contact with hazardous substances.

2. After the split spoon is removed from the borehole and opened by the driller or driller's assistant, it will be turned over to field team personnel.

3. The sample description, depth, time, and date will be logged in the field notebook.

4. Samples for laboratory analysis will be separated and transferred from the split spoon half into the sample jars by a decontaminated stainless steel utensil. Samples for VOC analysis will be separated and transferred first, followed by semivolatile samples. For volatile samples, avoid mixing soil before or during transfer. Homogenize rest of samples according to SOP Homogenization of Soil and Sediment Samples.

5. Split spoon and media transfer tools will be decontaminated before being used again.

STANDARD OPERATING PROCEDURE

Logging of Soil Borings

I. Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. Equipment and Materials

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCl, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index charts and tables to help with soil classification

III. Procedures and Guidelines

This section covers several aspects of the soil characterization: instructions for completing the CH2M HILL soil boring log Form D1586, field classification of soil, and standard penetration test procedures.

A. Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books. Information collected will be consistent with that required for Form D1586 (attached), a standard CH2M HILL form or an equivalent form that supplies the same information.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets.

B. Heading Information

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If stationing, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first initial and full last name.

C. Technical Data

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1 foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record recovery in feet.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A partial penetration of 50 blows for 4 inches is recorded as 50/4 inches. Penetration by the weight of the slide hammer only is recorded as "WOH."

Samples should be collected using a 140-pound hammer and 2-inch diameter split spoons.

Sample also may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. However, use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An "N" value need not be calculated.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below.`

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Health and safety monitoring data
- Drilling interval through a boulder

D. Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488-93, Visual-Manual Procedure for Description and Identification of Soils.

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests (ASTM D 2487). It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488-93, attached). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive

emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488-93 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2. Group symbol, in parentheses, for example, "(SP)."
3. Color, using Munsell color designation
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488-93.

E. Soil Name

The basic name of a soil should be the ASTM D 2488-93 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488-93. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488-93.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as "Interlayered Sand and Silt," should be used. In addition, the relative proportion of each soil type should be indicated (see Table 1 for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils,

such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488-93.

F. Group Symbol

The appropriate group symbol from ASTM D 2488-93 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488-93, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group. Grain size is estimated in accordance with ASTM D 2488-93 (Table 2).

G. Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

H. Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on Table 3.

I. Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586-84). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the in situ relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in Tables 4 and 5.

J. Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

K. **Equipment and Calibration**

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586-84. The split-barrel sampler should measure 2-inch or 3-inch O.D., and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is "A" rod (1-5/8-inch O.D.). A stiffer rod, such as an "N" rod (2-5/8-inch O.D.), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. Attachments

Soil Boring Log, CH2M HILL Form D1586, and a completed example

ASTM D 2488-90: Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).

V. Key Checks and Preventive Maintenance

Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later. Check that sample numbers and intervals are properly specified. Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP Decontamination of Drilling Rigs and Equipment.

Date: January 1990

Table 1
EXAMPLE SOIL DESCRIPTIONS

POORLY GRADED SAND (SP), light brown, moist, loose, fine sand size

FAT CLAY (CH), dark gray, moist, stiff

SILT (ML), light greenish gray, wet, very loose, some mica, lacustrine

WELL-GRADED SAND WITH GRAVEL (SM), reddish brown, moist, dense, subangular gravel to 0.6 inches max

POORLY GRADED SAND WITH SILT (SP-SM), white, wet, medium dense

ORGANIC SOIL WITH SAND (OH), dark brown to black, wet, firm to stiff but spongy undisturbed, becomes soft and sticky when remolded, many fine roots, trace of mica

SILTY GRAVEL WITH SAND (GM), brownish red, moist, very dense, subrounded gravel to 1.2 inches max

INTERLAYERED SILT (60 percent) AND CLAY (40 percent): SILT WITH SAND (ML), medium greenish gray, nonplastic, sudden reaction to shaking, layers mostly 1.5 to 8.3 inches thick; LEAN CLAY (CL), dark gray, firm and brittle undisturbed, becomes very soft and sticky when remolded, layers 0.2 to 1.2 inches thick

SILTY SAND WITH GRAVEL (SM), light yellowish brown, moist, medium dense, weak gravel to 1.0 inches max, very few small particles of coal, fill

SANDY ELASTIC SILT (MH), very light gray to white, wet, stiff, weak calcareous cementatic

LEAN CLAY WITH SAND (CL/MH), dark brownish gray, moist, stiff

WELL-GRADED GRAVEL WITH SILT (GW-GM), brown, moist, very dense, rounded gravel to 1.0 inches max

Date: September 13, 1989

Table 2
CRITERIA FOR DESCRIBING MOISTURE CONDITION

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below water table

Table 3
RELATIVE DENSITY OF COARSE-GRAINED SOIL
(Developed from Sowers, 1979)

Blows/Ft	Relative Density	Field Test
0-4	Very loose	Easily penetrated with ½-in. steel rod pushed by hand
5-10	Loose	Easily penetrated with ½-in. steel rod pushed by hand
11-30	Medium	Easily penetrated with ½-in. steel rod driven with 5-lb hammer
31-50	Dense	Penetrated a foot with ½-in. steel rod driven with 5-lb hammer
>50	Very dense	Penetrated only a few inches with ½-in. steel rod driven with 5-lb hammer

Table 4
CONSISTENCY OF FINE-GRAINED SOIL
(Developed from Sowers, 1979)

Blows/Ft	Consistency	Pocket Penetrometer (TSF)	Torvane (TSF)	Field Test
<2	Very soft	<0.25	<0.12	Easily penetrated several inches by fist
2-4	Soft	0.25-0.50	0.12-0.25	Easily penetrated several inches by thumb
5-8	Firm	0.50-1.0	0.25-0.5	Can be penetrated several inches by thumb with moderate effort
9-15	Stiff	1.0-2.0	0.5-1.0	Readily indented by thumb, but penetrated only with great effort
16-30	Very stiff	2.0-4.0	1.0-2.0	Readily indented by thumbnail
>30	Hard	>4.0	>2.0	Indented with difficulty by thumbnail

Date: September 13, 1989

Table 5
FIELD EQUIPMENT CHECKLIST FOR SOIL BORING LOGGING

Siting

___Lath, flagging, and orange spray paint
___Lumber crayon
___100-foot tape
___Brunton or Silva compass

Logging Equipment

___Soil Boring Guideline
___Clipboard
___Form D1586 on all-weather paper
___Pens/pencils
___Engineer's pocket tape measure with tape lock
___Field notebook on all-weather paper
___Squirt bottle with water
___Spatula
___HCL, 10 percent solution

Sampling and Packaging

___Jars with lids and labels (Form #131)
___Shelby tubes and plastic end caps
___Airtight tape (e.g., electrical)
___Newspaper
___Wax, stove, melting pot, and matches
___Indelible fine felt-tipped markers (e.g., "Sharpie" brand)

Test Equipment

___Pocket penetrometer
___Torvane
___Well sounder

Other

___Camera, film
___Hand lens
___Rags
___Ear protectors
___Screwdrivers
___Hard hat
___Sunscreen
___Insect repellent

Attachments

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 1 OF 3
DEN22371.G5	BL-3	

SOIL BORING LOG

PROJECT Howard Ave Landslide LOCATION Howard & 24th Ave, Cent

ELEVATION 513½ Feet DRILLING CONTRACTOR Kendall Explorations, Ashcan,

DRILLING METHOD AND EQUIPMENT 4"-inch H.S. Augers, Mobil B-61 rotary drilling

WATER LEVELS 3.2 Feet, 8/5/89 START August 4, 1989 FINISH August 8, 1989 LOGGER J.A. Michne

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Surface material consist of 4 inches AC underlain by 6 inches of ¾ inch minus base rock	Start Drilling @ 3:00
	2.5					
	4.0	1-S	1.5	2-3-4 (7)	POORLY-GRADED SAND WITH SILT, (SP-SM), fine, light brown, wet, loose	Driller notes water at 4 fe
	5.0					Driller notes very soft drill 4 ft, dark grey, wet silty cuttings.
5	6.5	2-S	0.9	WOH/12"-1	ORGANIC SILT, (OL), very dark, gray to black, wet, very soft; strong H_2S odor, many fine roots up to about 1/4 inch	
	8.0					
	10.0	3-ST	1.3	———	ORGANIC SILT, similar to 2-S, except includes fewer roots (by volume)	
10	11.5	4-S	1.3	2-2-2 (4)	SILT, (ML), very dark gray to black, wet, soft	water level @ 3.2 feet 8/5/89 @ 0730
						Driller notes rough drill action and chatter @ 13 ft
	15.0					
15	15.5	5-S	0.5	60/6"	SILTY GRAVEL, (GM), rounded gravel up to about 1 inch maximum observed size, wet, very dense	
	20.0					Driller notes smoother, fi drilling @ 19 ft some angular rock chips @ top of 6-S, poss boulders a
20	21.0	6-S	1.0	12-50/6"	LEAN CLAY WITH SAND, (CL), medium to light green, moist, very stiff	Driller notes very hard, s grinding, smooth drilling action from 21 to 23 ft, possibly bedrock
	23.0					
	23.1	7-S	-0-	50/1"	NO RECOVERY	
					END SOIL BORING @ 23.1 FEET SEE ROCK CORE LOG FOR CONTINUATION OF BL-3	

Figure 2
EXAMPLE OF CC 1
LOG FORM

REV 11/89 FO

Designation: D 2488 - 90

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

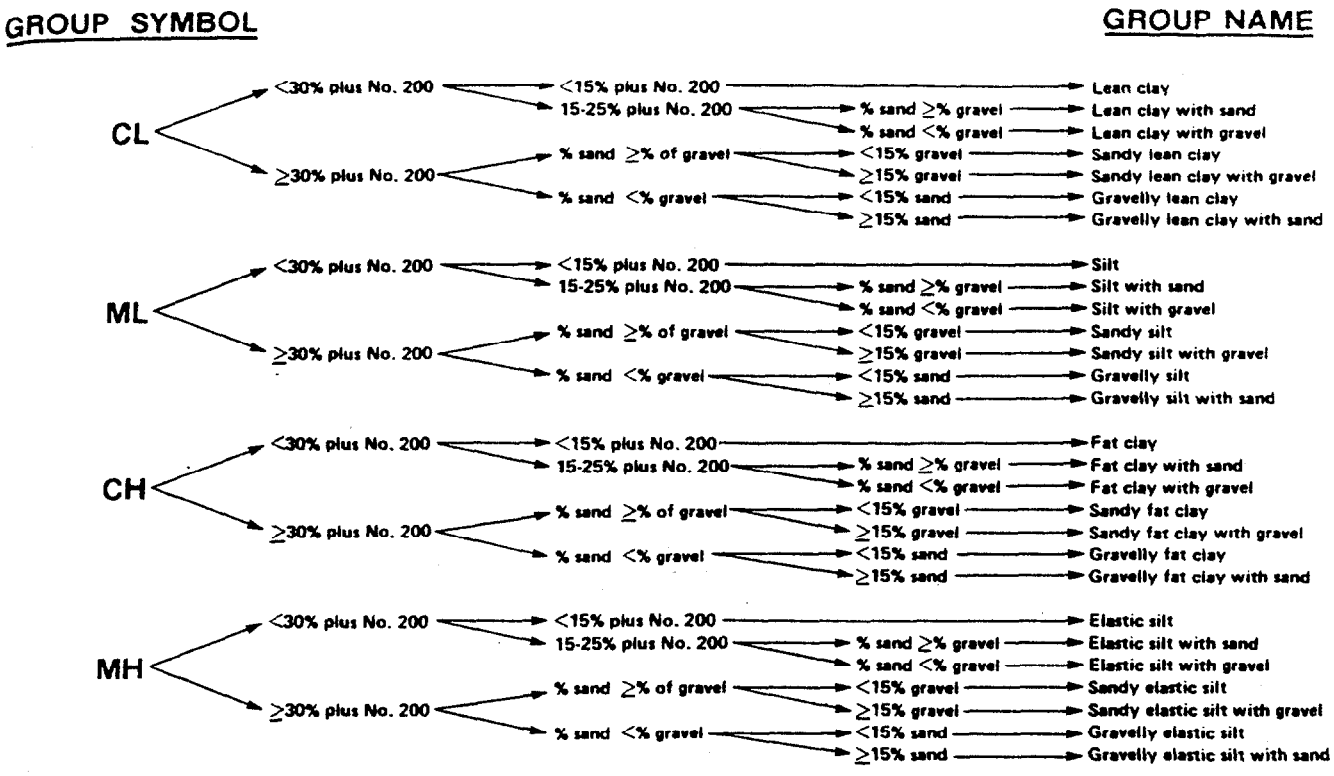
3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No. 4

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved June 29, 1990. Published August 1990. Originally published as D 2488 - 66 T. Last previous edition D 2488 - 84[ε1].

[2] *Annual Book of ASTM Standards*, Vol 04.08.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

(4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

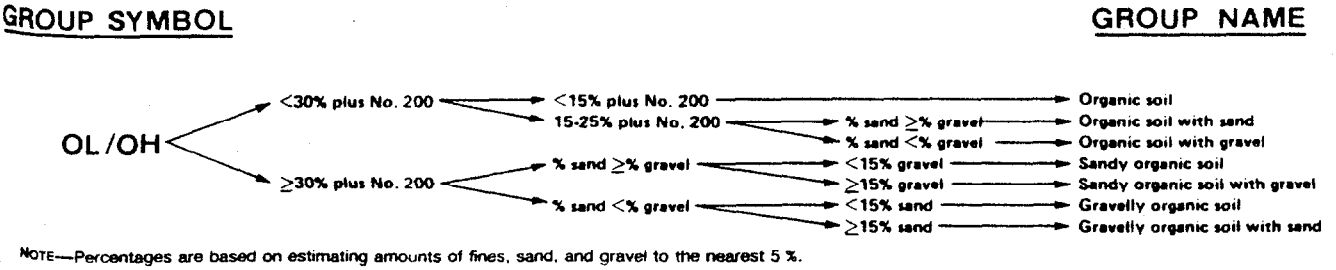
4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

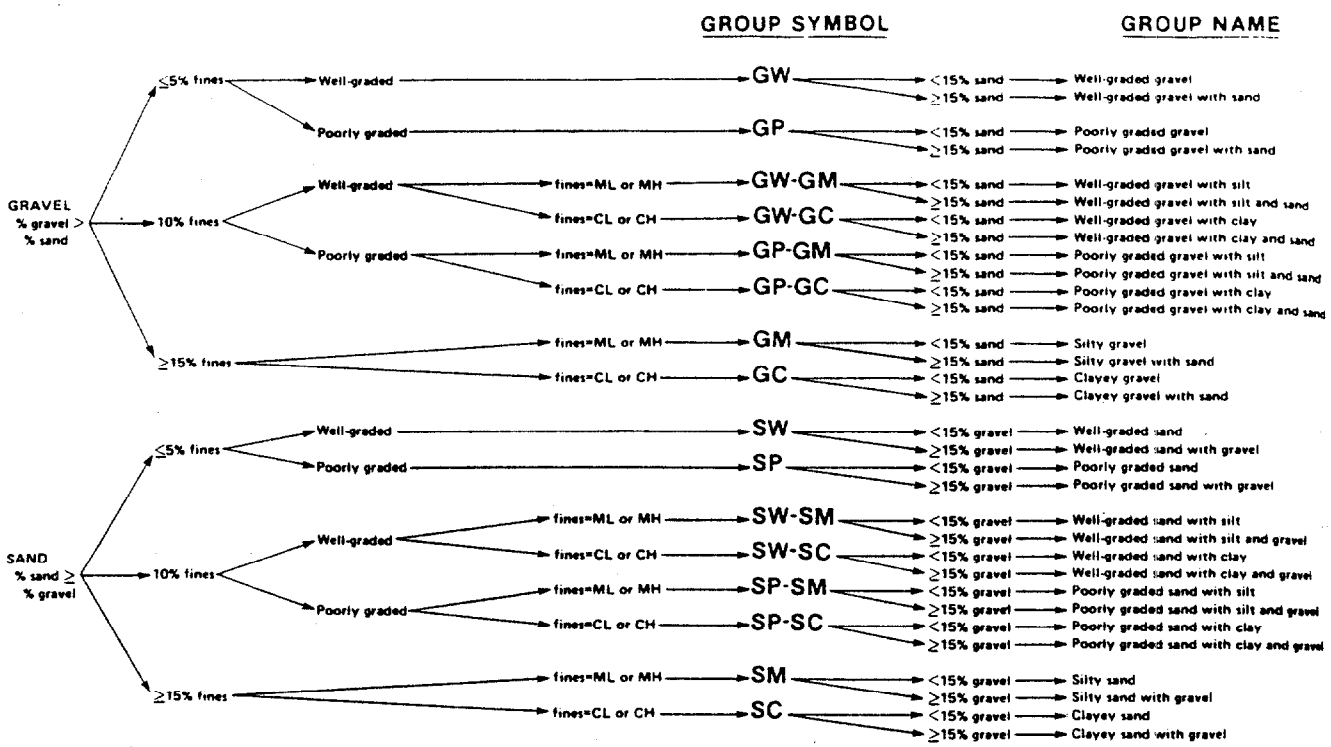
NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

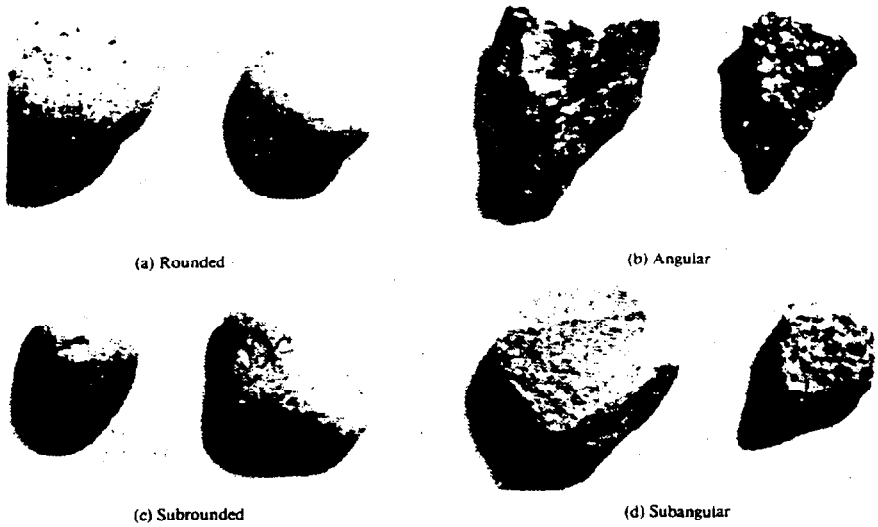


FIG. 3 Typical Angularity of Bulky Grains

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0..5 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

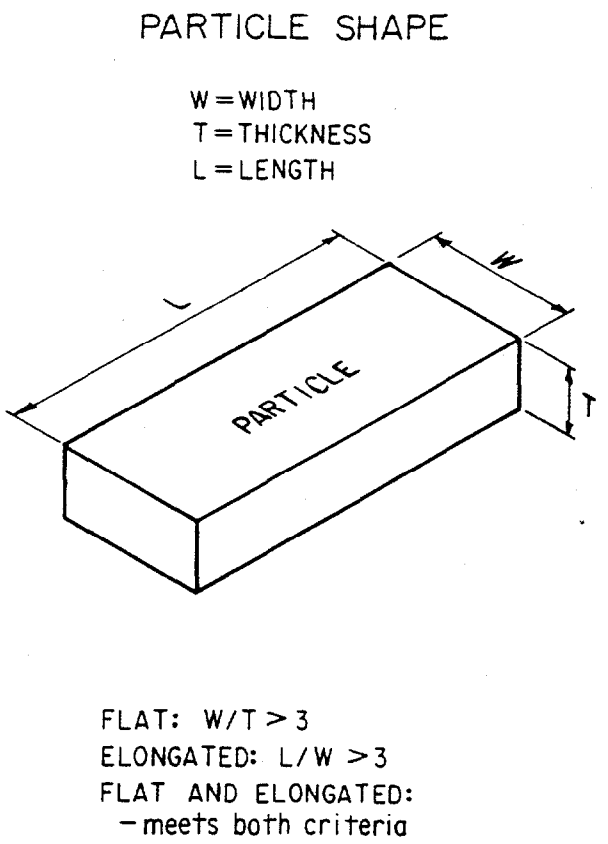


FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpre-

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

tation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness:*

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils:*

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

Standard Operating Procedure

Soil Gas and In-Situ Groundwater Sampling Surveys

I. Purpose

The purpose of this SOP is to describe the methods and procedures involved in conducting a soil gas survey.

II. Scope

The methods described in this SOP are applicable to the detection of groundwater and soil contamination, determining the extent of the contamination, and identifying the source(s) of contamination. Soil gas monitoring provides a quick means of waste site evaluation. Using this method, underground contamination can be identified, and the source, extent, and movement of the pollutants can be traced.

III. Definitions

Dynamic Device - A method whereby soil gas samples are extracted through a hollow steel tube using a vacuum extraction pump.

Passive Device - A method where adsorption devices are implanted in the shallow surface soils. These are left in place for days or weeks. After a set time, the devices are dug out and sent out for analysis.

Direct Connection - The direct transfer of soil gas into the on-site gas chromatograph (GC) via a vacuum pump.

Syringe - Device used to transfer the soil gas sample into the GC.

Gas Bulbs/Bags - Devices to hold soil gas samples prior to analysis.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or other approval methods are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the specific sampling techniques and equipment to be used, and documenting these in the Sampling and Analysis Plan. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that

personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper acquisition of soil gas samples.

V. Procedures

Prior to selecting sample locations, an underground utility search is recommended. The local utility companies or Base utility personnel can be contacted and requested to mark the locations of their underground lines. Sampling plans/designs can then be drawn up accordingly.

Typical methodology involves the insertion of (3/8-inch diameter) probes into the ground to a desired depth via a hydraulic pusher/puller mechanism. A 1/4-inch O.D. stainless steel probe is inserted into the hole and sealed at the top around the probe. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump.

Attachment A is a generalized SOP including quality control procedures performed by soil gas survey firms. The methods and procedures described herein are typical for this type of subsurface investigation.

Some soil gas firms have the ability to collect and analyze groundwater samples using the probe apparatus in a manner similar to collecting soil gas samples. Specific project requirements are documented in the site-specific work plan.

VI. Quality Assurance Records

Quality assurance records will vary between soil gas survey firms. Ordinarily QA/QC records accompany soil gas survey firm reports in the form of spike or blank results from analysis of "Field QA Samples" prepared and analysis, as required under each individual project. Project plans should include QA/QC specific requirements for the soil gas or in situ groundwater sampling program.

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ATTACHMENT A

Generalized
Soil Gas Survey Standard Operating Procedure
Soil Gas Sampling Procedure

I. Probe Placement

A. A clean probe (pipe) is removed from the "clean" storage tube.

B. The soil gas probe is placed in the jaws of hydraulic pusher/puller mechanism.

C. A sampling point is put on the bottom of the probe.

D. The hydraulic pushing mechanism is used to push the probe into the ground.

E. If the pusher mechanism will not push the probe into the ground a sufficient depth for sampling, the hydraulic hammer is used to pound the probe into the ground. Please note that concrete cutting may be required prior to probe placement pending sampling point location.

II. Sample Extraction

A. An adaptor is put onto the top of the soil gas probe.

B. The vacuum pump is hooked onto the adaptor.

C. The vacuum pump is turned on and used to evacuate soil gas.

D. Evacuation will be at least 30 seconds but never more than 5 minutes for samples having evacuation pressures less than 15 inches of mercury. Evacuation times will be at least 1 minute, but no more than 5 minutes for probes reading greater than 15 inches of mercury.

E. Gauges on the vacuum pump are checked for inches of mercury.

1. Gauge must read at least 2 inches of mercury less than maximum vacuum to be extracting sufficient soil gas to collect a valid sample.

III. Sample Collection

A. With vacuum pump running, a hypodermic syringe needle is inserted through the silicone rubber and down into the metal tubing or adaptor.

B. Gas samples should only contact metal surfaces and never contact potentially sorbing materials (i.e., tubing, hose, pump diaphragm).

C. The syringe is purged with soil gas then, without removing syringe needle from adaptor, a 10 mL soil gas sample is collected.

D. The syringe and needle are removed from the adaptor and the end of the needle is capped.

E. If necessary, a second 10 mL sample is collected using the same procedure.

IV. Deactivation of Sampling Apparatus

A. The vacuum pump is turned off and unhooked from the adaptor.

B. The adaptor is removed and stored with equipment to be cleaned.

C. Using the hydraulic puller mechanism, the probe is removed from the ground.

D. The probe is stored in the "dirty" probe tube.

E. The probe hole is backfilled, if required.

V. Log Book Notations for Sampling

A. Time (military notation)

B. Sample number

C. Location (approximate description - i.e., street names)

D. Sampling depth

E. Evacuation time before sampling

F. Inches of mercury on vacuum pump gauge

G. Probe and adaptor numbers

H. Number of sampling points used

I. Observations (i.e., ground conditions, concrete, asphalt, soil appearance, surface water, odors, vegetation, etc.)

J. Backfill procedure and materials, if used

VI. Other Recordkeeping

A. Data sheets are filled out, if required

B. Sample location is marked on the site map

Note:

Typical soil gas/in situ groundwater sampling investigations include a report of results from the soil gas survey. Report format and content may vary; however, project specific requirements (i.e., recordkeeping/documentation) should be identified and confirmed prior to onsite operations.

STANDARD OPERATING PROCEDURE

Geoprobe® Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using Geoprobe® sampling methods.

II. Scope

Standard Geoprobe® soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Geoprobe® sampling rods
- Geoprobe® sampling tubes and acetate liners (if desired)
- Pre-cleaned sample containers and stainless-steel sampling implements
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP Decontamination of Personnel and Equipment.

2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.

3. Remove the rods and sampling tube from the borehole and remove the sample from the tube.

4. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement.

5. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP Decontamination of Personnel and Equipment.

6. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.

2. Ensure that the Geoprobe® operator thoroughly completes the decontamination process between sampling locations.

3. Verify that the borehole made during sampling activities has been properly backfilled.

STANDARD OPERATING PROCEDURE

Surface Water Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting surface water samples. Materials, equipment, and procedures may vary; refer to the Field Sampling Plan and operators manuals for specific details.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the Field Sampling Plan should be consulted for project-specific details.

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Sample containers
- Meters for specific conductance, temperature, pH, and dissolved oxygen

III. Procedures and Guidelines

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP Decontamination of Personnel and Equipment. Methods for surface water sample collection are described below.

A. Manual Sampling

Surface water samples are collected manually by submerging a clean glass, stainless steel, or Teflon container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline. The most common sampler types are beakers, sealable bottles and jars, pond samplers, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly. Specific types of weighted bottle samplers include dissolved oxygen, Kemmerer, or Van Dorn, and are acceptable in most instances.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.

2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle.

3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.

4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time.

5. Measure dissolved oxygen, specific conductance, temperature, and pH at the sampling location.

STANDARD OPERATING PROCEDURE

Sediment Sampling

I. Purpose

These general outlines describe the collection and handling of sediment samples during field operations.

II. Scope

The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Operators manual , if available, should be consulted for specific details

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device)
- Stainless steel spoon or spatula for media transfer
- Measuring tape
- Log book
- Personal protection equipment (rubber or latex gloves, boots, hip waders, etc.)
- Materials for classifying soils, particularly the percentage of fines
- Sample jars, including jars for Total Organic Carbon and pH, as appropriate

IV. Procedures and Guidelines

1. Field personnel will start downstream and work upstream to prevent contamination of unsampled areas.
2. Make a sketch of the sample area showing important nearby river features and permanent structures that can be used to locate the sample points on a map. Whenever possible, include measured distances from such identifying features. Also include depth and width of waterway, rate of flow, type and consistency of sediment, and point and depth of sample removal (along shore, mid-channel, etc).
3. Transfer sample into appropriate sample jars with a stainless steel spoon or utensil. The sampler's fingers should never touch the sediment since gloves may introduce organic interferences into the sample. Classify the soil type of

the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.

4. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.

5. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.

6. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.

7. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.

8. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

None.

VI. Key Checks and Items

- Start downstream, work upstream.
- Log exact locations using permanent features.
- Beware of hidden hazards.

STANDARD OPERATING PROCEDURE

Flat Bottom Boat Sampling Operations

I. Purpose

Flat bottom boat sampling operations are a non-standard practice of RCRA/ CERCLA investigations. The objective of these operations is to access those sample locations inaccessible to larger, deeper draft, motorized water craft.

II. Scope

The provisions of this SOP apply to all program and project personnel engaged directly in technical boating operations, whether planning or executing those operations. These provisions apply whenever technical boating equipment or activities are used or included in project operations.

III. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans for boating operations and federal and state boating safety regulations are in accordance with these procedures, where applicable, or that other approved procedures are developed.

Field Team Leader - The Field Team Leader is responsible for ensuring that these boating procedures are implemented in the field, and for ensuring that personnel performing these activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the sampling personnel to follow these procedures or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper sampling procedures, proper operation of the boat and adherence to waterborne health and safety procedures.

IV. Procedures

The following procedures outline the planning and execution of flat bottom boat sampling operations:

1. All operations involving technical boating will be directed by qualified and experienced boater as the team leader.
2. All persons participating in boating operations will be directed by the Team Leader.

3. All persons participating in boating operations will have been trained by the Team Leader or provide proof of experience in operating such water craft.
4. All water craft shall operate on a "line of sight" rule. No water craft will go out of sight of each other.
5. All personnel shall wear their Personnel Floatation Devices at all times while they are on the water.
6. The boating team will include at least one person qualified in First Aid/CPR for nonstandard conditions (for example: fire rescue, air/land/sea rescue).
7. All personnel shall wear bright colors (for example: hunter orange, yellow, etc.) to enhance their visibility to one another.
8. All personnel shall collect one sample at a time, and return that sample to the "mother ship," the dock, or other location as determined by site conditions and situation.
9. Team Leader has final authority on operations with regards to weather and water conditions.

STANDARD OPERATING PROCEDURE

Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This procedure presents general guidelines for the collection of groundwater samples from monitoring wells. The procedure does not address purging and sampling using "low-flow" techniques. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Probe box with inlet/outlet ports for purged groundwater and watertight ports for each probe
- pH meter: Orion Model SA250 or equivalent
- Temperature/conductivity meter: YSI Model 33 or equivalent
- Dissolved oxygen meter: YSI Model 57 or equivalent
- In-line disposable 0.45μ filters: QED FF8100 or equivalent
- Bailer, teflon or stainless steel
- Peristaltic pump, bladder pump, or submersible sampling pump with tubing, support cables, and power supply (may not be required if well yield is low)

III. Procedures and Guidelines

A. Setup and Purging

1. For the well to be sampled, information is obtained on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.
2. A pump will be used for well purging if the well yield is adequate; otherwise, a bailer may be used.
3. Instruments are calibrated according to manufacturer's instructions.
4. The well number, site, date, and condition are recorded in the field logbook.

5. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed.

6. Water level measurements are collected in accordance with SOP Water Level Measurements, and the total depth of the well is measured.

7. The volume in gallons of water in the well casing or sections of telescoping well casing is calculated as follows:

   $0.052\ (\pi\ r^2h) = 0.163\ (r^2h) =$ gallons

   where: $\pi = 3.14$

   r = Radius of the well pipe in inches
   h = height of water in well in feet

   The volume of water in typical well casings may be calculated as follows:

   2-inch diameter well:
   0.163 gal/ft x ___ (linear feet of water) = gallons

   4-inch diameter well:
   0.653 gal/ft x ___ (linear feet of water) = gallons

   6-inch diameter well:
   1.469 gal/ft x ___ (linear feet of water) = gallons

   The initial field parameters of pH, specific conductance, and temperature of water are measured and recorded in the field logbook. The measurement probes are inserted into the probe box. The purged groundwater is directed through the box, allowing measurements to be collected before the water contacts the atmosphere.

8. Sampling equipment is cleaned and decontaminated prior to sampling in accordance with SOP Decon (Decontamination of Personnel and Equipment).

9. If a bailer is being used, it is removed from either its protective covering or the well casing and attached to a cord compatible with constituents and long enough to reach the bottom of the well. If a sampling pump is being used, the air line, discharge line, and support cable or rope are attached to the pump. The support line should bear the weight of the pump. If the well is purged using dedicated tubing, it is lowered into the well to the top of the screened zone.

10. The sampling device is lowered to the well interval from which the sample is to be collected. The pump intake will be placed above the top of the screen, where possible. If a bailer is being used, it is allowed to fill with a minimum of surface disturbance to prevent sample water

aeration. When the bailer is raised, the bailer cord must not touch the ground.

During purging, the field parameters are measured at least once for each well volume. In productive wells, the well purging end point is determined using the field measurements. In nonproductive wells, the well is repeatedly bailed dry to obtain a minimum of three well volumes, then allowed to recover before sampling.

12. Three to five well volumes are purged (more may be purged if parameters do not stabilize). Purging is stopped when field parameters have stabilized over three consecutive well volumes. Field parameters are considered stabilized when pH measurements agree within 0.5 units, temperature measurements agree within 1°C, and specific conductance and dissolved oxygen measurements agree within 10 percent.

B. Sample Collection

Once purging has been completed, the well is ready to be sampled. The elapsed time between completion of purging and collection of the ground-water sample from the well should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in bottles that are appropriate to the respective analysis and that have been cleaned to laboratory standards. Each bottle typically will have been previously prepared with the appropriate preservative, if any.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservatives added; laboratory sent to, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
5. Additional remarks

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.

2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs. Samples may be field filtered before transfer to the sample bottle. Filtration must occur in the field immediately upon collection. Inorganics, including metals, are to be collected and preserved in the filtered form as well as the unfiltered form. The recommended method is through the use of a disposable in-line filtration module (0.45 micron filter) using the pressure provided by the pumping device for its operation. When a bailer is used, filtration may be driven by a peristaltic pump.

3. VOC samples from wells purged using dedicated tubing and a sampling pump will be collected using a bailer

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to overflowing and capped.

5. The bottle is capped, then labeled clearly and carefully.

6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

7. If the sampler is dedicated, it is returned to the well and the well is capped and locked. Nondedicated samplers are cleaned and decontaminated in accordance with SOP Decontamination of Personnel and Equipment.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:

- Inspect sampling pump regularly and replace as warranted
- Bring supplies for replacing the bladder if using a positive-displacement bladder pump
- Inspect tubing regularly and replace as warranted
- Inspect air/sample line quick-connects regularly and replace as warranted
- Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

STANDARD OPERATING PROCEDURE

Geoprobe® Hydropunch® Groundwater Sample Collection

I. Purpose

To provide a general guideline for the collection of groundwater samples using Geoprobe sampling methods.

II. Scope

Standard Geoprobe groundwater sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Geoprobe sampling rods
- Polyethylene sampling tubing and stainless steel foot valve
- Pre-cleaned sample containers
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate slotted lead rod and other non-dedicated downhole equipment in accordance to SOP Decontamination of Personnel and Equipment.
2. Drive slotted steel lead rod to the desired sampling depth using the truck-mounted hydraulic percussion hammer.
3. Insert the stainless steel foot valve into the end of the polyethylene sampling tubing and insert tubing through the rods.
4. Fill all sample containers, beginning with the containers for VOC analysis.
5. Remove polyethylene sampling tubing from the rods. Remove the foot valve and discard polyethylene tubing.
6. Decontaminate all non-dedicated downhole equipment (lead rod, foot valve, etc.) in accordance to SOP Decontamination of Personnel and Equipment.
7. Backfill hole at each sampling location with like material (bentonite, asphalt patch, concrete, etc.).

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.

2. Ensure that the Geoprobe operator thoroughly completes the decontamination process between sampling locations.

3. Verify that the hole made during sampling activities has been properly backfilled.

Standard Operating Procedure

Low Flow Groundwater Sampling

I. Purpose and Scope

This procedure presents general guidelines for the collection of groundwater samples from monitoring wells using low flow sampling techniques. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Probe box with inlet/outlet ports for purged groundwater and waterweight ports for each probe
- pH meter: Orion Model SA250 or equivalent
- Temperature/conductivity meter: YSI Model 33 or equivalent
- Dissolved oxygen meter: YSI Model 57 or equivalent
- Oxidation-reduction potential (ORP) meter
- Multi-use meter (such as Horiba U-10 or equivalent) may also be used in place of the above individual meters
- In-line disposable 0.45u filters: QED FF8100 or equivalent
- Low-flow sampling pump (electric submersibles, submersible pneumatic bladder pump, or peristaltic pump)
- Flow-through cell

III. Procedures and Guidelines

A. Setup and Purging

1. For the well to be sampled, information is obtained on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.

2. Instruments are calibrated according to manufacturer's instructions.

3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed.

5. Water level measurements are collected in accordance with SOP Water Level Measurements, and the total depth of the well is measured.

6. The volume in gallons of water in the well casing or sections of telescoping well casing is calculated as follows:

   $(\pi r^2 h) = 0.163 (r^2 h) =$ gallons
   where: $\pi = 3.14$
   r = Radius of the well pipe in inches
   h = height of water in well in feet

   The volume of water in typical well casings may be calculated as follows:

   2-inch diameter well:
   gal/ft x ___ (linear feet of water) = gallons

   4-inch diameter well:
   gal/ft x ___ (linear feet of water) = gallons

   6-inch diameter well:
   gal/ft x ___ (linear feet of water) = gallons

   The initial field parameters of pH, specific conductance, and temperature of water are measured and recorded in the field logbook. The measurement probes are inserted into the probe box. The purged groundwater is directed through the box, allowing measurements to be collected before the water contacts the atmosphere.

7. Sampling equipment is cleaned and decontaminated prior to sampling in accordance with SOP Decon (Decontamination of Personnel and Equipment).

8. The air line, discharge line, and support cable or rope are attached to the sampling pump. The support line should bear the weight of the pump. If the well is purged using dedicated tubing, it is gently lowered into the well to the top of the screened zone.

9. The pump is operated slowly to purge the water from the discharge tubing and draw water from the aquifer formation through the screen immediately adjacent to the intake without mixing with the "stagnant" water in the well. Low flow sampling is an attempt to strike a balance between sampling the

undisturbed water column and purging water at higher than natural flow rates (which promote aeration, volatilization, and other geochemcial reactions). The pumping water level is carefully monitored to ensure the drawdown is kept to a minimum to prevent artificial aeration of the sample and mixing with stagnant well-bore water. A typical pumping rate is 1.0 - 1.5 L/min.

10. Field parameters such as turbidity, dissolved oxygen (DO), temperature, oxidation-reduction potential (ORP), electrical conductivity, and pH are carefully and continuously monitored (typically every three minutes) using a flow-through cell. Probes place in a small bucket or beaker that continuously oveflows with the discharge tubing placed near the probes is adequate, but using a larger vessel will dilute the discharge water and will mask the trend toward equilibrium. A flow cell contructed of a short length of 4-inch diameter PVC pipe with one end cap can be easily constructed with a discharge tubing barb tapped into the side of the pipe near the end cap. This will allow the purge water to continuously flow up and past the meter probes.

    Purging should continue until groundwater parameters have stabilized, regardless of the number of well volumes purged. Stabilization occurs when three consecutive readings fall within 10% of each other. With low-flow purging, equilibrium conditions are sometimes achieved in less than one well volume and commonly in less than three well volumes.

    Low-Yield Wells: In some cases the well recharges so slowly that it is impractical to collect a groundwater sample that is representative of formation groundwater with respect to key geochemical parameters. In such cases either sample the stagnant water from within the screened interval or slowly purge the well dry and collect the samples as soon as the volume needed for sampling has recharged. An increase in DO or ORP during or after purging is an indication of artificial aeration of the water, and the results should be qualified accordingly.

B. Sample Collection

Once purging has been completed, the well is ready to be sampled. The elapsed time between completion of purging and collection of the groundwater sample from the well should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

The samples should be collected before the groundwater reaches the flow-through cell to avoid cross contamination.

Samples will be placed in bottles that are appropriate to the respective analysis and that have been cleaned to laboratory standards. Each bottle typically will have been previously prepared with the appropriate preservative, if any.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)

2. Sample source and source description

3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements

4. Sample disposition (preservatives added; laboratory sent to, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

5. Additional remarks

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.

2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs. Samples may be field filtered before transfer to the sample bottle. Filtration must occur in the field immediately upon collection. Inorganics, including metals, are to be collected and preserved in the filtered form as well as the unfiltered form. The recommended method is through the use of a disposable in-line filtration module (0.45 micron filter) using the pressure provided by the pumping device for its operation.

3. VOC samples from wells purged using dedicated tubing and a sampling pump will be collected using a bailer.

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to overflowing and capped.

5. The bottle is capped, then labeled clearly and carefully.

6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

7. Nondedicated samplers are cleaned and decontaminated in accordance with SOP Decontamination of Personnel and Equipment.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:

- Inspect sampling pump regularly and replace as warranted
- Inspect tubing regularly and replace as warranted
- Inspect air/sample line quick-connects regularly and replace as warranted
- Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

STANDARD OPERATING PROCEDURE

Installation of Shallow Monitoring Wells

I. Purpose and Scope

The purpose of this guideline is to describe methods for drilling and installation of shallow monitoring wells and piezometers in unconsolidated or poorly consolidated materials. Methods for drilling and installing bedrock monitoring wells are presented in SOP Installation of Bedrock Monitoring Wells.

II. Equipment and Materials

Drilling

- Drilling rig
- Hollow-stem augers

Well Riser/Screen

- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch ID, flush-threaded riser; alternatively, stainlesss steel riser
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted screen; alternatively, stainless steel screen.

Bottom Cap

- PVC, threaded to match the well screen; alternatively, stainless steel
- Centering Guides (if used)

Well Cap

- Above-grade well completion: PVC, threaded or push-on type, vented
- Flush-mount well completion: PVC, locking, leak-proof seal
- Stainless steel to be used as appropriate

Sand

- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse) filter pack, and secondary (fine) filter pack. Grain size determined based on sediments observed during drilling.

Bentonite

- Pure, additive-free bentonite pellets
- Pure, additive-free powdered bentonite

- Coated bentonite pellets; coating must biodegrade within 7 days
- Cement-Bentonite Grout: proportion of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage

Protective Casing

- Above-grade well completion: 6-inch minimum ID steel pipe with locking cover, diameter at least 2 inches greater than the well casing, painted with epoxy paint for rust protection; heavy duty lock; protective posts if appropriate
- Flush-mount well completion: Morrison 9-inch or 12-inch 519 manhole cover, or equivalent; rubber seal to prevent leakage; locking cover inside of road box

Well Development

- Double surge block with solid bottom, top open, separated by 2 feet of slotted pipe
- Well-development pump, and associated equipment
- Containers (e.g., 55 gallon drums) for water produced from well.

III. Procedures and Guidelines

A. Drilling Method

Continuous-flight hollow-stem augers with a minimum 6-inch inside diameter (ID) will be used to drill shallow monitoring well boreholes. Split-spoon samples will be collected at selected intervals for chemical analysis and/or lithologic classification. Soil sampling procedures are detailed in SOP Shallow Soil Sampling.

The use of water to assist in hollow-stem auger drilling for monitoring well installation will be avoided, unless required for such conditions as running sands.

Hollow-stem augers, rods, split-spoon samplers, and other downhole drilling tools will be properly decontaminated prior to the initiation of drilling activities and between each borehole location. Split-spoon samplers and other downhole soil sampling equipment will also be properly decontaminated before and after each use. SOP Decon details proper decontamination procedures.

Drill cuttings and decontamination fluids generated during well drilling activities will be contained according to the procedures detailed in the Field Sampling Plan.

B. Monitoring Well Installation

Shallow monitoring wells will be constructed inside the hollow-stem augers, once the borehole has been advanced to the desired depth. If the borehole

has been drilled to a depth greater than that at which the well is to be set, the borehole will be backfilled with bentonite pellets or a bentonite-cement slurry to a depth approximately 1 foot below the intended well depth. Approximately 1 foot of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight and lowered inside the augers to the bottom of the borehole. Centering guides, if used, will be placed at the bottom of the screen and above the interval in which the bentonite seal is placed.

Selection of the filter pack and well screen intervals for the shallow monitoring wells shall be made in the field. Based on lithologic samples previously obtained at the site, and comparison with samples to be obtained in the well borings, standard well screen slot of 0.010-inch and silica sand gradations conforming to Morie No. 1 are anticipated.

A primary sand pack (Morie No. 1) consisting of clean silica sand will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. The augers will be raised gradually during sand pack installation to avoid caving of the borehole wall; at no time will the augers be raised higher than the top of the sand pack during installation. During placement of the sand, the position of the top of the sand will be continuously sounded. The primary sand pack will be extended from the bottom of the borehole to a minimum height of 2 feet above the top of the well screen. A secondary, finer-grained, sand pack will be installed for a minimum of 1 foot above the coarse sand pack. Heights of the coarse and fine sand packs and bentonite seal may be modified in the field to account for the shallow water table and small saturated thickness of the surficial aquifer.

A bentonite pellet seal at least 2 feet thick will be placed above the sand pack. The pellets will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted tape measure. If all or a portion of the bentonite seal is above the water table, clean water will be added to hydrate the bentonite. A hydration period of at least 30 minutes will be required following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface through a tremie pipe. The tremie pipe must be plugged at the bottom and have small openings along the sides of the bottom 1-foot length of pipe. This will allow the grout to diffuse laterally into the borehole and not disturb the bentonite pellet seal.

For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend at least 3 feet into the ground and 2 feet above ground but

should not penetrate the bentonite seal. The concrete pad will be square or round, with a minimum radius of approximately 3.5 feet. The concrete will be sloped away from the protective casing.

Guard posts may be installed in high-traffic areas for additional protection. Four steel guard posts will be installed around the protective casing, within the edges of the concrete pad. Guard posts will be concrete-filled, at least 2 inches in diameter, and will extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, Morrison 9-inch or 12-inch 519 manhole cover or equivalent, with a rubber-sealed cover and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad, approximately 3 feet per side, will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Concrete pads installed at all wells will be a minimum of 6 inches below grade. The concrete pad will be 12-inches thick at the center and taper to 6-inch thick at the edge. The surface of the pad should slope away from the protective casing to prevent water from pooling around the casing. Protective casing, guard posts, and flush mounts will be installed into this concrete.

Each well will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent well number.

C. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include two surge blocks separated by approximately 2 feet of coarsely slotted pipe. The lower surge block will be solid; the upper surge block will be open and attached to riser pipe leading to the ground surface. Water will be pumped continuously from the surge block screened interval throughout the surging process. The pumping will be accomplished by airlift induction methods or using a centrifugal pump or equivalent.

Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone.

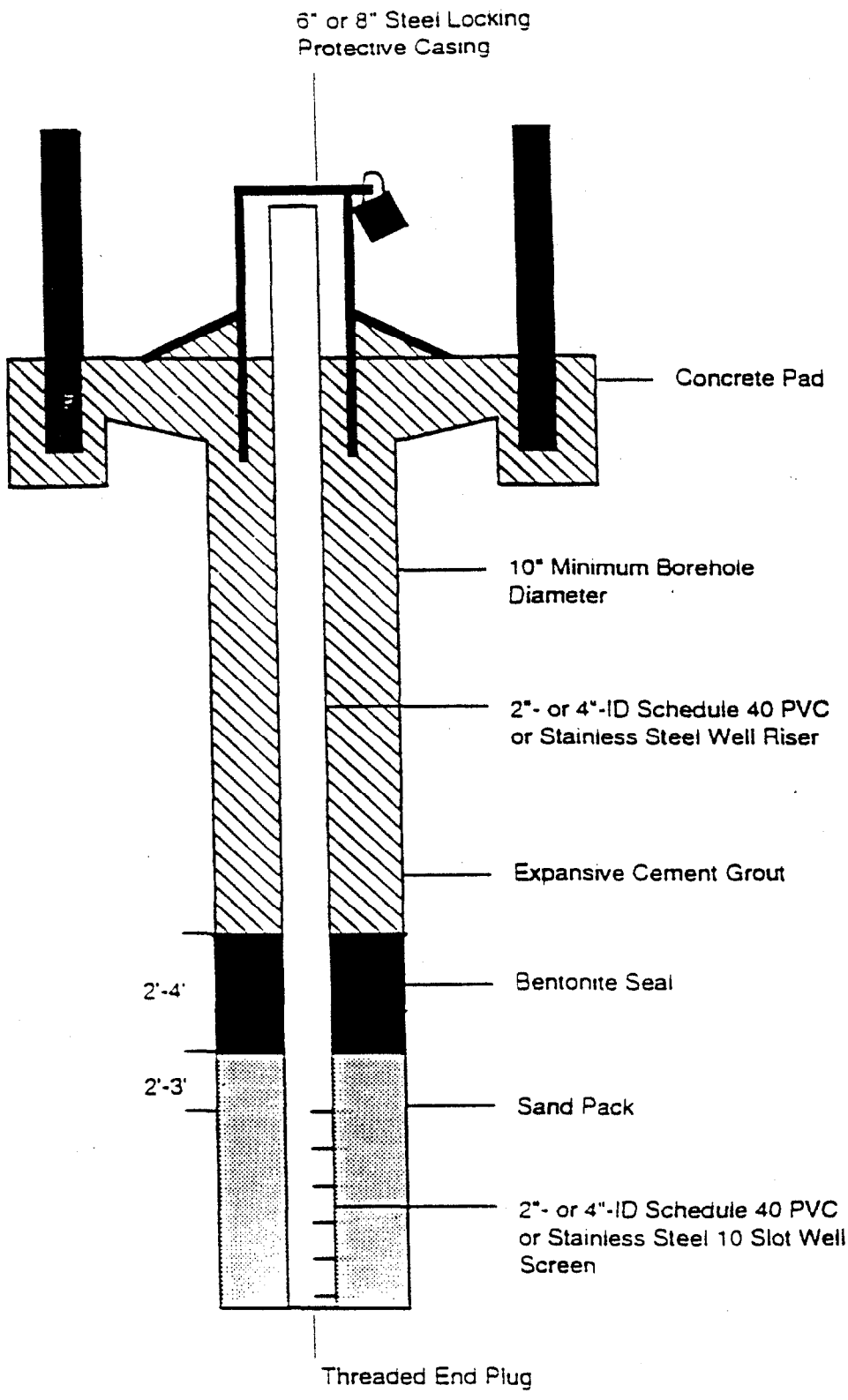
Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP Decontamination of Personnel and Equipment. Water generated during well development will be contained and managed as detailed in the Field Sampling Plan Investigation Denied Waste Management Plan.

IV. Attachments

Schematic diagram of shallow monitoring well construction



TYPICAL SHALLOW MONITORING WELL CONSTRUCTION

STANDARD OPERATING PROCEDURE

Bedrock Monitoring Well Installation

I. Purpose and Scope

The purpose of this procedure is to outline equipment and methods that will be used for bedrock well installation and development.

II. Equipment and Materials

- Drilling Rig
- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch ID, flush-threaded well casing
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted well screen
- PVC, bottom cap, threaded to match the well screen.
- Centering Guides (if used). Same material as the casing, except stainless steel may be used in lieu of PVC.
- Above-grade well completion: PVC well cap, threaded or push-on type, vented.
- Flush-mount well completion: PVC well cap, locking, leak-proof seal.
- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse) filter pack, and secondary (fine) filter pack. Grain size determined based on sediments observed during drilling.
- Bentonite seal: Pure, additive-free bentonite pellets.
- Bentonite for grout: Pure, additive-free powdered bentonite.
- Cement-Bentonite Grout. Proportion 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 10 pounds of bentonite added per bag of cement to reduce shrinkage.
- Above-grade protective casing: Permanent isolation casing with heavy duty locking cover, painted with epoxy paint for rust protection, industrial lock.
- Flush-mount protective casing: Morrison 9-inch or 12-inch 519 manhole cover; rubber seal for cover; heavy duty locking cap on permanent isolation casing.
- Double surge block with bottom solid, top open, separated by 2 feet of slotted pipe for well development
- Pump and associated development equipment

- Calibrated meters to ensure pH, temperature, specific conductance, Eh, and dissolved oxygen of development water
- Containerization for water produced from well

III. Procedures and Guidelines

A. Drilling Methods

Boreholes for the bedrock monitoring wells will be drilled in several stages.

Hollow-stem auger drilling, air rotary drilling, and surface casing installation procedures are detailed below.

1. Hollow Stem Auger Drilling

Hollow stem auger drilling techniques will be used to drill boreholes for installation of surface isolation casing. 8-inch minimum ID HSA will be used to drill the borehole into competent bedrock. Lithologic samples also will be collected. Sampling procedures and frequency are outlined in the SAP.

The use of water or other fluid to assist in hollow stem drilling is to be avoided.

The bit of the auger is placed at the ground surface and then turned with the soil coring rig. To collect split spoon samples, the auger is advanced to the top of the sampling depth, and the split-spoon sample is collected from below the auger head. The split spoon is advanced through repeated blows from a 140- or 30-pound hammer dropped from a height of 30 inches.

Soil brought to the surface on the outside of the augers should be containerized at a convenient space away from the working area. Soil may be stored on plastic sheeting and containerized at the completion of activities at the well cluster.

2. Rotary Drilling

Air rotary drilling techniques will be used to install isolation casings and wells in each of the bedrock monitoring wells.

When the borehole is advanced from ground surface to bedrock for placement of a 6-inch ID surface casing, the borehole will have a minimum diameter of 10 inches. The borehole will extend a minimum of 5 feet into competent bedrock for seating of the surface casing.

When the borehole is advanced beyond the 6-inch surface casing, the borehole will have a diameter of 5-7/8 inches.

The bit, drill rods, and other borehole rotary drilling equipment will be decontaminated prior to the initiation of drilling and between each borehole location, in accordance with the decontamination procedures

detailed in SOP Decon. Prior to the continuation of rotary drilling in boreholes where a surface casing has been installed, the bit, drill rods, and other downhole rotary drilling equipment will be thoroughly decontaminated before being inserted into the borehole.

Drill cuttings and decontamination fluids generated during rotary drilling activities will be contained according to the procedures detailed in SOP Disposal of Waste Fluids and Solids and the IDW-MP.

3. Surface Casing Installation

Surface casing will be constructed of 6-inch ID steel with a minimum wall thickness of 0.20 inches. Casing lengths will be welded or connected by threaded connections sealed with Teflon tape. The steel casing and threaded couplings must be free of paint, varnish, or coatings of any kind, both inside and outside. Threaded connections must be free of oils or grease. Welding of the casing is permissible provided that the welds meet the Standards of the American Welding Society. Surface casing will be decontaminated prior to installation in accordance with the procedures detailed in SOP Decontamination of Drilling Rigs and Equipment. The 6-inch ID surface casing will be installed in a minimum 10-inch diameter borehole, drilled at least 5 feet into competent bedrock.

The surface casing will be installed and grouted in place by a grout displacement method. The bottom of the surface casing is fitted with a tight, drillable plug. The borehole is then filled with the estimated volume of cement-bentonite grout to fill the annular space, and the casing is lowered to the bottom of the borehole (displacement method). If the weight of the casing is not sufficient to displace the grout and allow the casing to sink to the bottom of the borehole, the casing may be filled with clean water.

After the surface casing installation, the grout will be allowed to set up for at least 12 hours before drilling proceeds. The casings will be pressure tested by filling the casing with clean water to within a short distance of the top and pressurizing the casing to approximately 20 psi (net pressure above ambient groundwater). A pressure drop of less than 1 psi in 5 minutes will prove an adequate seal.

B. Monitoring Well Installation

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight, and lowered to the bottom of the borehole. Centering guides they will be placed at intervals around the well casing, at the base of the screen, and 5 feet above the top of the well screen.

Selection of final filter pack and well screen depths for the wells shall be made in the field.

A primary sand pack consisting of clean Morie No. 1 silica sand will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. During placement of the sand, the position of the top of the sand will be continuously sounded using a stainless steel weight attached to a fiberglass tape measure. The primary sand pack will be extended from the bottom of the borehole to a minimum height of 2 feet above the top of the well screen. A secondary (fine) sand pack will then be installed to a minimum of 1 foot above the primary sand pack.

A bentonite pellet seal at least 2 feet thick will be placed above the sand pack. The pellets will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted tape measure. A hydration period of at least 30 minutes will be allowed following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the top of the bentonite seal to the ground surface. The cement-bentonite grout will be installed through a tremie pipe. The tremie pipe must be plugged at the bottom. Small openings along the bottom 1-foot length of pipe will allow the grout to diffuse laterally into the borehole and to avoid disturbance the bentonite pellet seal.

For monitoring wells that will be completed above-grade, the surface casing itself will serve as the protective casing. The surface casing will be finished 2 to 3 feet above grade and fitted with a locking steel cap. A concrete pad with four guard posts will be installed.

The concrete pad will be square, approximately 3 feet per side, poured into wooden forms. The concrete will be sloped away from the protective casing. The concrete pad will extend at least 6 inches below and 6 inches above the ground surface.

Four steel guard posts will be installed around the locking casing, within the edges of the concrete pad. Guard posts would be concrete-filled, at least 2 inches in diameter, and would extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, a Morrison 519 manhole cover with a rubber-sealed cover and drain will be installed. The top of the manhole will be positioned approximately 1 inch above grade. A square concrete pad, approximately 3 feet per side, will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic. The concrete pad will extend at least 12 inches below the ground surface.

Inside the manhole, a locking cap will be placed over the permanent casing.

Each well will be labeled on the exterior of the locking cap with a metal stamp indicating the permanent well number.

STANDARD OPERATING PROCEDURE

General Guidance for Monitoring Well Installation

I. Purpose

To provide site personnel with a review of the well installation procedures that will be performed. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

II. Scope

Bedrock well installations and shallow unconsolidated well installations are planned.

III. Equipment and Materials

IV. Procedures and Guidelines

1. Wells will be installed in accordance with standard EPA procedures. Note that USEPA Region III requires any well penetrating a confining layer to be double cased.
2. The threaded connections will be water-tight.
3. Shallow well screens will be constructed of 0.010 slot Schedule 40 PVC and will be 5 to 10 feet in length depending on saturated thickness of unconsolidated sediments. The exact length will be determined by the field team supervisor.
4. Wells will be surrounded by three concrete-filled, 4-inch diameter guard posts.
5. A record of the finished well construction will be compiled.
6. All soils and liquids generated during well installations will be drummed for proper disposal.

Shallow Unconsolidated Well Installation

- Monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.
- Unconsolidated monitoring wells will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, schedule 40 PVC screen with threaded bottom plug and riser.
- Screens will be filter packed with a proper sized and graded, thoroughly washed, sound, durable, well-rounded basalt or siliceous sand.
- The filter pack will extend from 1 to 2 feet below the base to 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken.
- Annular well seals will consist of 2 feet of pelletized bentonite clay and placed above the filter pack.
- The top of the annular seal will be measured after the pellets have been allowed to settle and before the grout is applied.
- The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.
- The grout mixture consists of 94 lbs of cement (1 bag) per 6 gallons of water and 2 to 3 lbs of powdered bentonite per bag of cement to reduce shrinkage.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the bottom of the space to be grouted to the surface.
- After allowing the grout to settle overnight, additional grout will be added to maintain grade.
- A protective steel casing equipped with keyed alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and painted a bright color.

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened (at least 24 hours)
- The well will be developed by surging and pumping.
- Equipment placed in the well will be decontaminated before use.
- Development will include surging the well by abruptly stopping flow and allowing water in the well column to fall back into the well.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.

- Surging should continue throughout the development process.
- The air lift method will be used to pump materials out of the well. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- Well development will continue until the water produced is free of turbidity, sand, and silt.
- Development water will be considered hazardous and placed in sealed 55-gallon U.S. DOT approved steel drums supplied by CH2M HILL. CH2M HILL will label and date the drums, and transport the drums to an EPA designated site for storage.

V. Attachments

None.

VI. Key Check and Items

STANDARD OPERATING PROCEDURE

Aquifer Slug Testing

I. Purpose and Scope

The purpose of this procedure is to outline the equipment and methods that will be used to perform variable-head tests ("slug" tests) on the new monitoring wells.

II. Equipment and Materials

Campbell Scientific, Inc., Model 21X datalogger
Druck pressure transducers
Well testing assembly ("beast")
- packer
- fittings for pressure transducers
- fittings for air supply
- release valve

Compressed air
Computer and associated equipment
Solid displacement device with rope

III. Procedures and Guidelines

The tests which will be performed are rising head tests. The tests are accomplished by lowering the head of water in the well, and monitoring the recovery of the water level to the static water level. The water level will be lowered by one of two methods. In most cases, an air displacement device will be used. An alternate method is the use of a solid displacement device removed from the well.

The air displacement apparatus consists of a packer assembly, fittings to accommodate transducers and air pressurization, and a pressure-release valve. The packer is lowered into the upper portion of the monitoring well, secured in place and inflated, providing a seal between the apparatus and the inside of the well. Two fittings are provided for pressure transducers; one transducer is fed through the inside of the device and positioned below the water surface, and the other is inserted to measure the air pressure inside the assembly. A third fitting is connected to the pressurized air supply, a compressed air tank.

The datalogger will be programmed to display the air pressure in units of head, the head measured by the submerged transducer, and the difference between the two. The difference between the two pressure transducers is the height of the water column on the submerged transducer. These readings are recorded in a field notebook, and then the assembly is pressurized. The air pressure applied will be equivalent to 3 to 7

feet of head. The pressures are allowed to stabilize. The pressure of the air should not lower the water level to below the base of the bentonite seal installed in the well.

Each test is started by releasing the air pressure inside the assembly and allowing the water level to rise to the static water level. When the datalogger perceives a change in water level in the well above a preset trigger amount, it automatically begins to record the water levels and elapsed time. Each test will be terminated when the water level has recovered to at least 90 percent of the original equilibrium level before pressurization.

At some wells, it may be necessary to use an alternate method of lowering the water level because the well is screened across or near the water table. A single transducer will be installed in the well below the water table. A weighted solid displacement device is added to the well and the water level allowed to stabilize at the original static water level.

The test was started by rapidly removing the displacement device, which causes a drop in the water level. The data logger begins recording the water level and elapsed time when the preset trigger amount is reached. Readings are taken as above, and the test stopped when the well has recovered to 90 percent of the original level.

At the end of each day, the test results will be transferred to a computer disk. The computer will be attached to the data logger and the data downloaded and checked for preliminary completeness.

IV. Attachments

None.

V. Key Checks and Preventive Maintenance

Check that the packer assembly is in good condition and not leaking. Provide a repair kit including tape and clamps. Take additional packer assembly and other spare parts.

Check the batteries for the datalogger and computer. Check that the computer disks containing the programs for the datalogger are packed. Include blank computer disks for file storage.

Check the datalogger calculation of the well hydraulic conductivity at the end of each test to determine if these are consistent with expectations.

STANDARD OPERATING PROCEDURE

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in monitoring wells, where a second phase of floating liquid (e.g., gasoline) is not encountered. This SOP includes guidelines for discrete measurements of static water levels.

II. Equipment and Materials

A. Discrete Measurements of Static Water Level

- Electronic water level meter, Solinst or equivalent, with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less

III. Procedures and Guidelines

A. Measurement of Static Water Level

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Sight across the top of the locking well casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface. The measuring point will be a standardized surveyed location on the top of each well casing, adjacent to the lock hasp, indicated by a notch, paint mark, or similar method. Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the log book.

Measure and record the three following additional readings: (1) the depth of the well; (2) the depth from the top of the casing to the top of the well riser; and (3) the distance to the surface of the concrete pad or to ground. Measurements are to be taken with respect to the measuring point on the top of the well casing. The depth of the well may be measured using the water-level probe with the instrument turned off.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

A. Discrete Measurements of Static Water Level

Prior to each use, verify that the battery is charged by pressing the test button on the water-level meter. Verify that the unit is operating correctly by testing the probe in distilled or deionized water. Leave the unit turned off when not in use.

STANDARD OPERATING PROCEDURE

Seepage Meter

I. Purpose

The purpose of this procedure is to provide general guidance and reference material regarding the installation and use of seepage meters at various sites.

II. Scope

This SOP describes the methods of installing a seepage meter and calculating seepage flux.

III. Definitions

Seepage Meter - An instrument that measures the flow rate between the groundwater and the overlying surface water with plastic bag containing a known volume of water attached to an open bottom container covering an area of sediment and submerged in a water body.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project - specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for selecting qualified individuals for the monitoring activities.

Field Team Leader - It is the responsibility of the Field Team Leader to implement these procedures in the field, and to ensure that the Field Investigation Personnel performing the testing activities have been briefed and trained to execute these procedures before the start of site operations.

Field team - It is the responsibility of the field team to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader. The field team is responsible for installing the seepage meter and recording the results in the field logbook during each test.

V. Procedures

The seepage meter test will determine the type of hydraulic interaction between a shallow groundwater table and the surface water body. The test will also determine the groundwater velocity or seepage flux.

A. Seepage Meter Construction

The seepage meter instrument can be made by cutting the end section (approximately 5 to 10 inches long) from a 55-gallon drum. A valve is attached to the side near the closed top of the inverted drum. Tygon tubing with an in-line needle valve is attached to the valve. A thinwalled plastic bag containing a known volume of water is attached to the tubing.

B. Seepage Meter Testing

Installation of the seepage meter consists of slowly pushing the open end into the sediments until the top rests on the surface water body sediments, with a slight tilt so that the valve represents the highest point of the system. The plastic bag must be submerged to maintain the same piezometric head in the seepage meter as the surface water. The needle valve is opened to bleed any air in the system connecting the system to the surface water. After the sediments return to an undisturbed state, the test is started by opening the valve attached to the drum and monitoring time for the appropriate period. When the appropriate amount of time has passes, the valve attached to the drum is closed and the volume of water within the bag is measured. The type of hydraulic interaction between the groundwater and surface water body is determined. If the measured water volume is greater than the original volume, groundwater is discharging to the surface water, and if the measured amount of water is less than the original volume, the surface water is discharging to groundwater.

C. Calculations

The procedure for calculating the groundwater velocity or seepage flux is determined by the following equation:

$$Q\ (\mu m/s) = \frac{(\text{volume change, cm}^3)(0.0643)}{(\text{elapsed time, min.})}$$

where Q is seepage flux, the factor 0.0643 converts units of time, volume and area covered by the seepage meter (0.255 M2) to equivalent units of velocity (μm/s) or seepage flux ($cm^3/m^2/s$).

VI. Quality Assurance Records

The field logbook will serve as quality assurance record for water volume measurements and elapsed time monitoring.

VII. References

Lee, D. R. and J. A. Cherry. 1978. A field exercise on groundwater flow using seepage meters and mini piezometers. *Journal of Geological Education*. Volume 27.

STANDARD OPERATING PROCEDURE

Magnetometry

I. Purpose

This SOP provides general reference information and standard techniques for using magnetometry.

II. Scope

This SOP provides a description of the field procedures, equipment, and interpretation methods necessary to fully utilize this procedure.

III. Definitions

Diurnal variations - daily changes in the total magnetic field strength due to solar activity and which (may be as large as 100 gammas or more)

Gradient - change in magnetic field strength in a given vertical or horizontal distance

Magnetic storm - sudden and simultaneous variations of up to several hundred gammas throughout the world. Magnetic storms can occur as often as several times a month and can last one to several days.

Total magnetic field intensity - a scaler measurement of the magnitude of the earth's magnetic field vector independent of its direction.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that the project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for ensuring that the personnel operating and interpreting the geophysical data are trained, skilled in that endeavor, so far as to receiving documentation on the training and experience of the operating personnel.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the geophysical technique and equipment to be used. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that the field investigation personnel performing the activities have been briefed and trained to execute these procedures.

V. PROCEDURES

A. Overview

Magnetic surveying is a passive geophysical technique which measures the strength of the earth's magnetic field. The earth's field is a vector quantity having a unique magnitude and direction at every point on the earth's surface. A magnetometer is the instrument which measures the magnetic field strength in units of gammas or nanoteslas. In order to recognize a magnetic anomaly, it must be several times larger than the background noise level along that profile. Buried ferrous metal objects such as steel drums or tanks cause local variations or anomalies in the earth's magnetic field that can be detected by a magnetometer. Geologic features such as igneous intrusion or iron rich sands can also be mapped using magnetic surveying.

The earth's magnetic field is not completely stable. It undergoes long-term (secular) variations over centuries; small, daily (diurnal) variations (less than 1% of the total field magnitude); and transient fluctuations called magnetic storms resulting from solar flare phenomena. Both naturally-occurring and manmade magnetic materials can modify the earth's magnetic field locally.

Analysis of magnetic data by an experienced geophysicist can provide an estimate of the areal extent and quantity of buried ferrous objects. Depth of burial approximations can be made using graphical methods of interpretation such as slope techniques and half-width rules as described in Nettleton (1 976).

B. Application and Uses

Buried ferrous metal objects such as pipelines, barrels, tanks, etc., generally produce a perturbation in the earth's naturally occurring magnetic field. The size (amplitude) of this perturbation is related to the size of, distance to, susceptibility and remnant magnetization of the buried object. The magnetic survey method, therefore, is a useful tool for site studies to locate and identify buried ferrous metal. Non-anomalous magnetic data acquired over EM conductivity anomalies is an indication of the existence of buried conductive, non-ferrous metal (copper, aluminum, brass) objects.

Magnetic data also can be helpful in determining the size and geometry of geologic features such as fault zones, mineralized zones, and bedrock valleys and depressions. These features are characterized generally by longer wavelength anomalies and are readily distinguishable from anomalies associated with buried metal. In many areas, such geologic features may control or affect the direction and magnitude of groundwater flow.

The total field proton precession magnetometer, the fluxgate magnetometer, and the magnetic gradiometer are commonly used magnetometers in environmental site investigations. The total field proton precession magnetometer is the most commonly used magnetometer because they are easy to operate, have no instrumental drift, and can acquire data rapidly. The fluxgate magnetometer can better define the boundaries of buried ferrous objects than the proton precession magnetometer but is subject to instrument drift, and needs to be exactly oriented.

Magnetic gradiometer measurements enhance anomalies resulting from shallow magnetic sources.

C. Equipment

Magnetometers commonly used in hazardous waste site investigations include the total field proton procession magnetometer, the flux gate magnetometer, and the magnetic gradiometer. Text books such as Telford (1976) and Nettleton (1976) discuss in detail the operation and construction of these and other magnetometers.

The total field proton procession magnetometer is the most commonly used magnetometer in hazardous waste investigations. This instrument utilizes the precession of spinning protons of hydrogen atoms in a sample fluid (kerosene, alcohol or water) to measure the total magnetic field intensity. Total field proton precession magnetometers are portable and do not require precise orientation and leveling; the sensor must be oriented with one side facing approximately north and the sensor held stationary during the cycling period. Proton precession magnetometers have no instrument drift, do not require calibrations, are easy to operate, and have an accuracy of 0.1 gamma. Most modern proton precession magnetometers have digital readouts and electronic storage of data.

Vertical magnetic gradiometers are magnetometers that measure vertical differences of the earth's total magnetic field. Gradient measurements enhance magnetic anomalies resulting from near surface magnetic source and discrimination between neighboring magnetic anomalies is also enhanced. These measurements are generally made using an instrument similar to a total field magnetometer that has two or more sensors mounted on a staff. The sensors are vertically separated by a constant distance, usually one to three feet. Gradient readings are adversely affected by ferrous metal surface debris since signals from this surface debris are also amplified. Consequently, removal of surface metal should be considered before conducting a gradiometer survey.

The flux gate magnetometer was developed during World War II as a submarine detector. Text books such as Telford (1976), RAO and Murthy (1978) explain in detail the principals of operation of the flux gate magnetometer. A fluxgate magnetometer can define the boundaries of regions of buried ferrous metal objects more precisely than the proton precession magnetometer. There are several sources of errors in flux gate magnetometers including unbalance in the two coils, thermal and shock noise, circuit drift and temperature sensitivity. The advantages are direct readout, no azimuth orientation, coarse leveling required, light weight and portability (Telford, 1976).

D. Field Procedures

Magnetic data are generally acquired at relatively close station spacings (5 to 50 foot intervals) along closely spaced (10 to 50 feet) parallel survey lines.

Magnetic data can be acquired in a rectangular grid pattern or along traverses. Grid data are readings acquired at the nodes of a rectangular grid; traverse data is acquired at fixed intervals along a line. Traverse data is often preferable to grid data because it generally is less expensive to acquire (heavily vegetated sites require time

consuming brush cutting to establish a complete grid) and more useful for interpretation than an equal number of grid readings. Traverse lines generally ought to be oriented in a north-south direction so that the maximum amplitude of an anomaly can be detected. However, line orientations are often more dependent on site obstacles and sources of magnetic noise.

Station and line spacing intervals are determined on the basis of the desired resolution of the survey. If individual drums or clusters of deeply (greater than 25 feet) buried drums are the objective of the survey, then a detailed magnetic survey with relatively close station spacings (approximately 5 to 10 feet) and line spacings (approximately 10 to 25 feet) should be used. If large metal objects such as 10,000 gallon tanks or trenches filled with barrels are the objective of the magnetic survey, then a reconnaissance or screening survey with longer station spacings (25, 50, or 100 feet) and line spacings of (25, 50, or 100 feet) may be appropriate.

In conducting a survey, the field operator must avoid or note any sources of high magnetic gradients and alternating currents, such as power lines, buildings, and any large iron or steel objects. It is also important that the operator be relatively free of magnetic materials on his/her person and the magnetometer sensor be kept clean to avoid possible magnetic-bearing soil. Periodically during a survey, and particularly when an anomaly is detected, it is important to establish that the magnetometer is providing valid readings and not random, meaningless instrument noise. The simplest means of verifying magnetometer field readings is to take several successive readings at one location. These readings should repeat to within ± 1 gamma. Readings are taken at predetermined intervals which depend on the nature of the survey and which may have to be modified depending on the gradients encountered. For detailed surveys, a base station or the reoccupation of a set of stations several times a day or a continuous monitoring station (within 100 miles) is established to check for diurnal variations and magnetic storms. At the height of a magnetic storm, magnetic surveying may be impractical due to the large instantaneous changes in the total magnetic field.

E. Interpretation

1. Data Analysis

Magnetic data can be corrected for diurnal variations; however, diurnal changes are generally very gradual and linear and should not have the extreme fluctuations associated with buried ferrous metal objects. Magnetic data can be plotted in profile form or contoured depending upon the survey coverage. Noise sources (surface ferrous metal objects, fences, power lines, etc.) should be noted on the profiles or contour map so that anomalies due to these known sources can be accounted for. The amplitudes of similar sized surface metal objects should be compared. If similar sized ferrous metal surface objects have extremely different anomaly amplitudes, it may be an indication that buried ferrous metal objects exist in the vicinity of the higher amplitude anomalies.

2. Presentation of Results

The results of a magnetic survey should be presented in profile and/or contour map form. The orientation of the traverses should be indicated on profiles and lines of coverage on contour maps. Locations of observed ferrous metal and other cultural features (hills, valleys, streams, etc.) should be noted on both the profile and the contour maps.

3. Interpretation

Magnetic anomalies can be analyzed both qualitatively and quantitatively. The shape and gradient of an anomaly (slope, wave-length, amplitude, etc.) contains enough information to draw qualitative conclusions regarding the location and depth of the causative source.

Quantitative computer modeling interpretations of magnetic data are complicated both by the inherent complexity of dipole magnetic behavior and by the fact that a number of different types and configurations of sources can cause the same anomaly. Where the properties of the earth's field and the local geologic materials (inclination, declination, susceptibility, and remanent magnetization) are well known, reasonable assumptions regarding the nature of the source- can be made, and a fairly accurate model of the source generally can be derived.

F. Advantages and Limitations

Advantages of the magnetic survey method include:

- Rapid operation
- Low expense
- Identification of buried metal (ferrous)
- Sensitivity to small ferrous objects

Limitations of the magnetic survey method include:

- Susceptible to effects of manmade structures, utilities, buildings, fences, etc.
- Detection is limited to the distance to and quantity of ferrous metal present

VI. Quality Assurance Records

All data will be recorded in log books and/or data logging sheets designed for this procedure. All data will be entered with the following basic information: date, start and end times (military time), location, personnel on site, Contract Task Order number, and weather.

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STANDARD OPERATING PROCEDURE

Ground-Penetrating Radar (GPR)

I. Purpose

The purpose of this SOP is to provide general reference information and technical guidance on the methods and techniques of ground-penetrating radar (GPR).

II. Scope

These procedures provide overall technical guidance.

III. Definitions

Bistatic Antenna - An antenna system in which transmitting and receiver coils are housed in separate antenna units.

Deconvolution - A computer processing method. The process of undoing the effect of another filter (in this instance the "earth"). A process that removes ringing, multiples, ghosts, and some background noise (Sheriff, 1973).

Dielectric Permittivity - (Also known as the relative dielectric permittivity): 1. A complex number consisting of a real and imaginary part, which uniquely describes the propagation and attenuation of electromagnetic energy in every material. The real dielectric permittivity (dielectric constant) characterizes the propagation and reflection of electromagnetic (EM) waves, while the imaginary part (dielectric loss) characterizes the attenuation of EM signal (Kutrubes and Olhoeft, 1987). 2. A measure of the capacity of a material to store charge when an electric field is applied (Sheriff, 1973).

Electromagnetic Waves - One of the waves that are propagated by simultaneous periodic variations of electric and magnetic field intensity and that include radio waves, infrared, visible light, ultraviolet, X-rays and gamma rays (Webster's New Collegiate Dictionary. 1979).

Migration - here velocity varies laterally, data will migrate (relative to the time versus antenna distance plot), and ray tracing is used to determine migrated positions (Sheriff, 1973).

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that the project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for ensuring that the personnel operating and interpreting the geophysical data are

trained, skilled in that endeavor, so far as to receiving documentation on the training and experience of the operating personnel.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the geophysical technique and equipment to be used. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that the field investigation personnel performing the activities have been briefed and trained to execute these procedures.

V. Procedures

A. Overview

Ground penetrating radar (GPR) is an active geophysical system which transmits high frequency electromagnetic (EM) waves into the ground and detects the energy reflected back to the -surface. GPR operates on a similar principle as seismic reflection, except, instead of acoustic waves, electromagnetic waves of radio and microwave frequencies (80 MHz to 1,000 MHz) are utilized. Electromagnetic signals are reflected back to the surface from interfaces with differing electrical properties, such as dielectric permittivity and conductivity. The greater the contrast in the real dielectric permittivity (dielectric constant) between two materials, the more energy is reflected to the surface. Reflections typically occur at lithologic changes, subsurface discontinuities, and internal soil structures such as:

- Top of bedrock surfaces
- Soil and rock stratification
- Water table
- Seepage and leachate zones
- Buried metal objects such as drums and utilities
- Open and water filled voids
- Bedrock fractures
- Archaeological structures

The depth of penetration of GPR is site specific, being limited by the attenuation of the electromagnetic energy. Signal attenuation is controlled by four different mechanisms listed below, any or all of which may be present at a site.

- Scattering losses
- Conduction losses
- Water losses
- Clay losses

Energy losses due to scattering occur when signals are dispersed in random directions, away from the receiving antenna, by large irregularly shaped objects, such as boulders and tree stumps.

Signal attenuation due to conduction is a function of the conductivity of a material, which varies with mineral composition, the amount of water, and the total dissolved solids (salt, heavy metals) within the water. The greater the electrical conductivity

values of materials at a site, the more signal attenuation (hence less penetration) there will be.

Energy losses attributed to water occur when water molecules polarize in the presence of the applied electromagnetic field. Electromagnetic energy is lost to the radar system when it is converted to kinetic and thermal energy as a result of the rotation of water molecules.

Signal attenuation due to clay losses occurs when electrochemically charged ions polarize along clay surfaces in the presence of the electromagnetic field induced by the radar system. The migration and subsequent collision of these charged particles causes electromagnetic energy to be converted to kinetic and thermal energy, which is lost to the radar system.

Signal penetration is also dependent on the frequency of the transmitting antenna used in the radar system. Higher frequency antennas produce waves with shorter wave lengths, which are attenuated more rapidly with depth, but give better resolution. Specially designed 2 MHz antennas have been used to detect the ice-rock boundary of a 2 km thick glacier. Penetration of up to 75 feet has been reported for water saturated, clean sands in a Massachusetts glacial delta using a commercial antenna. Signal penetration in saturated clays, on the other hand, is on the order of magnitude of a few inches. Olhoeft (1986a) determined that even 5% clay added to a clean sand and gravel will cause a decrease in penetration by a factor of 20. Salt water is also a high loss substance, as signal penetration in sea water is less than a foot. It is important to note that in a layered medium a single, highly reflective layer alone can limit signal penetration by preventing the propagation of energy through it. In this instance the apparent loss of energy is caused by reflection rather than by signal attenuation.

B. Applications and Uses

Ground penetrating radar (GPR) is a shallow penetrating geophysical profiling system used where rapid and accurate surveys are desired. GPR can be used for both area and source detection studies. GPR has been used to locate underground pipes, buried drums, foundations, voids in rock and concrete, lithologic contacts, determine stratigraphy, depth to the water table, and depth to bedrock, locate buried archaeological artifacts, excavations, filled pits and lagoons, and numerous other site specific applications. GPR has been used successfully to delineate the lateral extent of plumes. Haeni et al. (1985) used GPR to investigate the thickness, type, and extent of sediments beneath a frozen lake with a 80 MHz antenna. The information acquired with GPR was used to help map the lateral extent of an aquiclude, and better estimate inputs to the mass balance equation for water budget calculations.

A GPR system can be used to determine depths to reflecting discontinuities by conducting a depth calibration. Typically, calibration is performed by moving the radar antenna over a metal target of known depth, such as a buried metal plate. Also, if transmitting and receiving antennas are housed in different units, designated as a bistatic antenna system, a common depth- point (CDP) survey, identical to surveys conducted with seismic reflection, can be used to calculate the

velocity of the medium, and hence depth to the reflector. Sakayama and others (1988) describe another method to calculate velocity from bistatic antennas where the receiving antenna is continually moved away from the stationary transmitting antenna. The velocities of the direct arrival and the first strong reflector are recalculated from the inverse slope of the time-distance display (antenna separation) on the GPR record in a similar manner as seismic refraction.

To verify GPR results, other geophysical or ground truth methods can be utilized. Haeni et al. (1985) utilized seismic refraction to correlate calculated depths of stratigraphic horizons and water tables with radar reflections. Magnetometry and electromagnetic induction methods have been utilized to verify the presence of buried drums and fuel tanks. Electromagnetic induction and electrical resistivity have been utilized to verify the lateral extent of conductive plumes. The depth to a particular reflector or target can also be verified by boreholes and/or test pit excavation.

C. Equipment

A ground penetrating radar system, shown on Figure 1, consists of.

- AC/DC power supply
- Control unit (pulse transmitter)
- Antenna(s)
- Graphic recorder
- Digital recorder (optional)
- Magnetic tape recorder (optional)
- Coaxial cable which connects the control unit to the antenna

Typically, radar antennas contain both the transmitter and receiver within one fiberglass unit. Once a radar impulse is transmitted, the antenna switches to the receiver mode and records reflected radar impulses. The pulse receiver contains an amplifier which increase the amplitude of reflected signals. Bistatic antennas (transmitter-receiver are separate) allow the coverage of larger areas with one pass, and multi-receiver combinations allow the "stacking" of radar data which increases the signal to noise ratio.

Field data are generally printed by a graphic recorder and simultaneously can be stored on magnetic tape or diskette. The graphic recorder produces a continuous time (vertical) versus distance (horizontal) profile of the subsurface for field quality control and qualitative interpretations. Radar impulses are synchronized with the swept-stylus type graphic recorder, producing a dark band proportional to the amplitude of reflected radar signal. Because the antenna is moving, each pass of the stylus represents a slightly different antenna position. Gradually, as the recorder paper advances under the moving stylus, a pattern of reflective interfaces emerges.

Storage of data on diskette or magnetic tape allows opportunity of additional printing and/or computer processing for the refinement of data. Deconvolution of stored data enhances stratigraphic reflections from the water table and soil

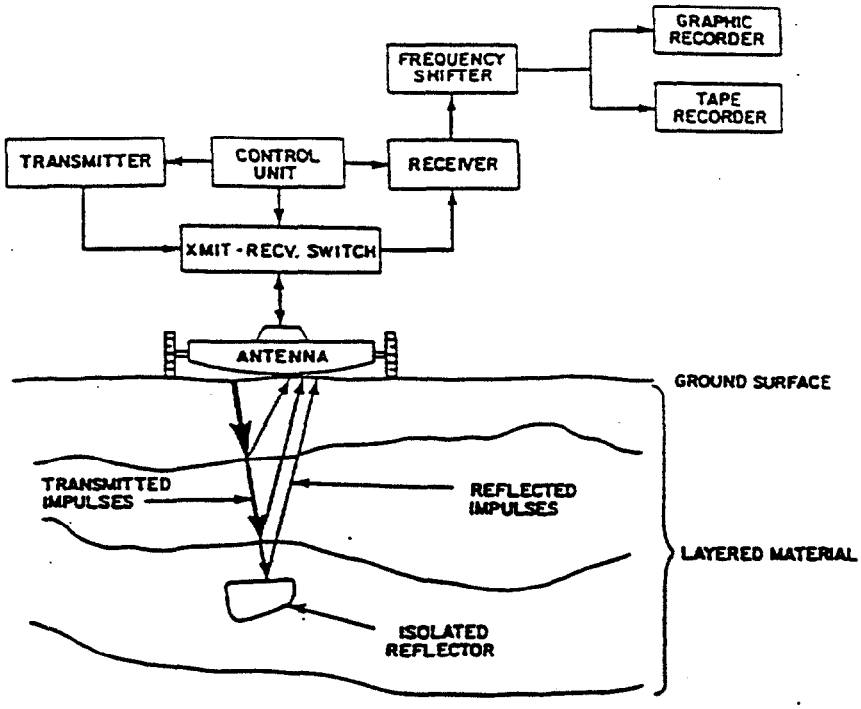
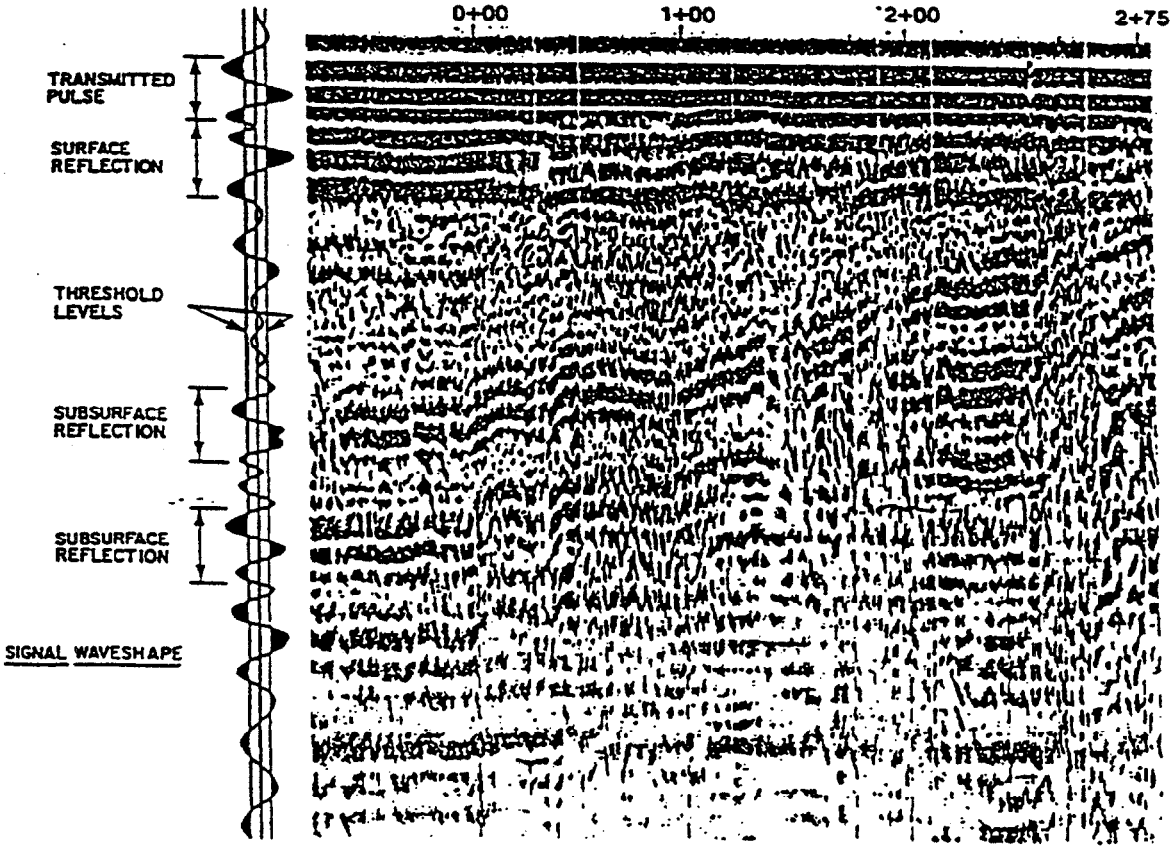


FIGURE 1

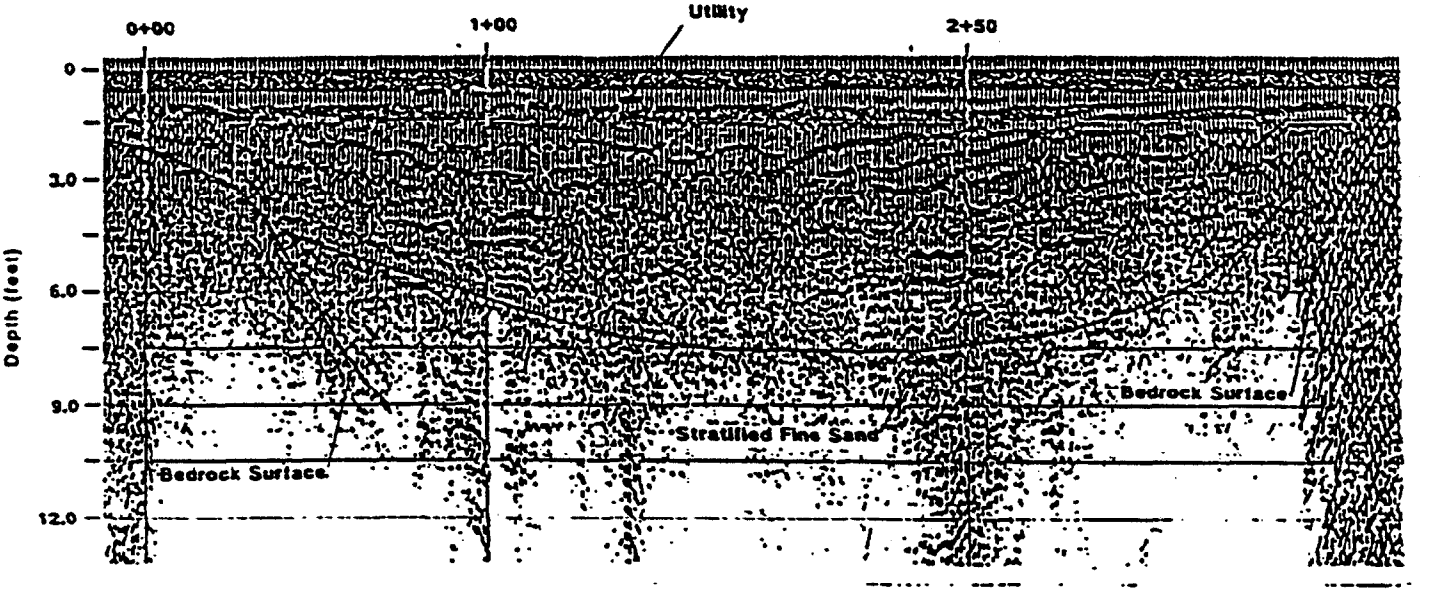
RADAR SYSTEM BLOCK DIAGRAM



TYPICAL RADAR RECORD

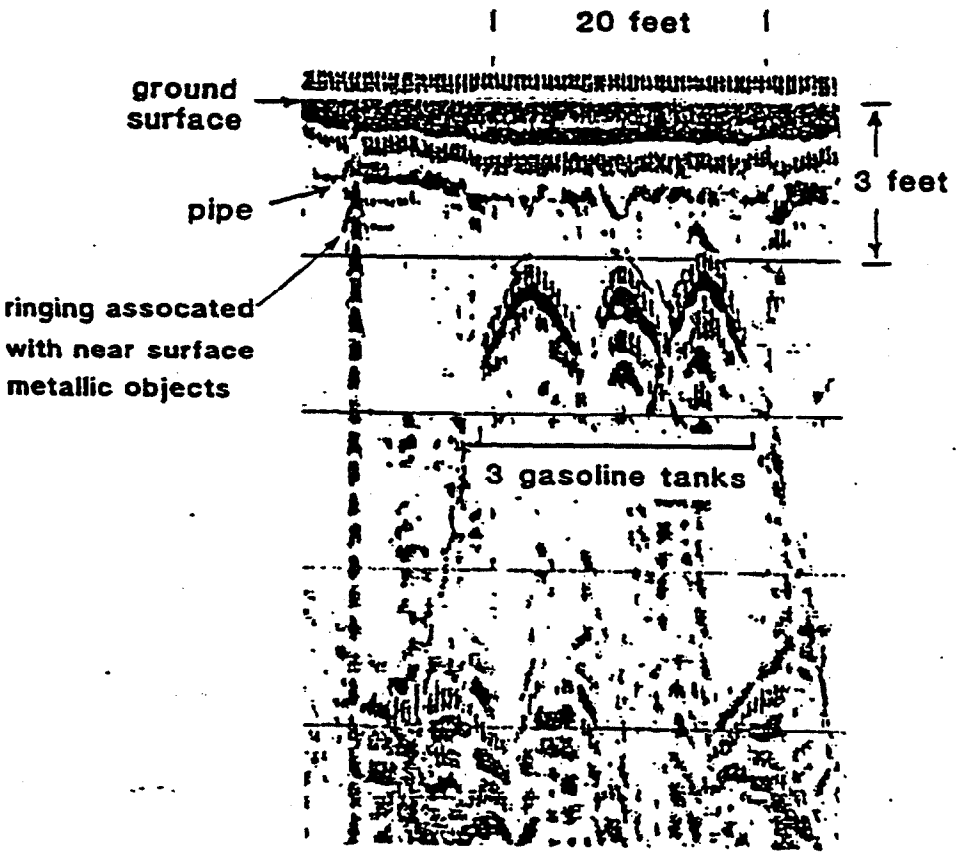
GROUND PENETRATING RADAR SET-UP

FIGURE 2



GROUND PENETRATING RADAR RECOI
OF A BURIED RIVER CHANNEL

FIGURE 3



GROUND PENETRATING RADAR RECORD OF BURIED FUEL TANKS

structures (Olhoeft, 1988). Migration of data allows easier resolution of metallic targets, such as buried drums, and delineation of excavations and sinkholes (Hogan, 1988).

Radar systems are designed to use antennas of various electrical characteristics. Selection of the antenna is dictated by the requirements of the survey. If high resolution, near-surface data are desired, a small, high frequency antenna is used; if the survey requires deeper probing, a larger, lower frequency antenna is used (80, 120, 250, 300, 400, 500, 900, and 1,000 MHz antennas are commercially available). The drawback of using the lower frequency antennas is that resolution of data is sacrificed for penetration. Also, the low frequency antennas (less than 250 MHz) are generally not shielded, making them susceptible to overhead power line noise and spurious reflections from passing cars. The 900 and 1,000 MHz antennas are used almost exclusively for short penetration projects such as the detection of rebar in concrete, as their penetration is generally limited to 2 to 3 feet.

D. Field Procedures

The majority of time involved with any GPR survey is spent establishing survey lines in the area of investigation so that detected anomalies can be easily located and excavated. Survey lines should be set to maximize coverage, while maintaining a grid spacing proportional to the presumed target dimensions. A minimum survey line spacing of 10 feet is desired when looking for a 1,000 gallon fuel tank, while a larger spacing of 50 feet or more may be used to define the lateral extent of a conductive plume.

At the onset of any GPR survey the radar control unit should be adjusted for the anticipated depth of penetration. Adjustments of the time window of exploration should be made by estimating the velocity of the medium and desired depth of penetration. Most surveys can be effectively conducted with a minimum time window of 50 nanoseconds.

Accurate determination of the depth to any layer requires calibration of the radar system. The easiest way of calibrating the GPR system to specific settings is by burying a plate at a measured depth, and moving the antenna slowly along the survey line. The plate will produce on the GPR record a thick, dark band, parabolic or flat in shape, with many multiple reflections beneath it. Once a certain confidence level is attained from depth calibration, the survey is conducted by slowly pulling the antenna along survey lines. A slow walking pace increases the horizontal resolution as radar signals are propagated in a 15 to 45 degree cone from the bottom of the antenna. A slow walking pace is recommended for hazardous waste investigations as targets are better defined and easier to resolve. On the other hand, the radar antenna can be towed from the back of a car or truck at speeds up to 10 miles an hour if the "target" is a continuous reflector, such as the water table.

E. Interpretation

A typical GPR record is shown on Figure 1. A representation of a single GPR signal pulse is shown along the side of the record. The horizontal scale of the record is maintained by marking on the record the locations of survey stations as they are

reached by the antenna. Accurate determination of the vertical scale (i.e., conversion of a time into a depth) requires calibration of the radar system. If the depth to a known reflector can not be determined through calibration or verification using boreholes and test pits, the velocity of the medium can be approximated from relationships involving the velocity of the medium, and the dielectric constant (real dielectric permittivity) of the medium. Values of the dielectric constant can be found in GSSI (1974), and Kutrubes (1986). It is important to note that the relationship is no longer valid when signal losses are great. The depth to the reflector can be calculated from time and velocity values.

Interpretation of GPR data is subjective, even among experienced interpreters. The strength of a reflected signal and/or the continuity of that reflector across the record may be indicative of a stratigraphic contact. The water table in an unconfined sand and gravel aquifer may also produce a similar signature on the GPR record. The strong continuous reflector shown in Figure 2 delineates the contact between bedrock and unconsolidated materials. Point targets, such as buried drums, pipes, boulders, tree stumps, etc., create a distinctive parabolic feature on GPR-records. Positive identification of point targets are subjective, as the GPR signature of a pipe is similar to that of a large boulder.

Figure 3 shows the characteristic parabolic signal created by a point target, underground storage tanks in this instance, which are situated in a clean sand and gravel deposit. Metallic objects, such as buried drums and pipes, also produce a characteristic parabolic signal on the record, and sometimes produces a "ringing" noise, denoted by the heavy, dark banding, as shown in Figure 3.

Recorded data from diskettes or magnetic tapes can be enhanced using numerous computer processing methods to remove constant noise problems, such as ringing, or to sharpen up geologic contact features and point target boundaries. Such methods are described in detail by Hogan (1988) and Olhoeft (1988). Computer processing is costly and generally not necessary in most instances.

F. Advantages/Disadvantages

Advantages of ground penetrating radar systems include:

- Rapid coverage of an area
- GPR is a non-destructive technique
- Portable equipment
- Provides high vertical resolution **profiles** in the field for immediate interpretation

Ground penetrating radar provides a cost effective way of evaluating a large site in a short amount of time. One day of work coverage completed by GPR may be equivalent to four or five days of work with seismic refraction or electrical resistivity. The GPR method is "nondestructive" in that it does not require any excavation or probing of the overburden materials, although verification of anomalies should be conducted.

Equipment can be easily loaded in the back of a truck as most pieces comprising the radar system weigh under 40 pounds. The 80 MHz antenna weighs about 100 pounds and is less portable as it is approximately 4 feet wide.

Limitations of radar systems include:

- Survey lines must be cleared to ground level
- Multiple receiver antennas are generally required to stack and process radar data
- Penetration is site specific, requiring data corroboration using alternative geophysical methods and/or verification
- Interpretations are subjective

To maximize resolution and minimize scattering losses, survey lines must be as level as possible to prevent the bouncing and jarring of the radar antenna. Survey lines cleared of debris also allow the antenna to be pulled at an even, continuous pace, permitting the easy determination of horizontal scale.

Application of GPR to a site is limited by soil type and presence of high loss materials. In New England, the presence of glacial tills, and lacustrine and marine clays limit the depth of penetration. Delineation of buried drums beneath a conductive plume also may not be possible. The unpredictability of radar effectiveness requires that site investigations be conducted with alternative geophysical methods, such as electromagnetic induction, seismic refraction, magnetometry, and/or electrical resistivity.

VI. Quality Assurance Records

All data will be recorded in field log books with the following information: date, location, personnel on site, start and finish times (in military time), instrument gain and time settings, and Contract Task Order number.

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STANDARD OPERATING PROCEDURE

Electromagnetic Induction

I. Purpose

The purpose of this SOP is to provide general reference information for using electromagnetic induction (EM) methods.

II. Scope

This SOP provides a description of field procedures, equipment, and interpretation methods necessary to fully utilize this procedure.

III. Definitions

Conductivity - Ability of a material to transmit an electrical current. Inverse of resistivity.

Horizontal dipole mode - Transmitter and receiver coils oriented vertically.

Vertical dipole mode - Transmitter and receiver coils oriented horizontally.

Vertical sounding - Multiple EM measurements centered at a point with varying coil spacings.

Vertical profiling - EM measurements along a traverse with a fixed coil spacing and coil orientation.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that the project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for ensuring that the personnel operating and interpreting the geophysical data are trained, skilled in that endeavor, so far as to receiving documentation on the training and experience of the operating personnel.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the geophysical technique and equipment to be used. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that the field investigation personnel performing the activities have been briefed and trained to execute these procedures.

Field team - It is the responsibility of the field team to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team

Leader and the Project Manager. Field personnel are responsible for the proper acquisition of geophysical data.

V. Procedures

A. Overview

Electromagnetic Induction (EM) methods are non-intrusive geophysical techniques of measuring the apparent conductivity of the subsurface materials. Electrical conductivity values of subsurface materials are determined by transmitting a high frequency electromagnetic (primary) field into the earth and measuring the secondary electromagnetic field produced by the eddy current as illustrated in Figure 1. The transmitter and receiver coils do not require direct ground contact thus permitting continuous profiling and rapid data acquisition.

The strength of the secondary field is a function of the inter coil spacing, operating frequency and ground conductivity. The ratio of the secondary to the primary magnetic field is directly proportional to the terrain conductivity which enables direct instrument readout of apparent conductivity values (measured conductivity values are the bulk average conductivity for the area or volume of earth sampled). Conductivity ranges typical of various earth materials are shown on Figure 2. EM conductivity values are usually expressed in units of milliohms per meter. Conductivity values are converted to resistivity values in ohm-meters by use of the following relationship:

$$\text{resistivity (ohm - meters)} \quad \frac{1{,}000}{\text{EM instrument readout (milliohms per meter)}}$$

The apparent conductivity of the subsurface materials is dependent upon subsurface conditions such as:

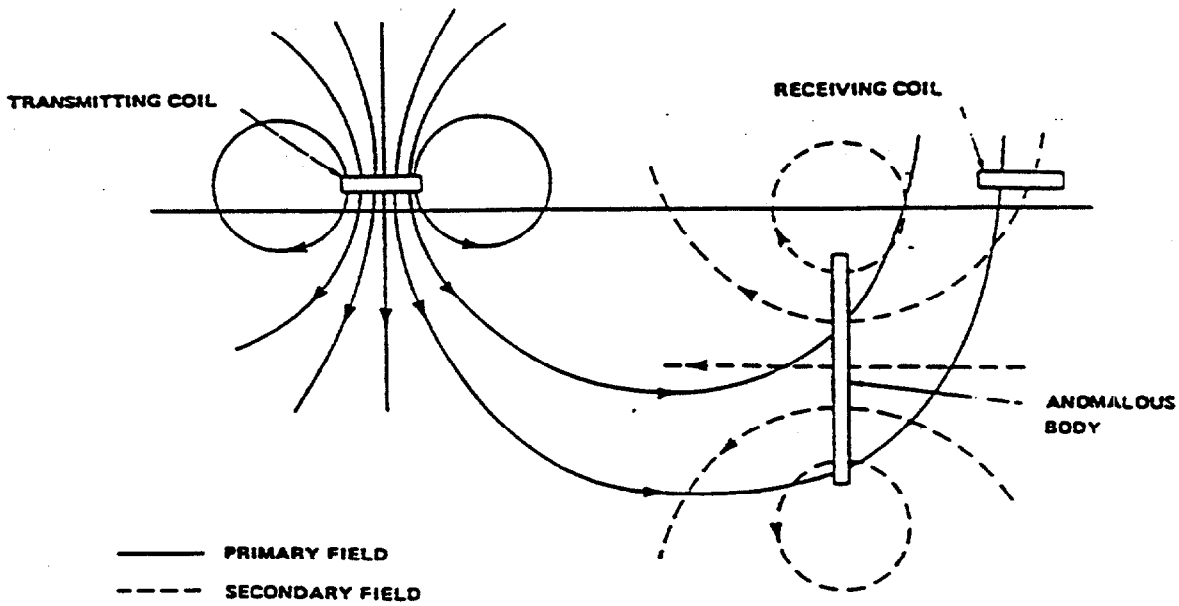
- Lithology
- Porosity
- Permeability
- Conductivity of subsurface pore fluids

Changes in these parameters causing measurable variations in electromagnetic conductivity can result from:

- Conductive contaminant plumes
- Abandoned trenches and lagoons
- Lateral changes such as backfill or landfill materials
- Bedrock fracture zones
- Lithological variations
- Buried metallic objects

The sampling depth or depth of investigation is related to the coil spacing and coil mode. The two coil modes used are the vertical dipole mode (coils horizontal) and the horizontal dipole mode (coils vertical). Figure 3 shows the relationship of the coil spacings, mode and relative responses.

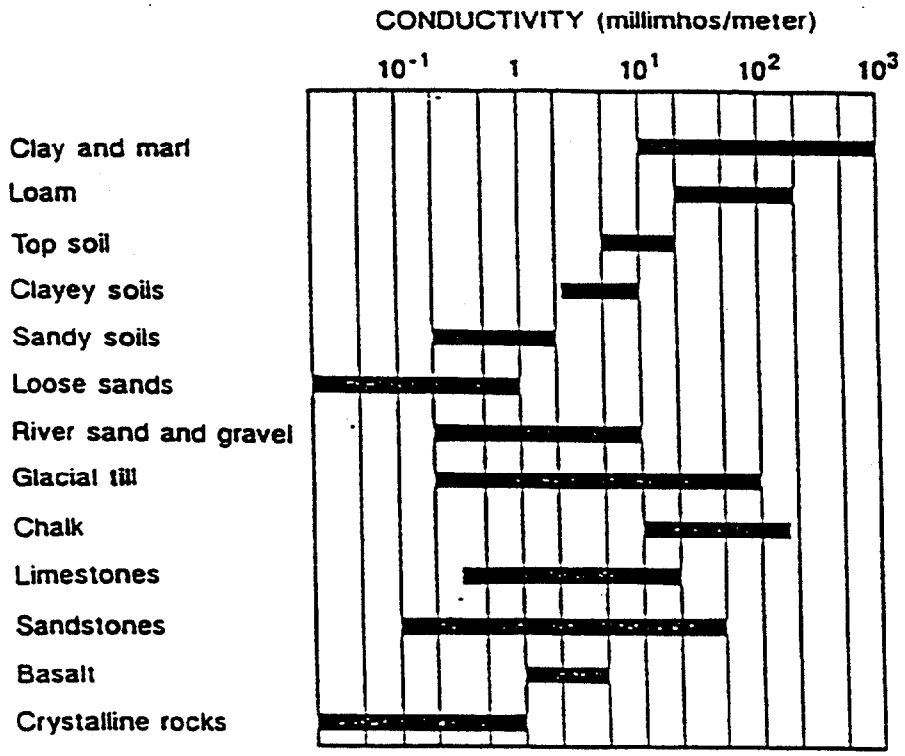
Figure 1



Source: Griffith and King, 1981

TWO-COIL ELECTROMAGNETIC INDUCTION APPARATUS

Figure 2



(after Culley et al.)

CONDUCTIVITY RANGES FOR COMMON EARTH MATERIAL

Two common terrain conductivity meter are EM-31 and the EM-34-3. The EM-31 has a fixed intercoil spacing of 3.7 meters and an effective depth of penetration of approximately 6 meters. The EM-34-3 has two coils which can be separated by 10, 20, or 40 meters and can be oriented in either the horizontal or vertical dipole modes, Intercoil separations increase the effective depth-of investigation as shown below.

Intercoil Spacing (meters)	Depth of Investigation (meters) Horizontal Dipoles	Vertical Dipoles
10	7.5	15
20	15	30
40	30	60

The coil orientation (horizontal or vertical) allows the EM-34-3 to respond to materials of different depths.

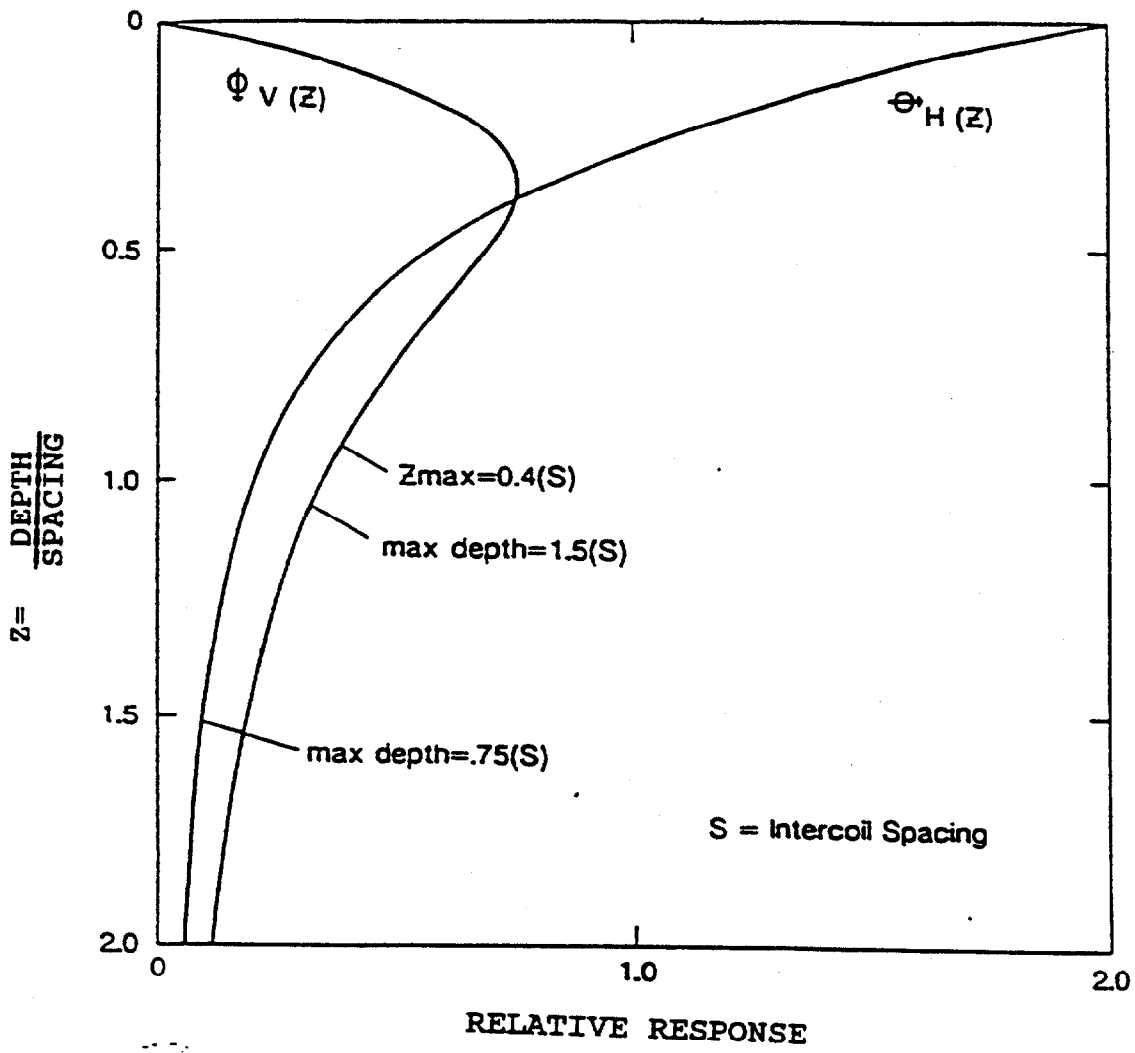
Vertical sounding and horizontal profiling are the two EM survey techniques. Vertical profiling is accomplished by multiple measurements about a point with varying coil spacing. Horizontal profiling is performed by making measurements along traverses with a fixed coil spacing. General discussions of electromagnetic induction methods are presented in texts by Grant and West (1965), Telford and others (1976), and Griffiths and King (1981).

B. Applications and Uses

The measurement of subsurface conductivity at a hazardous waste site provides a valuable contribution to site characterization. The conductivity (resistivity) of the hydrogeologic section is predominantly influenced by the pore fluids. Consequently, conductivity measurements provide indirect information on the porosity and permeability of subsurface materials, the degree of saturation, and the conductivity of the pore fluids. The conductivity of the pore fluid is influenced by the presence of dissolved electrolytes. Contaminant plumes in the unsaturated and saturated zones can be mapped provided there is a sufficient change in the conductivity to be detected by the EM instrument. Generally, contaminant plumes of inorganic waste are easily detected because the pore fluids often have conductivity values as much as three orders of magnitude above background values. Figure 4 illustrates an EM anomaly associated contamination plume. EM conductivity measurements can also be used to detect the presence of buried waste; filled disposal trenches, and buried metal objects such as drums, tanks or metal debris. Figure 5 illustrates an EM anomaly over a buried metal object. Electromagnetic surveys can be used to locate conductive as well as and non-conductive bodies. The many applications include:

- Contaminant plume mapping
- Locating abandoned trenches and lagoons
- Delineating bedrock fracture zones
- Determining thickness of weathered layers
- Lithology mapping

Figure 3



COMPARISON OF RELATIVE RESPONSES F
VERTICAL AND HORIZONTAL DIPOLES

- Locating buried metallic objects
- Lateral anomalies such as pockets or pits of different materials

Examples of EM applications at sites where groundwater is contaminated are presented by Duran (1982), Greenhouse (1983), and Greenhouse and Slaine (1983).

C. Equipment

The two-coil EM instrument and the VLF (very low frequency) instrument are basically the two different types of electromagnetic surveying instruments in use; each is capable of sensing to different depths. There are several models and manufacturers of this equipment.

The two-coil system consists of a transmitter coil and a receiver coil. Refer to Figure 1 which illustrates the basics of a two-coil electromagnetic induction apparatus. The transmitter coil induces an electromagnetic field of known strength and the receiver coil measures the resulting quadrature, or ratio of primary to secondary fields resulting from subsurface features. Each instrument is read directly in units of milliohms per meter (conductivity). EM readings represent the average bulk conductivity at a point halfway between the two coils.

The VLF instrument is a receiver which relies on specialized, very low frequency communication antennas for induction of an electromagnetic field. Surveying with the VLF or equivalent instrumentation is commonly referred to as VLF surveying.

The VLF Instrumentation is a small, lightweight hand-held instrument which can be operated by one person. Principal components of the instrument are a pair of mutually perpendicular coils and a receiving crystal with a frequency specific to a transmitting antenna. The two receiving coils are used to measure local characteristics of the primary induced field and any secondary fields emanating from bodies of variable conductivity. Typical sources of induced electromagnetic fields for VLF surveying are the very low frequency antennas used for submarine communications.

D. Data Acquisition

The advantage of the EM survey method is the speed and accuracy with which lateral changes of terrain conductivity can be measured. The EM conductivity data can be acquired using sounding and profiling techniques similar to those used in electrical resistivity. EM profiling is accomplished by traversing an area with a fixed coil spacing and orientation; EM sounding is accomplished by expanding the inter-coil spacings in a manner similar to that used by electrical resistivity soundings. Some commonly used EM equipment is limited in the number of available inter-coil spacings that can be used; however, there are other EM instruments available that can operate at many coil spacings and frequency ranges to provide numerous sounding data points necessary for accurate computer modeling and profiling.

The factors determining which instrument is used and what the grid spacing should be at particular sites are:

- Depth to target and size of target
- Accessibility of the site

- Effects of manmade structures and utilities, such as electric power lines
- Conductivity of the earth materials

EM induction instruments may have a depth of investigation of up to 200 feet depending upon coil spacing and orientations used (see Figure 3). The very low frequency VLF device has the greatest depth of investigation and is generally used to evaluate large geologic structures.

In conducting a VLF survey, VLF readings should be acquired with the instrument oriented perpendicular to a straight line from the site to the transmitter antennas. This orientation is necessary to ensure optimum data quality. All readings from a particular VLF station must be obtained with the instrument oriented in the same direction.

For an EM induction survey, a regular pattern of survey stations will provide coverage of the area in question. Typically, use of a grid spacing which is approximately equal to the size of the target sought by the survey, and a coil spacing with a maximum response for the depth of interest will produce satisfactory results. Specific needs for local detail, however, may require a refined coverage. The chosen spacing should always be site and target specific.

In conducting an EM survey, the field operator must avoid or note any potential sources of anomalous (noise) conductivity values such as power lines, buildings, fences, buried pipelines or any other large metal objects. Noise sources should be noted on the profiles or contour maps accounting for anomalies due to these known sources.

Important information that should be known for planning and before conducting an EM conductivity survey are: assumed hydrogeologic characteristics of the site, potential source locations and migration paths, characteristics of the hazardous substance of interest, and depths of interest. The level of detail necessary (size of object of interest and detail of resolution) determines the number of lines and station spacings of readings required.

EM data, if not recorded on a strip chart or digital recording instrument, should be recorded on standardized data sheets. At a minimum all data (strip chart, digital disks, or standard forms) should have the following information listed:

- Project/site location identification
- Company
- Date and time
- Operators name
- Instrument make, model
- Coil spacings and configuration
- Line and station numbers
- Instrument reading scales
- Weather conditions/temperature

E. Interpretation

1. Data Analysis

In general, electromagnetic survey data require relatively little processing before they can be interpreted. This is especially true for fixed coil spacing surveys because the data are recorded in units of conductivity; preliminary interpretations are made by comparison of conductivity values. A contour map can be prepared from the data and compared with results of other surveys. EM instruments also can be used for vertical soundings similar to resistivity sounding. Vertical sounding with EM equipment, however, has lower resolution than that performed with the resistivity technique. As a result, EM data are generally more useful for continuous profiling surveys.

VLF instruments do not read directly in units of conductivity. The in-phase measurement (the tilt of primary induced field) is read in terms of the tangent to the angle of tilt and is given as a percentage. Quadrature measurements, which are the ratios of voltage required to equalize the primary to secondary signal strengths, are also given as percentages. For field interpretation these two sets of data can be plotted in profile form, percentage versus distance. Greenhouse and Slaine (1983) describe a simple mathematical conversion so that VLF data can be presented in contour format and compared to other available data such as resistivity and magnetics. Digital data acquisition systems are now available that allow calculation of conductivity.

2. Presentation of Results

Results of an EM conductivity survey can be presented in profile and/or contour map form. The orientation of the traverses should be indicated on profiles in lines of coverage on contour maps. Locations of observed surface metal and other cultural features such as topography, buildings, fences, power lines etc. should be noted on both the profiles and the contour maps.

3. Interpretation

EM conductivity data can be analyzed qualitatively and quantitatively. Generally, profiling data are presented as a contour map or profiles. Profile lines should be stacked and aligned. A qualitative analysis of the contour map or aligned profiles usually can allow an interpreter to identify any conductivity trends that may be indicative of buried metal, groundwater flow and contaminant transport. A comparison of available geologic data, cultural ferrous metal and debris maps prepared during data acquisitions should be made to evaluate the causes of any conductivity trends observed.

Computer or chart comparisons of EM sounding data with available theoretical models can be made. This type of interpretation is similar to that used in electrical resistivity, but in EM sounding it is limited to relatively simple hydrogeologic conditions.

F. Advantages and Limitations

Advantages of the electromagnetic induction method include:

- No ground contact required
- Rapid data acquisition (faster than resistivity)
- Lightweight, one or two man operation
- Wide range of applications
- High lateral resolution
- Field interpretation possible

Limitations of the electromagnetic induction method include:

- Limited dynamic range l-1,000 milliohm/meter
- Susceptible to effects of man-made structures, utilities, etc.
- Less vertical resolution than resistivity
- Limited penetration
- Does not distinguish even simple layering without more complex application and interpretation
- Setting and maintaining instrument at zero

VI. Quality Assurance Records

Field data will be recorded in log books and/or data recording sheets accompanying the monitoring equipment. Data recorded in a field log book will be entered with the following data: date, site location, Contract Task Order number, personnel conducting the investigation, time (military time), start time and end time, weather.

VII. References

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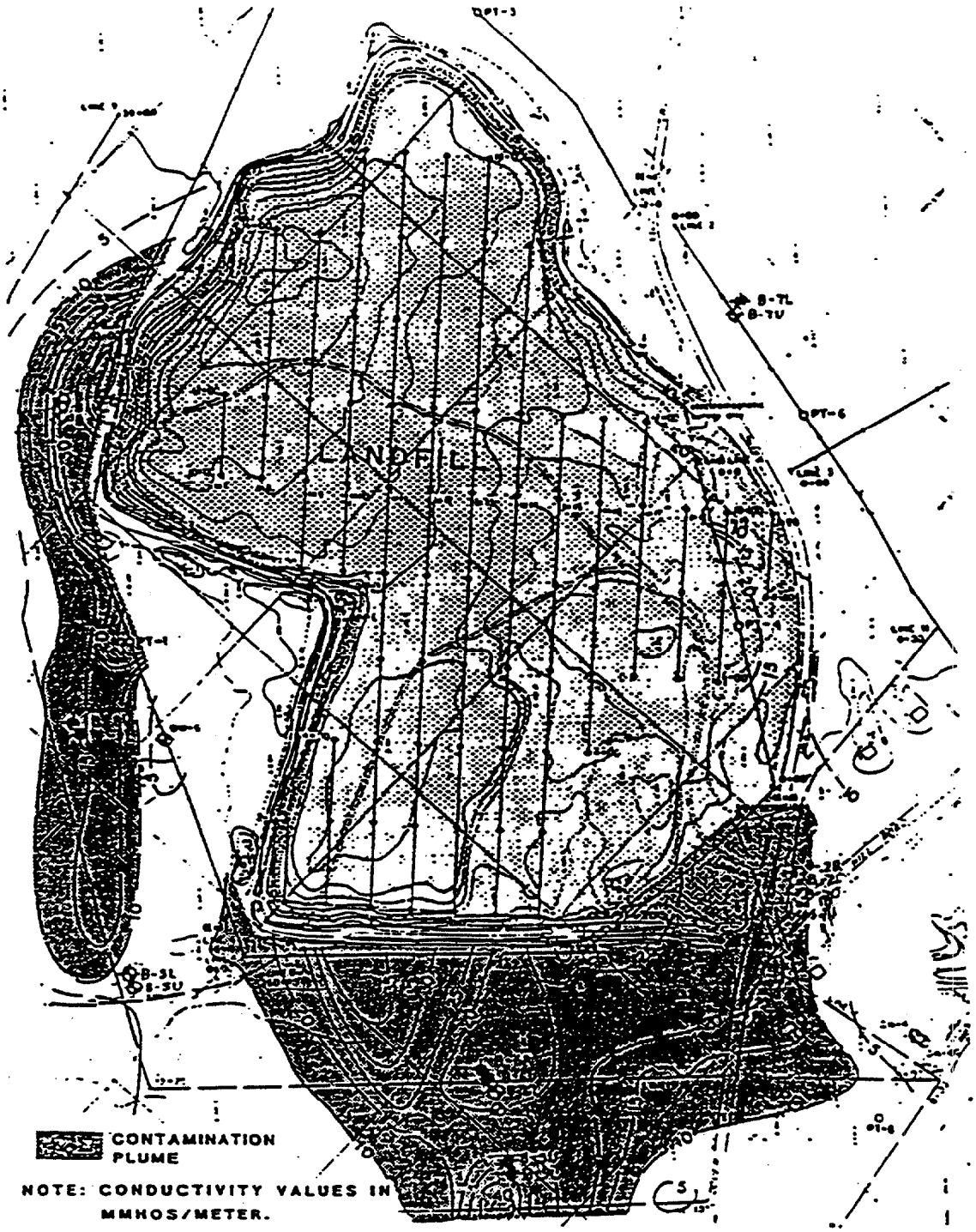
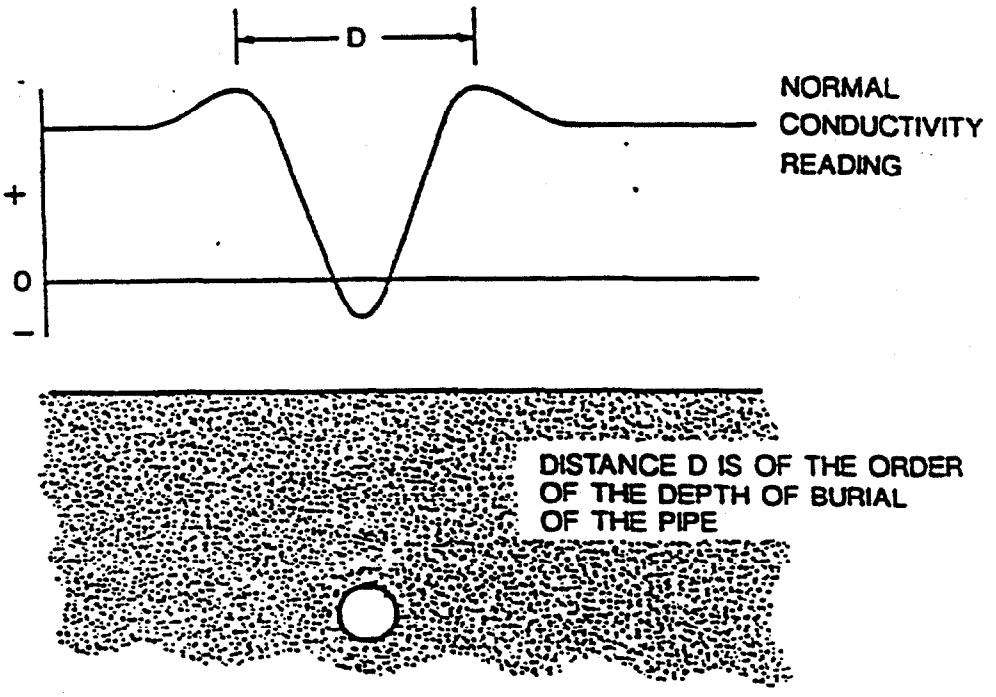
Figure 4



CONDUCTIVITY CONTOUR MAP

Figure 5



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TYPICAL EM RESPONSE OVER A METAL PIPE

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STANDARD OPERATING PROCEDURE

Gravimetry

I. Purpose

The purpose of this SOP is to provide general reference information for using gravimetric methods.

II. Scope

This SOP indicates a description of field procedures, equipment, and interpretation methods necessary to fully utilize this procedure.

III. Definitions

Bouguer slab - A slab of infinite horizontal extent, constant density and thickness

Bouguer anomaly - Gravity value after the observed (measured) gravity has been corrected for latitude, free-air, Bouguer slab and terrain.

Complete Bouguer anomaly - Gravity value after the observed (measured) gravity has been corrected for latitude, free-air, Bouguer slab and terrain.

Simple Bouguer anomaly - Gravity value after the observed (measured) gravity has been corrected for latitude, free-air, and Bouguer slab.

Earth tides - Variations in the gravitational attraction of the sun and the moon as their positions change with respect to the earth, (maximum amplitude 0.3 gal occurring in a period as short as an hour).

Residual gravity map - resulting gravity map after regional gravity affects are removed from Bouguer anomaly values.

The international gravity value - Equation that accounts for the fact that the earth is not a perfect sphere, but is more like a perfect fluid for which balance is maintained between the gravitational forces tending to make it spherical and the centrifugal forces of rotation tending to flatten it. As a result, the equatorial radius is approximately 21 km greater than the polar radius.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that the project-specific plans are in accordance with these procedures, where applicable, or other approval procedures are developed. The Project Manager is responsible for

development of documentation of procedures which deviate from those presented herein.

Field Team Leader - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that the field investigation personnel performing the activities have been briefed and trained to execute these procedures.

V. Procedures

A. Overview

The gravity survey method is a passive - geophysical technique which measures extremely small variations in the earth's gravitational field, using a highly sensitive instrument. Observed gravity measurements are variations of the earth's true gravitational attraction from one location on the earth's surface to another (Dobrin, 1960). Spatial variations in the value of observed gravity depend upon a number of factors including:

- Lateral density variations of earth materials in the vicinity of an observation point
- Elevation
- Latitude
- Surrounding terrain variations (topography)
- Tidal fluctuations

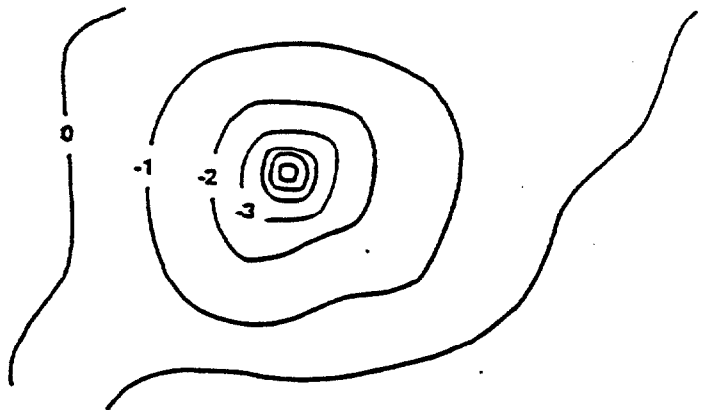
In gravity exploration the variation in density is the only significant factor (Telford, 1978). Lateral variations in the distribution of mass in the earth's crust produce distortions or differences in the gravitational field. Tectonics, faulting, erosion, deposition and other geologic movement involving rock often result in lateral density variations in the subsurface rocks. Measured gravitational differences are interpreted in terms of probable subsurface mass distributions, which are inferred from surface and near surface geologic conditions (Nettleton, 1975).

The acceleration of gravity at the earth's surface is approximately 980 centimeters per second squared or 980 gals. In gravity exploration work, anomalies as small as one ten-millionth of the earth's field are detected with gravimeters. The unit used in exploration gravity surveying is the milligal (10-3 gals). Microgravimeters are more sensitive instruments which can detect smaller magnitude anomalies, measured in the unit of microgals (10-6 gals).

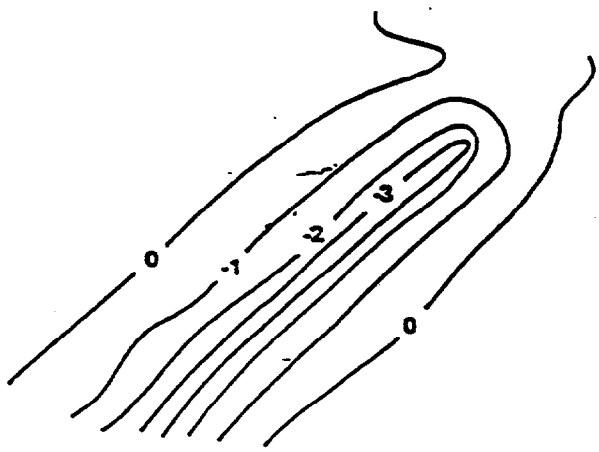
B. Applications and Uses

After the appropriate corrections have been made, gravity values can be presented as Bouguer anomalies. A Bouguer anomaly map (Figure 1) looks very much like a topographic contour map. Bouguer anomalies are interpreted in terms of the size, shape and position of the subsurface structures. Microgravity measurements can be used to detect the following conditions:

FIGURE 1



A.) GRAVITY ANOMALY OF SPHERICAL CAVITY

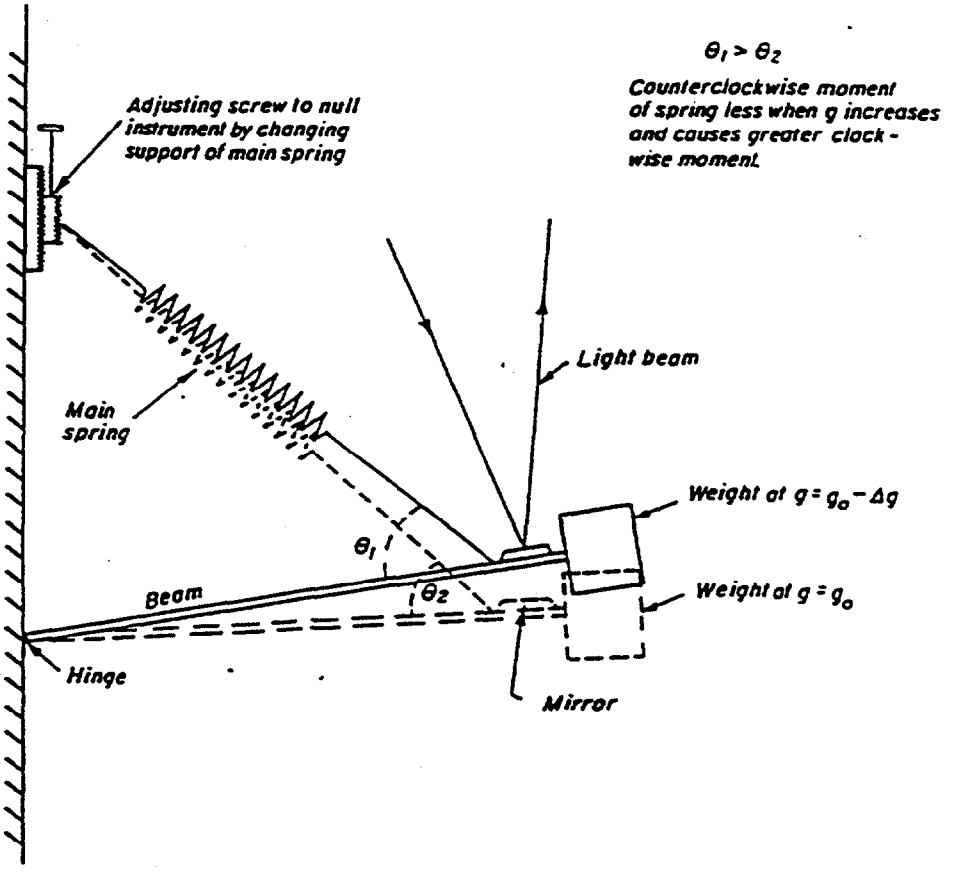


B.) GRAVITY AND ANOMALY OF HORIZONTAL CYLINDRICAL CAVITY

Source: Butler, 1977

CONTOUR MAPS ILLUSTRATING NEGATIVE GRAVITY ANOMALIES

FIGURE 2



OPERATION OF LACOSTE AND ROMBERG GRAVIMETER (SCHE

- Joints
- Dissolutions
- Collapses
- Cavities
- Buried river channels
- Fault scarps

C. Equipment

The Lacoste - Romberg and Worden gravimeters are two commercially available gravimeters. The Lacoste-Romberg Model D is the only commercially available microgravimeter. These instruments measure the elongation of a spring which supports a weighted beam. An increment of elongation of the spring is proportional to an increment of gravity. The principal of operation of a Lacoste-Romberg microgravimeter is illustrated in Figure 2.

The Lacoste-Romberg gravimeter is heated to maintain a constant instrument temperature and, consequently, a more sensitive and stable reading. Some instruments are not temperature controlled and, consequently, instrument temperatures must be noted and corrected for. Gravimeters with heaters require a portable energy source (batteries) and must have an appropriate warm up time (approximately one day) to acquire stable, accurate readings.

D. Field Procedures

The gravimeter itself can be operated by a single operator. The topographic survey can be performed before, during, or after the gravity measurements.

The operation of the instrument is rather straightforward, but acceptable levels of accuracy require meticulous attention to details, such as:

- Instrument leveling
- Surveyed location
- Surveyed elevation
- Instrument drift
- Time of measurement

Survey accuracies of at least one-tenth of a foot of elevation, and horizontal accuracy of approximately 2 feet are required for microgravity surveys. The high level of accuracy required in gravity surveys dictates repeated readings at a base station throughout the period of the survey to compensate for time variations (drift) inherent in all instruments. Typically, base station readings are taken at least three times a day and often are repeated in one-hour intervals. Loop times for microgravity instruments that have been recently reheated to operating temperatures initially should be at about 30 minutes intervals. Loop times can then progress up to a maximum of 1 hour. Initial short loop times are to minimize errors due to mechanical adjustments caused by internal thermal stress. Microgravity instruments with fluid levels should have 30 second levels rather than 60 second levels. The 30 second levels provide a more precise leveling accuracy.

At each station the gravimeter is set on a metal tripod which provides a stable base. The instrument is leveled by two horizontal and mutually-perpendicular levels in the instrument. Three readings are commonly taken at each station. Levels checked between readings to ensure data quality and minimize operator error.

Important information that should be recorded in field note books are:

- Instrument identification number
- Date and time of reading
- Operator
- Station identification number
- Base station location
- Instrument readings

To assure correlation between data sets, the relative gravity for each base station can be established by looping with absolute base stations which are part of an international gravity network adjusted to the 1979 Potsdam value. A listing of absolute base station locations can be obtained from NOAA in Washington, D.C.

Gravity stations are arranged either in gridded survey patterns or in linear traverses. Gridded survey patterns provide more detailed information, but at a higher cost due to the higher number of stations.

Precautions should be taken in locating gravity stations to avoid whenever possible areas with nearby (50 + feet) severe topographic changes. These topographic changes affect gravity measurements. Hills rising above the gravity station and valleys (lack of material) affect the gravity measurements by reducing the recordings due to upward attraction of hills or lack of downward attractions by a valley (Telford). Earthquakes and other vibratory phenomena also can adversely affect gravity readings. Generally, when an earthquake has occurred the instrument reading beam may drift and cannot be stabilized. Depending on the distance to and magnitude of the earthquake, gravity measurements should be suspended for a few hours or Fail -the next day. Another potential problem in conducting a gravity investigation is unstable ground materials such as loose sand, nearby sources of vibration (heavy truck traffic, construction equipment, etc.) or stone ballast. Generally, these situations can be overcome with patience, slight changes in station locations or altering the time of day in which the investigation is conducted.

E. Interpretation

1. Data Analysis

Gravity data obtained in the field must be corrected for:

- Instrument drift
- Earth-tide variations
- Elevation
- Bouguer slab
- Latitude
- Influence of surrounding topographic (terrain) variations

All gravity stations within a common data set must be reduced to a common elevation datum plane. Sea level is the most often used datum plane.

Instrument Drift and Earth-Tide Variations

The observed gravity for each station is determined by looping with a base station with a known gravity value and correcting readings for instrument drift and earth tide variations. Instrument drift and earth tide variations are calculated by dividing the difference in the base station readings (end of loop minus beginning of loop) by the time required to complete the loop. Each station reading is then corrected by adding the drift factor by the time between stations. Observed gravity values are then calculated by multiplying the corrected meter reading difference between the base and the gravity station by factors unique to the particular gravity meter.

Elevation Correction

Since gravity varies inversely with the square of distance, it is necessary to correct for changes in elevation. Correction for elevation or the free-air correction compensates for elevation variations between stations so that all the field readings are reduced to common datum surface. Sea level is the common datum surface used for the free-air corrections. When the gravity stations are above the datum plane, the free-air corrections are added to the observed gravity values (Telford, 1978).

Latitude Corrections

Latitude corrections compensate for the centrifugal acceleration due to the rotation of the earth and radius variation between the poles and equator. Maximum latitude corrections occur at latitude 450 where the variation is approximately 0.01 milligals per 40 feet of north-south displacement.

The International Gravity Formula of 1967 incorporates the latitude correction in the calculation of theoretical gravity. When gravity stations are north of the reference latitude, all corrections are subtracted from the observed gravity values (Telford, 1978).

Bouguer Slab-Correction

The free-air correction accounts for elevation differences, but not for attraction of the material between the station and the common datum surface. The Bouguer correction accounts for the attraction of this material. Bouguer corrections assume a slab of infinite horizontal extent.

A commonly used slab density in New England is 2.67 g/cm , which is the approximate density of the granitic crust. Bouguer corrections are applied in the opposite sense of the free-air corrections; that is, they are subtracted when the station is above the common datum plane (Telford, 1978).

Terrain Correction

Terrain corrections are applied to the gravity data when the topography of the surveyed area is not relatively flat. Nearby hills result in an upward component of gravity and nearby valleys result in an apparent loss of mass between the station

and datum elevation. Both effects diminish the measured gravitational field, therefore, the terrain correction is always added to the data. Terrain corrections are calculated using the slab density used in the Bouguer slab correction. There are several graphical methods for calculating terrain corrections. All require a good topographic map of the area at a minimal 10 foot contour interval. The most commonly used graphical method uses templates that divide the area into zones for which the average elevation can be estimated and the terrain correction calculated. Tables of terrain corrections, for zone charts of particular dimensions developed by Hammer (1939) facilitate this operation considerably (Telford 1976).

Theoretical Gravity

The difference between the corrected station gravity and the calculated theoretical gravity for each station is the Bouguer gravity. Theoretical gravity values are calculated using station latitudes and a relationship adopted by the International Association of Goedesy.

2. Presentation of Results

The results of a gravity survey can be presented as contour maps or as profiles depending upon the data processing and/or interpretation techniques. A raw-data map presents the gravity readings that have been corrected for instrument drift and earth-tide effects. A free-air gravity map is the raw data corrected for station elevations (reduced to a common elevation datum). A simple Bouguer map is the free-air gravity values corrected for the Bouguer slab. A complete Bouguer map is the simple Bouguer values corrected for terrain variations. Residual anomaly map is the residual gravity values after regional gravity affects have been separated. Data processing procedures to prepare each of the above mentioned maps include assumptions that may or may not be true and may bias the interpretation of the gravity data. Therefore, the preparation and qualitative analysis of these maps may be necessary to identify any bias or anomalies that may be created due to the data processing calculations.

Interpreted gravity results are presented as 2-D, 2 1/2-D or 3-D profiles or maps. The 2-D results assume infinite lengths in the 3rd dimension, 2 1/2-D results have a finite length in the 3rd dimension and 3-D modeling results have 3 dimensional geometric shapes.

3. Interpretation

The complete Bouguer anomaly map represents the contribution of all earth materials that exist beneath the ground's surface. Therefore, the first step in the interpretation of gravity data is to separate the anomaly components arising from the source of interest from the sources of no interest. This step is called the regional residual separation and it is the residual values that are of primary interest.

The residual or shorter wavelength gravity data can be separated and modeled independent of the deeper-seated, longer wavelength regional gravity data. The residual data can be separated from the regional data in a number of ways. The averaging method, polynomial fitting, and upward continuation and wavelength

filtering regional residual separation methods are a few. Text books such as Telford (1976), Nettleton (1976) etc. explain in detail regional residual separation methods.

There is extensive literature on the subject of and significant problems involved in regional residual separation. The techniques listed above are some of the more common techniques used. The choice of the method used for removing the regional, depends upon many factors, the most important being the total labor involved, the complexity of the gravity map, the density and distribution of the stations and quality of the data.

The residual gravity maps are a by-product of the regional residual separation. These maps are used to predict the physical characteristics and proximity of near surface anomalous bodies.

Before a quantitative interpretation is attempted, a qualitative analysis of the data should be made to determine the presence of anomalous sources and to get a general idea of depth, strike, and density of sources. Qualitative analysis includes an evaluation of the polarity, magnitude, gradient and trends of residual anomalies, as well as a comparison with other available geophysical (magnetic, seismic, electrical) and geological data.

Based on the qualitative analysis of the regional map a quantitative interpretation to determine possible individual sources of the anomalies can be undertaken. The quantitative interpretations are accomplished using 2 and 3 dimensional computer modeling techniques. Each anomaly body is assigned a geometric shape and a value which represents the bodies contrasting density values. All gravity interpretations benefit from incorporation of geologic constraints. Such constraints can come from surface geology, geomorphology, subsurface geology, boring logs, seismic reflection and refraction data, magnetic surveys, and geochemical data.

Interpretation of gravity data is subject to two limitations:

- The inherent ambiguity in the possible source of a given gravity anomaly.
- The complete dependence of gravity anomalies on the existence and magnitude of horizontal variations in the density of the rocks.

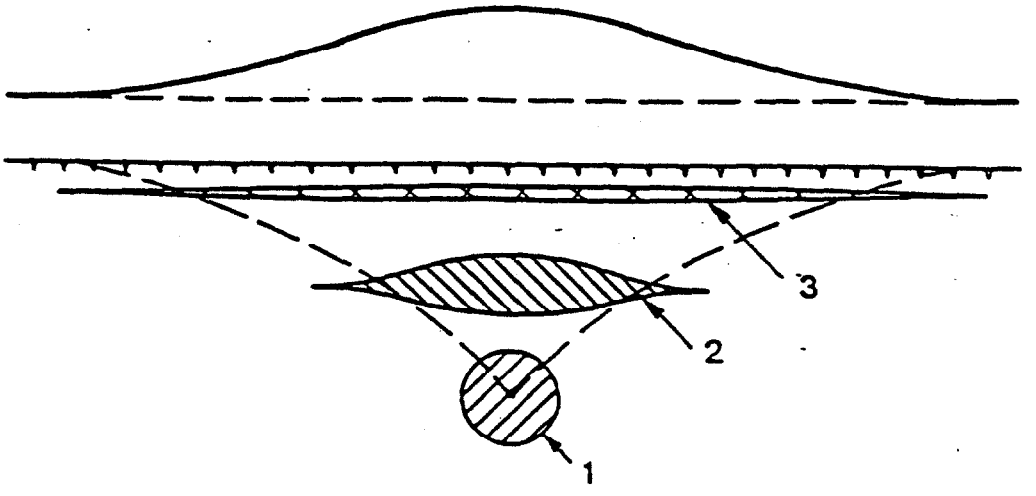
For a given distribution of gravity there is no single, unique distribution of mass which will have a calculated effect that corresponds to the observed gravity. That is, for a given width of anomaly there is a corresponding maximum depth and a cone of possible sources, as illustrated in Figure 3.

F. Advantages and Limitations

The advantages of a gravity survey are:

- Field work can be carried out by one to three persons in any accessible area, including highly developed urban and industrialized sites, over pavements, fills, landfills, on lake ice, inside buildings, etc.
- Instrumentation is portable, the work can be silent and produce no visible disturbance to an environment other than stakes or other station markings.

FIGURE 3



Gravity anomaly shown can be approximated by a deep sphere (1) or by a shallower broader body, such as (2) or (3) [from Nettleton, 1976]

- The method lends itself well to areal coverage. Contour maps of bedrock or other features have obvious advantages over information at points or along profiles.
- Used appropriately, it is highly cost effective either by itself or in combination with other exploration methods.

The limitations of a gravity survey are:

- Applications are limited to mapping of density - dependent interfaces
- Accurate station locations and elevations are necessary.
- Calibration with geological "knowns" such as outcrops, borings, seismic profiles, etc. is necessary for quantitative work.
- Excessive topography, access problems, and certain bedrock complexities may seriously limit the accuracy of data interpretation.

VI. Quality Assurance Records

All data will be recorded in log books under the following format: date, start and end time (military time), personnel on site, Contract Task Order number, and weather.

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STANDARD OPERATING PROCEDURE

VOC Sampling--Water

I. Purpose

To provide general guidelines for sampling aqueous volatile organic compounds.

II. SCOPE

Standard techniques for collecting representative samples are summarized. Site specific details are discussed in the FSP.

III. EQUIPMENT AND MATERIALS

- Sample vials, clean latex or surgical gloves, pH meter
- Hydrochloric acid (HCl) for preservation
- pH meter or pH indicating paper
- Surgical or latex gloves

IV. PROCEDURES AND GUIDELINES

1. Sample VOCs before sampling other analyte groups.

2. When sampling for VOCs, especially residential wells, evaluate the area around the sampling point for possible sources of air contamination by VOCs. Products that may give off VOCs and possibly contaminate a sample include perfumes and cosmetics, skin applied pharmaceuticals, automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) and household paint products (paint strippers, thinners, turpentine, etc.).

3. To check the amount of hydrochloric acid (HCl) that needs to be added at each location, fill a test vial (40 ml) with the water to be sampled, add one drop of hydrochloric acid (HCl), gently mix, and check the pH. Repeat this cycle (if necessary) until you reach a pH of 2, counting the number of drops of HCl required. DISCARD THE TEST VIAL and add an equal number of drops of HCl to each of the sample vials. proceed to sample.

4. Keep the caps off the sample vials for as short a time as possible.

5. Wear clean latex or surgical gloves.

6. Fill the sample vial immediately, allowing the water stream to strike the inner wall of the vial to minimize formation of air bubbles. DO NOT RINSE THE SAMPLE VIALS BEFORE FILLING.

7. Fill the sample vial with a minimum of turbulence, until the water forms a positive meniscus at the brim.

8. Replace the cap by gently stetting it on the water meniscus. Tighten firmly, but DO NOT OVERTIGHTEN.

9. Invert the vial and tap it lightly. If you see air bubbles in the sample, do not add more sample. Use another vial to collect another sample. Repeat if necessary until you obtain a proper sample.

V. ATTACHMENTS

None.

VI. KEY CHECKS AND ITEMS

- Check for possible sources of contamination.
- Check pH.
- Fill slowly, with as little turbulence as possible.
- Check for air bubbles.

VOC_AQ01.DOC

STANDARD OPERATING PROCEDURE

Preserving Non-VOC Aqueous Samples

I. Purpose

To provide general guidelines for preserving aqueous samples.

II. Scope

Standard aqueous sample preservation procedures for non-VOC samples are provided.

III. Equipment and Materials

- Disposable eye droppers
- Clean beakers for transfer of small portions of chemical preservative
- pH paper strips (Range 0 to 14)
- Chemical preservatives, as appropriate
- Personal protection, as appropriate
- Clean out door or vented indoor area

IV. Procedures and Guidelines

1. Remove caps from sample containers to be chemically preserved in designated area. Add appropriate amount of chemical preservative to opened container. To determine the approximate amount of preservative which will be required, preserve a sample of potable water and calculate the volume of preservative required.

2. After adding the appropriate preservatives to the sample containers, cap containers tightly. Invert sample container a few times to mix.

3. After preserving all the sample containers and mixing, open the container and check the pH of the sample by pouring out a small quantity of the sample to a clean receptacle and dipping a pH indicating strip into the sample. Add more preservative to the sample to adjust the pH, if necessary repeating steps 1 and 2. When three times the amount of preservative used to preserve a sample of potable water has been added, record the pH and notify the sample manager that the sample could not be preserved.

4. Wrap, package, and ice samples according to the SOP Packaging and Shipping Procedures.

V. Attachments

None.

VI. Key Check Items

STANDARD OPERATING PROCEDURE

Field Rinse Blank Preparation

I. Purpose

To prepare a blank to determine adequacy of decon procedures and whether any cross-contamination is occurring during sampling.

II. Scope

The general protocols for preparing the rinse blank are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II grade water)
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP Decontamination of Personnel and Equipment.

B. To collect the sample for volatiles analysis, pour blank water over one piece of equipment and into 40-ml vials until there is a positive meniscus and seal vials. Note the sample number and associated piece of equipment in the field notebook.

For non-volatiles, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

C. Document and ship samples in accordance with the procedures for other samples.

D. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II grade water.

STANDARD OPERATING PROCEDURE

Field Filtering

I. Purpose

To provide a general guideline for the field filtering of water samples for dissolved metals analysis.

II. Scope

This is a general discussion of the standard method of field filtering techniques. Operating manuals should be consulted regarding specific procedures.

III. Equipment and Materials

- Geotech Filtering apparatus or equivalent
- Pump
- nitric acid (HNO_3) solution - high grade - reagent grade not acceptable
- Glass fiber prefilters
- Vacuum source
- 45 µm cellulose acetate filters
- inline filters

IV. Procedures and Guidelines

A. REAGENT PREPARATION

1. 10% HNO_3 solution: Add about 900 ml of ASTM Type II water to a 1 liter Erlenmeyer flask. Using a graduated cylinder, ASTM Type II, add 100 ml concentrated HNO_3 to the DI water while stirring.

B. PROCEDURE

1. Attach a vacuum source (pump, syringe, etc.) or a Q.E.D. online filter or equivalent to the receiver assembly.

2. Flush the entire filter system with 10% HNO_3 solution. Open assembly, discard rinsate, and reassemble unit.

3. Flush the entire filter system with 60 ml ASTM Type II water. Open assembly, discard rinsate and reassemble unit (not required when using Q.E.D. online filter).

4. Filter sample and transfer to polyethylene bottle (with preservative) for shipment.

5. Discard filter assembly and prefilter.

V. Attachments

None.

VI. Key Checks and Items

- 10% HNO_3 solution for cleaning
- All water must be ASTM Type II
- Prefilter with glass fiber filters if sample is turbid
- Record lot number of nitric acid and water
- Note monitoring wells with high concentrations of suspended solids in field notebooks
- The equipment blank collected with the sample is called a filtration blank and is collected through the filter.

STANDARD OPERATING PROCEDURE

Homogenization of Soil and Sediment Samples

I. Purpose

The homogenization of soil and sediment samples is performed to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

II. Scope

Standard techniques for soil and sediment homogenization and equipment are provided in this SOP. These procedures do not apply to aliquots collected for TCL VOCs or field GC screening; samples for these analyses should NOT be homogenized.

III. Equipment and Materials

Sample containers, stainless steel spoons or spatulas, and stainless steel pans.

IV. Procedures and Guidelines

Soil and sediment samples to be analyzed for semivolatiles, pesticides, PCBs, metals, cyanide, or field XRF screening should be homogenized in the field. After a sample is taken, a stainless steel spatula should be used to remove the sample from the split spoon or other sampling device. The sampler should not use fingers to do this, as gloves may introduce organic interferences into the sample.

Samples for VOCs should be taken immediately upon opening the spoon and should not be homogenized.

Prior to homogenizing the soil or sediment sample, any rocks, twigs, leaves, or other debris should be removed from the sample. The sample should be placed in a decontaminated stainless steel pan and thoroughly mixed using a stainless steel spoon. The soil or sediment material in the pan should be scraped from the sides, corners, and bottom, rolled into the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the pan and mixed with the entire sample again.

All stainless steel spoons, spatulas, and pans must be decontaminated following procedures specified in SOP Decontamination of Personnel and Equipment prior to homogenizing the sample. A composite equipment rinse blank of homogenization equipment should be taken each day it is used.

STANDARD OPERATING PROCEDURE

Packaging and Shipping Procedures

I. Low-Concentration Samples

A. Prepare coolers for shipment:

- Tape drains shut.
- Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with about 3 inches of vermiculite.

B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.

C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.

E. Arrange sample bottles in coolers so that they do not touch.

F. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.

G. Fill remaining spaces with vermiculite.

H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

I. Separate copies of forms. Seal proper copies (traffic reports, packing lists) along with a return address label within a large zip-lock bag and tape to inside lid of cooler.

J Close lid and latch.

K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. **Do not** cover custody seals.

M. Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

II. Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with several additional restrictions. First, a special airbill including a Shipper's Certification for Restricted Articles is required. Second, "Flammable Liquid N.O.S." or "Flammable Solid N.O.S." (as appropriate) labels must be placed on at least two sides of the cooler. Third, sample containers are packaged in metal cans with lids before being placed in the cooler, as indicated below:

- Place approximately ½ inch of vermiculite in the bottom of the can.
- Position the sample jar in the zip-loc bag so that the sample tags can be read through the plastic bag.
- Place the jar in the can and fill the remaining volume with vermiculite.
- Close the can and secure the lid with metal clips.
- Write the traffic report number on the lid.
- Place "This Side Up" and "Flammable Liquid N.O.S." or "Flammable Solid N.O.S." (as appropriate) labels on the can.
- Place the cans in the cooler.
- For medium concentration samples, ship samples with ice or "blue ice" inside the coolers. (Double bag ice in zip-lock plastic bags.)

III. Special Instructions for Shipping Medium and High Concentration Samples by Federal Express

A. Label cooler as hazardous shipment:

- Write shipper's address on outside of cooler. If address is stenciled on, just write "shipper" above it.
- Write or affix sticker saying "This Side Up" on two adjacent sides.
- Write or affix sticker saying "ORM-E" with box around it on two adjacent sides. Below ORM-E, write NA#9188.
- Label cooler with "Hazardous Substance, N.O.S." and "liquid" or "solid," as applicable.

B. Complete the special shipping bill for restricted articles.

- Under Proper Shipping Name, write "Hazardous Substance, N.O.S." and "liquid" or "solid," as applicable.
- Under Class, write "ORM-E.
- "Under Identification No., write NA No. 9188.

C. For high concentration samples, ship samples with "blue ice" only inside coolers.

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sample Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

V Procedures

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

V.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s);
- CTO Number;
- Project Sample Number;
- Sample location or sampling station number;
- Date and time of sample collection and/or measurement;

- Field observations;
- Equipment used to collect samples and measurements; and,
- Calibration data for equipment used.

Measurements and observations shall be recorded using waterproof ink.

V.1.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - Contract Task Order (CTO) Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 12/21/85).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identify of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

V.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

V.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographs will be stored in the project files. It is good practice to identify sample locations in photographs by including an easily read sign with the appropriate sample/location number.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.

V.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below.

- Enter header information (CTO number, samplers, and project name).

- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).

- Sign, date, and enter the time under "Relinquished by" entry.

- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).

- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner;

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample shipping package. Retain the copy with field records.

- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.

- Place the seal across the shipping container opening so that it would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

VI Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VII Attachments

Sample Label
Chain of Custody Form
Custody Seal

VIII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

Attachment A

Example Sample Label

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: Low Con. VOA **PRES.:** HCl pH <2, Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: Low Con. VOA **PRES.:** HCl pH <2, Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: TCL SVOAs/Pest/PCBs **PRES.:** Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: Nitramines **PRES.:** Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: TAL Metals (unfiltered) **PRES.:** HNO_3 pH<2, Cool 4C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: TAL Cyanide **PRES.:** NaOH pH >12, Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: Low Con. VOA **PRES.:** HCl pH <2, Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: TCL SVOAs/Pest/PCBs **PRES.:** Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: TCL SVOAs/Pest/PCBs **PRES.:** Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNE
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: Nitramines **PRES.:** Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002F
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: TAL Metals (filtered) **PRES.:** HNO_3 pH<2, Cool 4 C

CDM Federal Programs Corporation
13135 Lee Jackson Memorial Highway Fairfax, VA 22033

NAVY C.L.E.A.N. - ST. JULIEN'S CREEK ANNEX
SITE: 02 **SAMPLE ID:** SJS02-GW1S-002
DATE: _____ **TIME:** _____ **SAMPLER:** LC/TS
ANALYSIS: Total Phosphorous **PRES.:** H_2SO_4 pH , Cool 4 C

Attachment B

Example Chain-of-Custody Record

CHAIN OF CUSTODY RECORD

CDM FEDERAL PROGRAMS CORPORATION

2030 Powers Ferry Road, Suite 490
Atlanta, Georgain 30339
404-952-7393

PROJECT NO.	PROJECT LEADER	REMARKS (Air Bill No.)
PROJECT NAME/LOCATION		

ESD SAMPLE TYPES

1. SURFACE WATER
2. GROUND WATER
3. POTABLE WATER
4. WASTEWATER
5. LEACHATE
6. SOIL/SEDIMENT
7. SLUDGE
8. WASTE
9. AIR
10. FISH
11. OTHER _____

SAMPLERS (SIGN)

CIRCLE/ADD parameters desired. List no. of containers submitted

ANALYSES

STATION NO.	SAMPLE TYPE	19__ DATE	TIME	COMP	GRAB	STATION LOCATION/DESCRIPTION	TOTAL CONTAINERS	COD. TOC. NUTRIENTS	BOD. SOLIDS	METALS	EXT ORG/PEST/PCBs	VOA	CYANIDE				TAG NO./REMARKS	LAB USE ONLY

RELINQUISHED BY: (PRINT) / (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) / (SIGN)	RELINQUISHED BY: (PRINT) / (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) / (SIGN)
RELINQUISHED BY: (PRINT) / (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) / (SIGN)	RELINQUISHED BY: (PRINT) / (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) / (SIGN)

DISTRI : White and pink copies accompany sample shipment to laboratory: Pink copy retair boratory.
White copy is returned to samplers: Yellow copy retained by samplers.

0/89)

Attachment C

Example Custody Seal

ENVIRONMENTAL SAMPLING SUPPLY

SAMPLE # _____ DATE _____

CUSTOMER _____

SIGNATURE _____

9501 San Leandro Street, Oakland, California 94603
(510) 562-4988 (800) 233-8425

SAMPLE LABLE

CUSTODY SEAL

Person Collecting Sample _____ Sample No. _____
(signature)

Date Collected _____ Time Collected _____

SAMPLE CUSTODY SEAL

STANDARD OPERATING PROCEDURE

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP Decontamination of Personnel and Equipment. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Alconox or Liquinox
- Buckets
- Brushes
- Distilled organic-free water
- Methanol, pesticide grade
- Six-molar nitric acid, analytical grade
- ASTM-Type II grade water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Prior to the onset of drilling, after each borehole, prior drilling through permanent isolation casing, and prior to leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam cleaning area will be designed to contain decontamination wastes and waste waters and can be a HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned prior to the onset of drilling, prior to drilling through permanent isolation casing, and between boreholes. This will

include, but is not limited to, rods, split-spoons or similar samplers, coring equipment, augers, and casing.

Prior to the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Prior to the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. **Field Analytical Equipment**

1. Water Level Indicators

   Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

   a. Rinse with tap water
   b. Rinse with deionized water
   c. Solvent rinse with methanol
   d. Rinse with deionized water

2. Probes

   Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, OVM equipment, the probe will be wiped with clean paper-towels or cloth wetted with methanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

The effectiveness of field cleaning procedures will be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis. Any time a sampling event occurs, at least one such quality control sample shall be collected. The total number of equipment blanks will be at least 5 percent of the number of samples collected during large-scale field sampling efforts.

At least one piece of field equipment shall be selected for this procedure each time equipment is washed. An attempt should be made to select different pieces of equipment for this procedure.

STANDARD OPERATING PROCEDURE

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water)
- Distilled water
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) trisodium phosphate ("TSP") and water solution
- Concentrated (V/V) pesticide grade methanol (DO NOT USE ACETONE)
- 10% (V/V) nitric acid (HNO_3) and water solution (only ultrapure grade HNO_3 is to be used)
- Large plastic pails or tubs for TSP and water, scrub brushes, squirt bottles for TSP, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Phthalate-free gloves
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in TSP solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with TSP solution, remove, and discard into DOT approved 55-gallon drum.
2. Wash outer gloves in TSP solution, rinse, remove, and discard into DOT approved 55-gallon drum.
3. Remove disposable coveralls ("Tyveks") and discard into approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Spread plastic on the ground to keep hoses from touching the ground
3. Turn off pump after sampling. Remove pump from well and place pump in decontamination tube, making sure that tubing does not touch the ground
4. Turn pump back on and pump 1 gallon of TSP solution through the sampling pump.
5. Rinse with 1 gallon of 10% methanol solution pumped through the pump. (DO NOT USE ACETONE).
6. Rinse with 10% HNO_3 solution pumped through the pump, when sampling for inorganics (carbon steel split spoons will be rinsed with a 1% solution).
7. Rinse with 1 gallon of tap water.
8. Rinse with 1 gallon of deionized water.
9. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.

10. Collect all rinsate and dispose of in a DOT approved 55-gallon drum.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Prior to entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with TSP solution.
5. Rinse with potable water.
6. Rinse with 10% HNO_3 solution when sampling for inorganics (carbon steel split spoons will be rinsed with a 1% solution).
7. Rinse with distilled or potable water and methanol solution (DO NOT USE ACETONE).
8. Air dry.
9. Rinse with deionized water.
10. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
11. Collect all rinsate and dispose of in a DOT approved 55-gallon drum.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with TSP solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT approved 55-gallon drum.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with TSP solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN

SEALED. Repeat the above steps using potable water.

2. Dispose of all used paper towels in a DOT approved 55-gallon drum.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Navy

2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of TSP, methanol, nitric acid, and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

STANDARD OPERATING PROCEDURE

Disposal of Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced.

II. Equipment and Materials

A. Fluids

- 55-gallon steel drums
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- 55-gallon steel drums
- Tools for securing drum lids
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes, capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will be labeled as they are filled in the field and labels indicating that the contents are potentially hazardous affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. The drum sampling will be accomplished through the collection and submittal of composite samples as a series of 10 drums containing the same media. The compositing of the sample will be accomplished through the collection of a

specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. The analysis will be used to determine if drilling wastes are covered by land disposal restrictions.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents. A portion sample will be obtained from each drum. A composite sample from 10 drums will be submitted to an approved analytical laboratory for analysis of disposal parameters.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the fenced drum storage area by the drilling services subcontractor.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste,

and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination will be disposed of through the sanitary sewer system at the site. Prior to disposal to the sanitary sewer system, contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

Check that representative samples of the drummed materials are obtained.

STANDARD OPERATING PROCEDURE

Buried Metal Investigations

I. Purpose

To provide reference material and general guidance on test pitting around buried metal items.

II. Scope

Test pitting using a backhoe, excavating and overpacking buried drums, and obtaining representative soil samples from the test pits. Sampling wastes from buried drums and tanks are addressed in SOP Sampling Contents of Tanks and Drums.

III. Equipment and Materials

- backhoe equipped with explosion shield, drum grapler, and 3-ft copper-beryllium (non-sparking) spike with 6-in collar (to puncture drums for sampling)
- shovels, picks, scoops
- camera, slate (or other erasable material) board
- plastic sheeting and stakes and/or sand bags to cover test pits and excavateds soil
- barricades with flashers to secure excavation
- overpack drums
- onsite drum storage area (plastic sheeting surrounded by a locking privacy fence)
- onsite decontamination pad
- bagged lime to extinguish any acid fires
- Level C personnel protection equipment and onsite site safety officer
- clean top soil or fill to "top off" test pits and return ground surface as close to the original configuration as possible
- grass seed
- for dewatering area 11 prior to test pitting:
  - liquid waste tank truck(s) equipped with pumping equipment

- backhoe for berming and ditching needed to reroute flow from seep around excavation; sand bags to fortify ditch if needed
- timber/mats to prevent heavy equipment from sinking

IV. Procedures and Guidelines

General Considerations

Test pits will be excavated around buried metal items using a backhoe. The maximum depth is expected to be 15 ft, based on the anticipated depth to top of rock. Dewatering may be necessary depending on site conditions.

The onsite crew will photograph any significant features exposed by the test pit. Photographs will include a slate board (or other marker) marked with (at a minimum) test pit number, date and time of photograph, description of feature. Other observations (including soil descriptions) will be recorded in the logbook.

Once test pitting is complete, the pits will be backfilled with the stockpiled soil. They will be topped off using clean fill/top soil and regraded to mimic the original ground surface contour. Excavated areas will be reseeded to minimize erosion.

Stage A Test Pits

1. Establish work zone according to the site safety plan.
2. Lay out plastic sheeting downwind of the test pit. This will be used for soils excavated from the test pit.
3. Using a clean backhoe (decontaminated following SOP Decontamination of Personnel and Equipment), begin excavating the area defined by the geophysical anomaly. Carefully excavate soil until the source of the anomaly is observed, recording all observations in the logbook. Remove only enough soil to quantify the need for Stage B activities at that site. This requires determining the number, size, and type of each container.
4. If buried containers are not found, Stage B activities are not needed at that site. Photograph and document any significant features, postulate a reason for the anomaly (such as presence of sheet metal), backfill the test pit, discard plastic sheeting, decontaminate the backhoe, and set up on the next location in need of Stage A investigation.
5. If buried containers are found, Stage B activities will be needed at that site. Photograph and document any significant features. Cover the soil and the excavation with plastic, securing the ends with sand bags or stakes (prevent water from running on). Erect sufficient barricades (saw horse with reflective tape or flashers) to prevent any inadvertent intrusion into the area. Decontaminate the backhoe and move to the next location in need of Stage A investigation.

Stage B Investigations Around Buried Drums

1. Set up work zones according to the site safety plan.

2. Set up an area for over-packing drums on plastic sheeting in the exclusion zone near the excavation. Based on Stage A test pits, have on hand sufficient overpack drums to contain what will be excavated from the test pit.

3. Remove plastic coverings from soil and excavation.

4. Begin cautiously excavating the soil from around the drum until it is loosed from the ground and the grappling hook (or the bucket of the backhoe, or a sling) can be used to transfer it to an overpack drum. The grappling hook is preferred because the backhoe operator can move the drum with little assistance from other personnel. Use of the backhoe requires rolling the drum and man-handling it into the overpack drum. A sling also requires man-handling of the drum.

5. Assign a number to the drum and affix the number of the test pit and the drum to the top and side of the overpack drum.

6. Collect a soil sample from the spoils pile that is representative of the soil excavated from around the drum.

7. Continue steps 4 through 6 until each drum is removed from the test pit. Backfill the excavation, discard plastic sheeting, decontaminate the backhoe, and set up on the next location in need of Stage B investigation.

8. Move the drums from the area of the test pit to the onsite drum storage area, after visible dirt has been removed from the exterior of the drums. Discard remaining plastic sheeting in drums.

9. Sample the contents of the excavated drums all at once, following SOP Sampling Contents of Tanks and Drums.

Stage B Investigations Around Buried Tanks

1. Set up work zones according to the site safety plan.

2. Remove plastic coverings from soil and excavation.

3. Begin cautiously excavating the soil from around the tank until a sampling port is exposed. Affix the number of the test pit and the tank to the top of the tank, near the sampling port.

4. Collect a sample of the contents of the tank following SOP Sampling Contents of Tanks and Drums.

5. Excavate around the tank on all sides so that up to 4 soil samples representative of the soil excavated from around the tank can be collected. "Representative" means that samples are taken from above and below the water table, each side of the tank, and in areas where contamination is evident.

6. Backfill the excavation marking tank corners and the sampling port at the ground surface with stakes. Do not regrade since the tanks will be removed at a later date. Cover the excavation with the plastic sheeting and secure with the barricades. Decontaminate the backhoe, and set up on the next location in need of Stage B investigation.

Test Pitting Beneath a Pond

To investigate the anomaly detected beneath the pond, it will be necessary to isolate the area for test pitting by berming, dewatering the bermed portion of the pond and possibly rerouting around the excavation any seeps that may feed the pond. The water in the pond will be pumped as free board and into another portion of the pond; some may be pumped into tanks and stored onsite until test pitting activities are complete. If seeps are found to feed the pond, they will also be pumped to onsite tankers, if there is sufficient flow to require containment. Otherwise, they will be rerouted around the excavation. Excavated soil will be placed on plastic near the excavations since the soil and the water will be returned to the pond once test pitting activities are completed. After dewatering is accomplished, the test pitting activities (described in previous sections) can be performed. After test pit investigations are complete, the pond water stored in the onsite tanks will also be returned to the pond.

V. Attachments

None.

VI. Key Checks and Items

VII. Noteworthy Miscellaneous Information

- plastic drums frequently contain strong acids or bases
- corrugated drums commonly contain metal-plating wastes which can have some pretty nasty sludges containing acids and cyanide
- fiberboard drums commonly contain food products and fall apart easily
- stainless steel drums are expensive (about $500 each) and indicate a sincere effort to contain its contents
- on tanks, fill ports are usually straight and vents are usually curved (to prevent moisture from dripping into tanks) so it is important to know what you are trying to use as a sampling port
- consider the location of the water table with respect to the tank; many tanks have anchors to prevent them from "floating"; these anchors include concrete slabs and vaults
- do not disturb any anchors that hold tanks down unless you have a plan for securing it afterwards
- some tanks have cathodic protection so don't be alarmed if you observe cables on tanks
- don't open valves on lower sides or bottoms of tanks

- if you suspect a tank contains leaded gasoline, remember that the metals precipitate, forming a sludge at the bottom
- waste samples are treated as high hazard samples and will need double containment (clean "paint cans") for shipping and handling
- don't add water to acids

STANDARD OPERATING PROCEDURE

Trenching for Landfill Delineation

I. Purpose

To provide reference material and general guidance on test pitting using a backhoe during landfill boundary confirmation activities.

II. Equipment and Materials

- Backhoe
- Shovels, picks, scoops
- Camera, slate (or other erasable material) board
- Plastic sheeting and stakes and/or sand bags to cover test pits and excavated soil
- Barricades to secure area around excavation
- Onsite decontamination pad
- Level D personnel protection equipment and onsite site safety officer

IV. Procedures and Guidelines

General Considerations

Test pits will be excavated along the landfill boundary as indicated by the results of the geophysical survey. The minimum trench depth is expected to be 6 ft, based on the anticipated depth to the top of the buried material.

The onsite crew will photograph any significant features exposed by the test pit. Photographs will include a slate board (or other marker) marked with (at a minimum) test pit number, date and time of photograph, description of feature. Other observations (including soil descriptions) will be recorded in the logbook.

Once test pitting is complete, the pits will be backfilled with the stockpiled soil and regraded to mimic the original ground surface contour.

Trenching Activities

1. Establish work zone according to the site safety plan.

2. Calibrate all air quality monitoring instruments.

3. Using a clean backhoe (decontaminated following SOP Decon), begin excavating perpendicular to and just outside of the area defined as the landfill boundary during the geophysical survey. Carefully excavate towards the boundary, recording all

observations in the logbook, until buried material is encountered. Remove only enough soil to identify the landfill boundary.

4. Monitor the air quality in the breathing zone at 5 minute intervals during trenching activities to ensure the proper level of respiratory protection in being worn by all field team members.

5. Photograph and document the trenching activities as appropriate. Backfill and regrade the test pit, discard plastic sheeting, decontaminate the backhoe, and set up at the next trenching location.

V. Attachments

None.

VI. Key Checks and Items

VII. Noteworthy Miscellaneous Information

STANDARD OPERATING PROCEDURE

Sampling Contents Of Tanks And Drums

I. Scope and Application

This procedure provides an overview approach and guidelines for the routine sampling of drums and tanks. Its purpose is to describe standard procedures and precautions which are applied in sampling drums and tanks. Procedures for opening drums with the individual instruments are included in Attachment D.

The samples obtained may be used to obtain physical chemical or radiological data. The resulting data may be qualitative or quantitative in nature, and are appropriate for use in preliminary surveys as well as confirmatory sampling.

II. References

A. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, U.S. Environmental Protection Agency, Washington, D.C., 1987.

B. *Data Quality Objectives for Remedial Activities - Development Process*, EPA/540/G-87/003, U.S. Environmental Protection Agency, Washington, D.C., 1987.

C. Annual Book of ASTM Standards, *Standard Recommended Practices for Sampling Industrial Chemicals*, ASTM-E-300, 1986.

D. *Test Method for Evaluating Solid Waste*, SW-846, Volume II, Field Methods, Second Edition, U.S. Environmental Protection Agency, Washington, D.C., 1982.

E. U.S. Environmental Protection Agency, *Characterization of Hazardous Waste Sites – A Method Manual: Volume II, Available Sampling Methods*, USEPA Environmental Monitoring Systems Laboratory, Las Vegas, EPA-600/4-84-076, December, 1984.

F. *Environmental Surveillance Procedures*, Quality Control Program, Martin Marietta Energy Systems, ESH/Sub/87-21706/1, Oak Ridge, TN, September 1988.

III. Summary of Methods

Drums are generally sampled by means of sampling tubes such as glass sample tubes or COLIWASA samplers. In either case, the sampling tube is manually inserted into the waste material. A sample of the drum contents is withdrawn by the sampling device upon its

removal. Should a drum contain a bottom sludge, a glass tube will retrieve a sample of this as well.

Storage tank and tank trailers, because of their greater depths, require sampling devices which can be lowered from the top, filled at a particular depth, then withdrawn. Such devices are a COLIWASA, a Kemmerer depth sampler, or a bacon bomb. Where samples of bottom sludge are desired, a gravity corer can be utilized. This heavy tube with a tapered nose piece will penetrate the sludge as it free falls through the tank.

IV. Comments

The sampling of tanks, containers, and drums present unique problems not associated with environmental samples. Containers of this sort are generally closed except for small access ports, manways, or hatches on the larger vessels, or taps and bungs on smaller drums. The physical size, shape, construction material, and location of access limit the types of equipment and methods of collection that can be used.

When liquids are contained in sealed vessels, gas vapor pressure can build up, sludges can settle out, and density layerings (stratification) can develop. Bulging drums may be under pressure and extreme caution should be exercised. The potential exists for explosive reactions or the release of noxious gases when containers are opened. All vessels should be opened with extreme caution. Check the HSP for the level of personnel protection to be worn. A preliminary sampling of any headspace gases is warranted. As a minimum, a preliminary check with an explosimeter and an organic vapor analyzer may be of aid in selecting a sampling method.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

V. Required Equipment and Apparatus

A. **Health and safety equipment/materials**: As listed in the site safely plan.

B. **Sampling equipment**: COLIWASA, glass sample tubes, Kemmerer depth sampler, Bacon bomb, gravity corer.

C. **Tools**: Rubber mallet, bung wrench, speed wrench with socket, etc., all non-sparking, paint marker.

D. **Heavy equipment**: Backhoe equipped with explosion shield, drum grapper, and 3-foot copper-beryllium (non-sparking) spike with 6-inch collar (to puncture top of drums for sampling, if necessary).

E. **Sample Containers**: As specified in the field sampling plan.

VI. Procedures

A. Drums

NOTE: DO NOT open more than one drum at a time. Each drum must be handled and sampled as a separate entity to reduce vapors in the sampling area.

1. Drums will be sampled on an area-by-area basis. Drums will be sampled after they have been placed in overpack drums but before they are transferred from the excavation to the onsite storage area.

2. Record, in logbook, all pertinent information from visual inspection of drum; i.e., physical condition, leaks, bulges, labels, etc. Label each drum with a unique identifying number.

3. If possible, stage drums for easy access.

4. If necessary, attach groundstrap to drums and grounding point.

5. Remove any standing material (water, etc.) from container top.

6. Using nonsparking tools, carefully remove the bung or lid while monitoring air quality with appropriate instruments. If necessary (and as a last resort), the nonsparking spike affixed to the backhoe can also be used to puncture the drum for sampling. See Attachment D for method of drum opening. Record air-quality monitoring results.

7. When sampling a previously sealed vessel, a check should be made for the presence of a bottom sludge. This is accomplished by measuring the depth to apparent bottom then comparing it to the known interior depth.

8. Agitation to disrupt the layers and rehomogenize the sample is physically difficult and almost always undesirable. If the vessel is greater than 3 feet in depth (say, a 55-gallon drum), the appropriate sampling method is to slowly lower the sampling device (i.e., suction line of peristaltic pump, glass tube) in known increments of length. Discrete samples can be collected from various depths, then combined or analyzed separately. If the depth of the vessel is greater than the lift capacity of the pump, an at-depth water sampler, such as the Kemmerer or Bacon Bomb type may be required.

9. Extract a representative sample from the drum using a glass rod, COLIWASA, Bacon Bomb, Kemmerer bottle, or gravity corer (See Attachments). Ensure that the entire depth of material is penetrated. Depending on the size of the opening of the drum, 3 to 4 takes should be collected from random locations across the drum surface, to ensure a representative sample. Any observed stratification must be recorded in logbook, including number and thickness of the layers and a conceptualized sketch.

10. Record a visual description of the sample; i.e., liquid, solid, color, viscosity, percent layers, etc.

11. When possible, sampling equipment (like glass tube) should be expendable and be left inside the drum for disposal with drum contents, once sampling is completed.

12. Place lid, bung, cap, etc., back in place on drum. Tighten hand tight. If necessary, the sampling port can be sealed using a cork.

13. Wipe up spilled material with lab wipes. Wipe off sample containers.

14. Mark the drum with a unique sample identification number and date using a paint marker.

15. Samples will be handled as high hazard samples. Samples will be placed in containers defined according to the analytical needs, wiped clean and then packed in paint cans for shipping. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in the field sampling plan.

B. Underground Storage Tanks

1. A sampling team of at least two people is required for sampling—one will collect samples, the other will relay required equipment and implements.

2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.

3. Do not attempt to climb down into tank. Sampling is accomplished from the top.

4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.

5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.

2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.

3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.

4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)

5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.

6. Sample each trailer compartment.

7. If compositing is necessary ship samples to laboratory in separate containers for laboratory compositing.

8. Samples will be handled has hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

D. **Refer to Attachment B for procedures for sampling with appropriate devices as follows:**

<u>Drum</u>

Glass tube	–	Procedure 1
COLIWASA	–	Procedure 2

<u>Storage Tank and Tank Trailer</u>

COLIWASA	–	Procedure 2
Bacon Bomb	–	Procedure 3
Gravity Corer (for bottom sludge)	–	Procedure 4

VII. Contamination Control

Sampling tools, instruments and equipment will be protected from sources of contamination prior to use and decontaminated after use as specified in SOP Decon. Liquids and materials from decontamination operations will be handled in accordance with the waste management plan. Sample containers will be protected from sources of contamination. Sampling personnel shall wear chemical resistant gloves when handling any samples. Gloves will be decontaminated or disposed of between samples.

VIII. Attachments

A. Collection of Liquid Containerized Wastes Using Glass Tubes

B. Sampling Containerized Wastes Using the Composite Liquid Waste Sample (COLIWASA)

C. Sampling Containerized Wastes Using the Bacon Bomb Sample

D. Gravity Corer for sampling Sludges in Large Containers

E. Construction of a Typical COLIWASA

F. Drum Opening Techniques and Equipment

IX. Field Checklist

_____ Sampling Instruments

_____ Tools

_____ Rubber Mallet

_____ Logbook

_____ Safety Glasses or Monogoggles

_____ Safety Shoes

_____ Ice/Cooler, as required

_____ Custody Seals, as required

_____ Chain-of-Custody Forms

_____ Drum Labels, as required

_____ Paint Marker, if drum sampling

_____ Black Indelible Pen

_____ Monitoring Instruments

_____ Labels

_____ Sampling and Analysis Plan

_____ Health and Safety Plan

_____ Decontamination Equipment

_____ Lab Wipes

_____ Lab Spatulas or Stainless Steel Spoons

_____ Chemical Preservatives, as required

_____ Appropriate Containers for Waste and Equipment

_____ Duct Tape

_____ Plastic Sheeting

Attachment A Collection of Liquid Containerized Wastes Using Glass Tubes

Discussion

Liquid samples from opened containers (i.e., 55-gallon drums) are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters long and 6 to 16 millimeters inside diameter. Larger diameter tubes may be used for more viscous fluids if sampling with the small diameter tube is not adequate. The tubing is broken and discarded in the container after the sample has been collected, eliminating difficult cleanup and disposal problems. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides for a quick, relatively inexpensive means of collecting concentrated containerized wastes. The major disadvantage is from potential sample loss which is especially prevalent when sampling low-viscosity fluids. Splashing can also be a problem and proper protective clothing should always be worn.

Note: A flexible tube with an aspirator attached is an alternative method to the glass tube, and allows various levels to be sampled discretely.

Procedures for Use

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 centimeters extend above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the tube with a safety-gloved thumb or a stopper.
5. Carefully remove the capped tube from the drum. If the tube has passed through more than one layer, the boundary should be apparent in the glass tube.
6. Insert the bottom uncapped end into the sample container.
7. Partially release the thumb or stopper on the top of the tube and allow the sample to slowly flow into the sample container. If separation of phases is desired, cap off tube before the bottom phase has completely emptied. It may be advisable to have an extra container for "waste," so that the fluid on either side of the phase boundary can be directed into a separate container, allowing collection of pure phase liquids in the sample containers. The liquid remaining after the boundary fluid is removed is collected in yet a third container. NOTE: It is not necessary to put phases in separate containers if analysis of separate phases is not desired.
8. Repeat steps 2 through 6 if more volume is needed to fill the sample container.

9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

1. Remove the cover from the container opening.
2. Insert glass tubing slowly almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 cm extends above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Gently push the tube towards the bottom of the drum into the sludge layer. Do not force it.
5. Cap the top of the tube with a safely-gloved thumb or stopper.
6. Carefully remove the capped tube from the drum and insert the uncapped end in the sample container.
7. Release the thumb or stopper on the top of the tube and allow the sample container to fill to approximately 90 percent of its capacity. If necessary, the sludge plug in the bottom of the tube can be dislodged with the aid of the stainless steel laboratory spatula.
8. Repeat if more volume is needed to fill sample container and recap the tube.

Note:

1. If a reaction is observed when the glass tube is inserted (violent agitation, smoke, light, etc.), the investigators should leave the area immediately.
2. If the glass tube becomes cloudy or smokey after insertion into the drum, the presence of hydrofluoric acid maybe indicated, and a comparable length of rigid plastic tubing should be used to collect the sample.
3. When a solid is encountered in a drum (either layer or bottom sludge) the optional method described above may be used to collect a core of the material, or the material may be collected with a disposable scoop attached to a length of wooden or plastic rod.

Attachment B: Sampling Containerized Wastes using the Composite Liquid Waste Sample (COLIWASA)

Discussion

The COLIWASA is a much cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside diameter) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. See Attachment E: Construction of a COLIWASA.

Uses

The COLIWASA is primarily used to sample containerized liquids. The PVC COLIWASA is reported to be able to sample most containerized liquid wastes except for those containing ketones, nitrobenzene, dimethylforamide, mesityloxide and tetrahydrofuran. A glass COLIWASA is able to handle all wastes unable to be sampled with the plastic unit except strong alkali and hydrofluoric acid solutions. Due to the unknown nature of many containerized waste, it would therefore be advisable to eliminate the use of PVC materials and use samplers composed of glass or Teflon.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult, if not impossible, to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Check to make sure the sampler is functioning properly. Adjust the locking mechanism if necessary to make sure the neoprene rubber stopper provides a tight closure.

2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

3. Slowly lower the sampler into the liquid waste. (Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample).

4. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the

closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present can be observed through the tube.

6. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

The Bacon Bomb is designed for the withdrawal of samples from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable cover provides a point of attachment for the sample line and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber o-ring acting as the plunger sealing surface. Stainless steel versions are also available. The volumemetric capacity is 8, 16, or 32 oz (237, 473, or 946 ml).

Uses

The Bacon Bomb is a heavy sampler suited best for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version would be used, or any of the samplers could be coated with Teflon.

Procedures for Use

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill for a sufficient length of time before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line, thereby accidentally opening the bottom valve.
6. Wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

A gravity corer is a metal tube with a replacement tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel and many can accept plastic liners and additional weights.

Uses

Corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples which represent the strata profile that may develop in sediments and sludges during variations in the deposition process. Depending on the density of the substrate and the weight of the corer, penetration to depths of 75 cm (30 in.) can be attained.

Exercise care when using gravity corers in vessels or lagoons that have liners, because penetration depths could exceed that of the substrate and result in damage to the liner material.

Procedures for Use

1. Attach a precleaned corer to the required length of sample line. Solid braided 5 mm (3/16 in.) nylon line is sufficient; however, 20 mm (3/4-in.) nylon is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer if necessary.

2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.

3. Allow corer to free fall through the liquid to the bottom.

4. Retrieve corer with a smooth, continuous, up-lifting motion. Do not bump corer as this may result in some sample loss.

5. Remove nosepiece from corer and slide sample out of corer into stainless steel or Teflon pan (preferred).

6. Transfer sample into appropriate sample bottle with a stainless steel lab spoon or laboratory spatula.

Attachment E: Construction of a Typical COLIWASA

The sampling tube consists of a 1.52 m (5 ft) by 4.13 cm (1-5/8 in) I.D. translucent plastic pipe, usually polyvinyl chloride (PVC) or borosilicate glass plumbing tube. The closure-locking mechanism consists of a short-length, channeled aluminum bar attached to the sampler's stopper rod by an adjustable swivel. The aluminum bar serves both as a T-handle and lock for the samplers' closure system. When the sampler is in the open position, the handle is placed in the T-position and pushed down against the locking block. This manipulation pushes out the neoprene stopper and opens at the sampling tube. In the closed position, the handle is rotated until one leg of the T is squarely perpendicular against the locking block. This tightly seats the neoprene stopper against the bottom opening of he sampling tube and positively locks the sampler in the closed position. The closure tension can be adjusted by shortening or lengthening the stopper rod by screwing it in or out of the T-handle swivel. The closure system of the sampler consists of a sharply tapered neoprene stopper attached to a 0.95 cm (3/8 in) O.D. rod, usually PVC. The upper end of the stopper rod is connected to the swivel of the aluminum T-handle. The sharply tapered neoprene stopper can be fabricated according to specifications by plastic products manufacturers at an extremely high price, or it can be made in-house by grinding down the inexpensive stopper with a shop grinder.

COLIWASA samplers are typically made out of plastic or glass. The plastic type consists of translucent plastic (usually PVC) sampling tube. The glass COLIWASA uses borosilicate glass plumbing pipe as the sampling tube and a Teflon plastic stopper rod. For purpose of multiphase sampling, clear plastic or glass is desirable in order to observe the profile of the multiphase liquid.

The sampler is assembled as follows:

a. Attach the swivel to the T-handle with the 3.18 cm (1 1/4 in) long bolt and secure with the 0.48 cm (3/16 in) National Coarse (NC) washer and lock nut.

b. Attach the PFTE stopper to one end of the stopper rod and secure with the 0.95 cm (3/8 in) washer and lock nut.

c. Install the stopper and stopper rod assembly in the sampling tube.

d. Secure the locking block sleeve on the block with glue or screw. This block can also be fashioned by shaping a solid plastic rod on a lathe to the required dimension.

e. Position the locking block on top of the sampling tube such that the sleeveless portion of the block fits inside the tube, the sleeve sits against the top end of the tube, and the upper end of the stopper rod slips though the center hole of the block.

f. Attach the upper end of the stopper rod to the swivel of the T-handle.

g. Place the sampler in the close position and adjust the tension on the stopper by screwing the T-handle in or out.

Attachment F: Drum Opening Techniques and Equipment [1]

I. Introduction

The opening of closed drums prior to sampling entails considerable risk if not done with the proper techniques, tools, and safety equipment. The potential for vapor exposure, skin exposure due to splash or spraying, or even explosion resulting from sparks produced by friction of the tools against the drum, necessitate caution when opening any closed container. Both manual drum opening and remote drum opening will be discussed in the following paragraphs. When drums are opened manually risks are greater than when opened remotely. For this reason, the remote opening of drums is advised whenever possible.

Prior to sampling, the drums should be staged to allow easy access. Also, any standing water or other material should be removed from the container top so that the representative nature of the sample is not compromised when the container is opened. There is also the possibility of encountering a water reactive substance.

II. Manual Drum Opening

A. Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium, (a non-sparking alloy formulated to reduce the likelihood of sparks). The use of bung wrenches marked "NON SPARKING" is encouraged. However, the use of a "NON SPARKING" wrench does not completely eliminate the possibility of spark being produced. Such a wrench only prevents a spark caused by wrench-to-bung friction, but it cannot prevent sparking between the threads on the drum and the bung.

A simple tool to use, the fitting on the bung wrench matching the bung to be removed is inserted into the bung and the tool is turned counterclockwise to remove the bung. Since the contents of some drums may be under pressure (especially, when the ambient temperature is high), the bung should be turned very slowly. If any hissing is heard, the person opening the drum should back off and wait for the hissing to stop. Since drums under pressure can spray out liquids when opened, the wearing of appropriate eye and skin protection in addition to respiratory protection is critical.

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[1] Taken from EPA Training Course: "Sampling for Hazardous Materials," U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Support Division, March 24, 1987.

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums). Drums with removable heads must be opened by other means.

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote pressure release method prior to using the deheader.

C. Hand Pick or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available: whereas, the spikes are generally uniquely fabricated four foot long poles with a pointed end. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used for drum opening have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, "sprayers" may result and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

III. Remote Opening

A. Backhoe Spike

The most common means used to open drums remotely for sampling is the use of metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Drums should be "staged" or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This combined with the normal sampling safety gear should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system. The hole in the drum can be sealed with a cork.

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump which pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this line and is pushed into the drum by the hydraulic pressure. The piercing device and be attached so that a hole for sampling can be made in either the side or the head/lid of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-day, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time consuming and is the major drawback of this device. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening

techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

STANDARD OPERATING PROCEDURE

Civil Surveying

I. Surveying: General

Modified third order survey procedures will be used for all surveying.

II. Records

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person talking field notes will be identified in the log. Information on weather (wind speed/wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Notes should also include instrument field I.D. number and environmental settings. Graphite pencils or waterproof ballpoint pens should be used. Erasing is not acceptable; use a single-strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Pafford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work. (Field notebooks will be available on site.)

III. Traverse Survey

Horizontal angular measurements shall be made with a 20-second or better theodolite or transit. When using a 20-second instrument the horizontal angles shall be turned 4 times, (2 each direct and inverted) with the mean of the fourth angle being within 5 seconds of the mean of the second angle. When using a 10 second or better instrument the angles shall be doubled, (once each direct and inverted) with the mean of the second angle within 5 seconds of the first angle. Minimum length of any traverse courses shall be 300 feet.

Distance measurements shall be made with a calibrated steel tape corrected for temperature and tension or a calibrated electronic distance meter (EDM). When using a EDM the parts per million (PPM), curvature and refraction corrections shall be made. Vertical angle measurements used for distance slope corrections shall be recorded to the nearest 20 seconds of arc deviation from the horizontal plane.

Horizontal traverse stations shall be established and referenced for future use. All stations shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The station shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, or iron rod and cap.

Vertical Survey

When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent bench mark. If practical, level circuits should close on a known bench mark other than the starting bench mark. The following criteria shall be met in conducting the survey:

- Instruments shall be pegged weekly or after any time it is dropped or severely jolted.
- Foresight and backsight distances shall be reasonably balanced and shall not be greater than 250 feet in length.
- No side shot shall be used as a beginning or ending point in another level loop.
- Rod readings shall be made to 0.01 foot and estimated to 0.005 feet.
- Elevations shall be adjusted and recorded to 0.01 foot.

Temporary bench marks (TBMs) shall be established and referenced for future use. All TBMs shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The TBMs shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, etc. or spikes set in the base of trees (not power poles), or tops of anchor bolts for transmission line towers, etc. (Horizontal traverse stations will not be considered as a TBM, but may be used as a permanent turning point.)

Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step One—Coordinate closures will be computed using unadjusted bearings and unadjusted field distances.
- Step Two—Coordinate positions will be adjusted (if the traverse closes within the specified limits) using the compass rule.
- Step Three—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.
- Step Four—The direction and length of the unadjusted error of closure, the ratio of error, and the method of adjustment shall be printed with the final adjusted coordinates.

Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for the circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustments.

Monitoring Well Surveys

Monitoring well locations will be surveyed only after the installation of the well casing, (with its tamper-proof locking cover), which is set in concrete. The horizontal plane survey accuracy is ±1 foot and is measured to any point on the well casing cover. The vertical plane survey must be accurate to ±0.01 foot. The following two elevations will be measured:

- Top of the outer protective casing (on the lip next to the lock hasp, not the cap).
- Ground surface (on the north side of the well).

If no notch or mark exists, the point at which the elevation was measured on the inner casing, shall be described so that water level measurements may be taken from the same location. Wells will not be opened because of health and safety concerns.

Grid Surveys

Selected soil boring locations may be located by the survey crew after the soil borings are complete. The selected borings will be staked in the field by the field team leader. The stake will be marked with the boring number for reference. The horizontal plane survey accuracy is ± 1 foot and is measured to any point on the ground surface immediately adjacent to the stake.

Exhibit A
STANDARDS FOR MODIFIED THIRD-ORDER PLANE SURVEYS

Traverse	
Max Number of bearing courses between azimuth checks	30
Astronomical bearings: standard error of results	6"
Azimuth closure at azimuth checkpoint not to exceed	20" $\sqrt{N}$
Standard error of the mean for length measurements	1 in 50,000
Position closure per loop in feet before azimuth adjustment	1:10,000
Leveling	
Levels error of closure per loop in feet	0.05 $\sqrt{M}$

N = the number of stations for carrying bearing
M = the distance in miles

STANDARD OPERATING PROCEDURE

On-Site Test Kit Sampling of Explosives

I. Purpose

This procedure describes methods and equipment used for testing HMX and RDX in environmental samples of soil or water onsite.

II. Scope

The information presented in this SOP is generally applicable to all environmental sampling of soil (Section 5.1 through 5.3) and water (Section 5.2 and 5.3). Specific sampling deviations from this SOP shall be documented and presented in the Sampling and Analysis Plan.

III. Definitions

None.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures,-where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation for procedures which deviate from these presented herein.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the specific sampling techniques and equipment to be used, and documenting these in the Sampling and Analysis Plan. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper acquisition of soil and water samples.

V. Procedures

Collecting the soil and water samples shall be accomplished in accordance with the procedures outlined in the following SOPS:

Soil Sampling
Groundwater Sampling
Geoprobe Hydropunch Groundwater Sampling
Surface Water Sampling
Sediment Sampling
Sampling Contents of Tanks and Drums

A. Soil Sample Extraction

The following procedures pertain to the extraction techniques for soil samples.

1. Inspect the TNT/RDX Soil Extraction Pac (Item No. TK-1001S-1) and the RDX Explosives Test Kit (Item No. TK-1005-1) from D TECH to determine if all sampling equipment is included.

2. Sampling of Soil

   a. Mix and break up soil in the sampling bowl so that it is a uniform sample.

   b. Remove all debris, such as sticks, stones, and leaves.

   c. Utilizing the TNT/RDX Soil Extraction Pac first, draw back the Soil Sampling Tube plunger until it stops. Push the Soil Sampling Tube into the soil several times with a twisting action to firmly pack and fill the tube. Sandy soil may require a scooping action to fill the tube.

   d. Remove excess soil from the external surface of the sampling tube and barrel end.

   e. Dispense the soil into Bottle 1 from the TNT/RDX Soil Extraction Pac by positioning the barrel into the neck of the bottle and firmly pushing the plunger. Squeezing the barrel of the Soil Sampling Tube will help expel a tightly packed sample. Extraction of TNT and RDX is more effective if the soil plug is broken into sections during the addition to Bottle 1.

   f. If the soil lodges in the neck of the bottle, use the sampling tube to push it into the bottle. If soil adheres to the threads of the bottle neck and cap, wipe clean before placing cap on bottle to limit the loss of volatile compounds.

3. Cap the bottle tightly.

4. Extraction from Soil

   a. Mix the soil and liquid in Bottle 1 by shaking continuously over a 3 minute period.

b. Allow the soil to settle for approximately 1 minute. Some soils will settle more slowly than others.

5. Diluting the Extraction Solution

a. Remove cap from Bottle 2 from the TNT/RDX Soil Extraction Pac.

b. Place an unused tip on the pipette from the TNT/RDX Soil Extraction Pac.

c. Fully depress the plunger of the pipette before placing it into the bottle. With the plunger fully depressed, place the pipette tip into the liquid layer of Bottle 1 and slowly release the plunger.

d. Dispense the contents of the pipette tip into Bottle 2 by placing the pipette tip into the liquid and depressing the plunger.

e. Mix Bottle 2 thoroughly. Replace the cap tightly on Bottle 1 and return it to the tray. Place the used pipette tip on the right side tray compartment of the TNT/RDX Soil Extraction Pac.

B. Testing Procedures for Soil and Water Samples

1. Choose the corresponding sample source to determine the next step. All of the following steps will utilize the RDX Explosives Test Kit.

a. Water: Using a new calibrated pipette, transfer 1 ml of sample to Bottle A. Snap filter tip on Bottle A. Gently mix.

b. Soil: Using a new calibrated pipette, transfer 1 ml of Bottle 2 solution from the TNT/RDX Soil Extraction Pac to Bottle A. Snap filter tip on Bottle A. Gently mix. Re-cap Bottle 2 and set aside.

2. Mixing Procedures

a. Squeeze Bottle A filling the RDX vial to a level between the two lines (approximately 13 to 14 drops). Gently mix.

b. Squeeze the contents of Reagent C (white cap) to fill the RDX Reference vial to a level between the two lines. Gently mix.

c. After 5 minutes, pour the contents of RDX vial onto the T (test) side of the cup assembly. Pour the contents of the Reference vial onto the R side of the cup assembly. Allow the liquid to drain completely through on both sides.

d. Add approximately 8 to 12 drops of Reagent D solution (yellow cap) into each side of the cup assembly. Drain completely.

e. Add approximately 5 drops of Reagent E solution (blue cap) to each side of the cup assembly. Be sure to add this solution immediately to the second well after addition to the first well. Drain completely.

f. Read results when color of R (left) side of the cup assembly matches the color of the reference bar of the Color Card. (The color development time is approximately 10 minutes at 70 degrees Fahrenheit. More time is required at lower temperatures and less time is required at higher temperatures.) Match the color on the T side of the cup assembly to the Color Card.

3. Record result on a cup assembly label and apply to the cup. Record this result in the logbook.

Note: To preserve the color for up to 4 hours (optional), add approximately 8 drops of Reagent F solution (red cap) into each side of the cup assembly. Drain completely.

C. Sample Dilution

RDX concentrations greater than the upper limit of the test may be determined by diluting the extract from a 100 ppm soil sample, processed using the TNT/RDX Soil Extraction Pac, may be diluted 1:25 in acetone and run in the RDX Explosives Test Kit. The concentration of the undiluted sample (100 ppm) is determined by multiplying the RDX concentration of the diluted sample (4.0 ppm) by the dilution factor (25).

VI. Quality Assurance Records

The description of the sampling event and the resultant concentration readings in the field logbook shall serve as a quality assurance record. Other records include the chain-of-custody and sample analysis request forms for the confirmatory sampling.

7.0 References

1. DTECH™, 1993. "TNT/RDX Soil Extraction Pac Instruction Guide," DTECH™ Environmental Detection Systems, TK-1001S-1.

2. DTECH™, 1993. "RDX Explosives Test Kit Instruction Guide," DTECH™ Environmental Detection Systems, TK-1005-1.

For further information about the above test kits contact:

EM Science
480 South Democrat Road
Gibbstown, NJ 08027-1297
1-800-222-0342

STANDARD OPERATING PROCEDURE

Evaluation of Surface Radiation Contamination

I. Purpose

This procedure describes the methods of surveying equipment or materials for release to unrestricted use from work sites.

II. Scope

This procedure applies to work sites and to materials, equipment, etc., that are subject to release for unrestricted use.

III. References

U.S. Department of Energy (DOE) Order 5480.11, Radiation Protection of Occupational Workers, Attachment 2, *Surface Radioactivity Guides*

CH2M HILL Radiation Safety Manual, November 1989

CH2M HILL Radiation Protection SOP Fixed and Removable Contamination Surveys, November 1, 1989

IV. Equipment and Materials

Alpha Scintillation Detector (Eberline AC-3 or equivalent)

Pancake-Geometry Beta-Gamma Detector (Eberline HP-210, HP-260, or equivalent)

Portable Ratemeter/Scaler (Eberline PRS-1 or equivalent)

Scintillation Alpha Counter (Eberline SAC-4 or equivalent)

Equipment and Materials Release Form 7.1

Cloth swipes and envelopes (NuCon smears or equivalent)

V. Instructions

A. Release of Items for Unrestricted Use

Both direct and transferable surveys shall be made on equipment, materials, or vehicles that are to be released for work sites for unrestricted use. This shall include any item that has entered a Controlled Area or items that may have come in direct contact with contamination. The potential for objects to have become contaminated by airborne dust particles must also be considered. The potential for contamination should be considered prior to any release of equipment or materials.

All items to be released shall be surveyed in such a manner as to fully demonstrate that external and internal areas (of items being released) comply with surface contamination limits specified in Table 1 of this procedure.

The Site Safety Coordinator (SSC) shall review survey data and inspect items prior to release.

In the event the SSC has any question about internal contamination potentials, this item shall not be released until a complete review of pertinent information has been completed by the health physics technician. Upon completion of this review, determinations of equipment release requirements will be quickly resolved and the Radiation Health Manager (RHM) shall be advised.

Release limits specified in NRC Regulatory Guide 1.86 are shown in Table 1. CH2M HILL release criteria are shown in Table 2.

When items to be released have met the release limits specified in Table 2, the SSC shall sign the release form. Items released shall have a completed and signed copy of Form 7.1 attached to its exterior surface. No item shall be considered releasable without this form attached. Vehicles are not required to have this form attached unless the vehicle is to remain at the site for later removal.

Any large item to be released that does not have a copy of Form 7.1 attached shall be considered potentially contaminated and will require a release survey. Small items (hand tools, etc.) that are to be released may be placed in a clean carton or box with a copy of Form 7.1 attached to the container prior to release. Small items that are to be released to individuals do not require the attached form if such items are immediately removed from the site after the release surveys.

B. Surface Measurements

Perform a direct surface contamination survey initially to determine the gross amount of activity on the item surveyed. See SOP Fixed and Removable Contamination Surveys.

Surfaces must be dry for effective alpha contamination monitoring.

Vehicles hauling contaminated materials in their contained truck beds need only the exterior portions of the vehicle surveyed until they are released from the project.

C. Direct Surface Contamination Survey

Beta/Gamma Measurement

1. Pass the Geiger-Mueller (GM) detector about 1 cm from the surface or item to be surveyed.
2. Scan the item, covering the potentially contaminated areas, at the rate of 1 to 2 cm per second.
3. Record and identify all locations surveyed. If practical, sketch the item and identify the measurement locations on the sketch.
4. All measurements shall be reported in units of dpm per 100 cm2.

Direct Alpha Measurements

1. Place the alpha scintillation detector on or near the surface to be surveyed.
2. Scan the item using the fixed point measurement technique and allowing 30 sec per measurement.
3. Record and identify locations surveyed using a sketch, if practical.
4. All measurements shall be reported in units of dpm per 100 cm2.

Evaluation of Direct Measurements

If the activity for either alpha or beta/gamma is greater than the criteria for direct surface contamination, then the item should be considered for decontamination.

D. Transferrable Surface Contamination Survey

Transferrable Surface Contamination Surveys are described in SOP Fixed and Removable Contamination Surveys.

Counting Transferrable Contamination Smears

Additional instructions for counting smear samples are provided in SOP Fixed and Removable Contamination Surveys.

1. Gross Alpha Counting
   - Using the scintillation alpha counter, count each smear for 1.0 min.
   - Record the results on the survey form.
   - Compute the dpm/100 cm^2.
   -
2. Gross Beta/Gamma Counting
   - Using the gross beta/gamma counting system, count each smear for 1.0 min.
   - Record the results on the survey form.
   - Compute the dpm/100 cm^2.

3. Quality Control

- Take one duplicate smear for every 20 smears obtained.
- The duplicate reading will be recorded on the same survey form with the original measurement and identified as a duplicate reading (D).

Table 1
NRC Regulatory Guide 1.86
Surface Radioactivity Contamination Limits
for Release for Unrestricted Use

Nuclide[a]	Average[bc]	Maximum[bd]	Removable[be]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d]The maximum contamination level applies to an area of not more than 100 cm^2.

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Table 2 CH2M HILL Surface Radioactivity Action Levels* for Unrestricted Release of Equipment and Materials			
Direct Survey-DPM/100 cm^2		Transferable Survey-DPM/100 cm^2	
Alpha	Beta-Gamma	Alpha	Beta-Gamma
300	1,000	20	200
*No 100 cm^2 area greater than this value.			

STANDARD OPERATING PROCEDURE

Fish Community Sampling Using Electroshocking Method

I. Purpose

To provide a general guideline for conducting fish community surveys using electroshocking equipment.

II. Scope

A standard fish survey method is provided using electroshocking methods. Site-specific details are discussed in related sections of the field sampling plan.

III. Equipment and Materials

- Field log book
- Data sheets
- Backpack electroshocker
- Boat-mounted electroshocker
- Seines
- Hip boots or chest waders
- Outer and inner rubber gloves
- Plastic bottles or containers
- Measuring board
- Cooler/Ice
- Water buckets
- Site Health and Safety Plan
- Instrument operation manuals
- Gasoline
- Formalin solution
- Waterproof labels
- Fish taxonomy keys

IV. Procedures and Guidelines

1. Fish in ponds should be collected with a boat-mounted electrofishing unit.
2. Fish in wetlands and stream habitat should be collected with a backpack electrofishing unit.
3. Sample intervals to be conducted at sample station should consist of approximately 30 minutes of shocking time or until no new fish species are

collected in 10 minutes of shocking. Actual shocking time is to be recorded for each sample.

4. Fish will be collected with a long-handled dip net and placed in to a live tank or bucket.

5. Information on species, size class, location and physical condition will be recorded for each fish captured. Any physical abnormalities will be noted.

6. As soon as possible after captured measurement fish specimens will be returned to the water.

7. As necessary, selected fish will be retained and stored frozen for taxonomic verification and documentation of physical abnormalities.

8. Sampling equipment including the fish measuring board will be cleaned and rinsed between each sample station.

9. Sample stations will be mapped and information on habitat condition of each sample station will be recorded including water depth, substrate type, shoreline profile or vegetation and degree of shading.

10. Photographs of sample stations in ponds, wetlands and creek habitats should be taken to supplement written descriptions.

V. Attachments

None

VI. Key Checks and Items

- Follow recommended safety precautions in operating the fish electroshocking equipment.
- Clean sample equipment between sample stations.

STANDARD OPERATING PROCEDURE

Fish Population Sampling Using Seining Procedures

1.0 Purpose

The purpose of this SOP is to provide general reference information and technical guidance on the procedure to sample and characterize fish communities using seining procedures. The collected samples provide information used in the determination of population statistics of the fish community and can be used to collect fish samples for chemical analysis of tissues. This information will be used in the assessment of risks to human health and the environment.

2.0 Scope

This guideline provides information on proper sampling equipment and techniques for the collection of fish in shallow streams, ponds, and nearshore areas of lakes, impoundments, bays, estuaries, and ocean shoreline. This technique is more suited for use in smoothbottomed, low-sloped areas.

This procedure is not very effective when the seine is pulled over weeds and other obstructions as they may tend to roll up, and allow the fish to pass under the seine.

Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The technique described should be followed whenever applicable, noting that site-specific conditions or project-specific plans may require adjustments in methods.

3.0 Definitions

Abiotic	Non-biological components of the environment, including water body structure and
natural	or manmade disturbances.
Biotic	Biological components of the environment, including organisms and vegetation.
Bow	The front of the boat.
Reach	The designated portion of a stream or river.
Riffles	A stretch of water flowing over, rocks, debris, or shallow sediments causing a disturbance of the water.
Riparian	Along the bank of a river or lake.

Runs	A stretch of water flowing without any disturbances.
Stern	The back of the boat.

4.0 Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures that deviate from those presented herein.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the specific sampling techniques and equipment to be used, and documenting these in the Sampling and Analysis Plan. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sample Personnel - It is the responsibility of the field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager.

5.0 Procedures

The primary considerations for collecting fish for population studies include identifying sampling locations, proper sampling techniques for the haul seine and proper documentation of samples. Detailed procedures for conducting fish populations utilizing the haul seine are described in the sections to follow.

5.1 Equipment

The following list is an example of the type of equipment that generally must be on hand when collecting fish samples with a haul seine:

Seine

- Fish Measuring Board
- 0-16 oz scale, 1-4 lb scale, 1-15 lb scale
- Appropriate sampling keys for species to be sampled, and any required instruments to aid in the identification
- Live Well (large tub) with overflow pipe to outside of boat
- Field sampling data sheets
- Glass jars for storage of fish
- Formalinl"
- Black Permanent Marker
- Camera
- Required Personal Protective Equipment
- Portable Air Pumps

5.2 Preliminary Activities

Apply for and receive applicable scientific collection permits as required by the state. Contact local fish or game officials and inform them of your activities.

Collect and determine all information pertinent to the fish sampling project, including water depth, station locations, nearby boat access locations, known sediment contamination, any waterway obstructions or inconsistencies (e.g. shallow or grassy areas, low structures, pipe crossings), any other biological studies previously conducted on or near the site, species used locally for human consumption and the degree of such consumption, species most likely present, and the most appropriate sampling method for the species of interest that is permitted by law.

Before sampling occurs, conduct a site reconnaissance using a site map. The objective of this exercise is to categorize habitats, and map dividing lines and descriptors identifying the various types of habitats available. Make notations on the map depicting the "abiotic" characteristics of the reach including features such as pools, riffles, runs, substrate, water depth, channel shape, degree of bank erosion, tidal variations shade/sun exposure, and relative current velocity and direction. Also make notations on the site map to show "biotic" characteristics of the reach including fish species observed, evidence of fisherman use, and aquatic and riparian vegetation including wetlands. In addition, identify station locations at this point, along with the total area to be sampled. Choose the station locations, where possible, to represent ecologically similar aquatic environments.

Ensure adequate number of sample collection jars and volume of FormalinO for entire trip.

Set up a continuous flow through water system using the live wells and the pumps. Place the overflow pipes about five inches from the top of the well. Attach a mesh/screen over the inlet of the overflow pipe to prevent loss of small fish species.

5.3 Operating Procedure

Determine the area to be sampled, and mark it with flagging, if possible. Stretch the seine across the area to be sampled, with a minimum of one field personnel on either side of the seine. Ensure that the weighted side of the seine is at the bottom. Best results are achieved when the water level is no deeper than two thirds the height of the slack net.

Rapidly walk through the water at the same speed, while keeping a constant distance apart. If sampling in a stream, walk upstream against the current. As the end of the sampling area approaches, Pull the seine rapidly toward the shore, and lift the weighted end out of the water. Place the collected fish into the live wells.

If other field personnel are present, have them walk towards the seine to chase the fish in that direction. In addition, have them help to lift the seine when the sampling effort is complete.

Conduct sampling in areas that will ensure adequate qualitative and/or quantitative representation of the fish community, whichever is necessary. These areas should

include riffles/runs, shorelines, snags, natural fish holding areas, vegetation beds and other habitats.

At the end of a sampling reach, identify, measure, weigh and release the specimens. Record the proportion of individuals as hybrids and the proportion of individuals with disease, tumors, fin damage, skeletal anomalies, and any other pertinent information on a field data sheet.

At a minimal, preserve one representative fish from each species in 10% Formaline, as a voucher specimen. Record the station location, date sampled, and species name on the label.

6.0 Quality Assurance Records

Quality Assurance records will be maintained for each sample that is collected. The following information will be recorded in the Field Logbook:

- Sample identification (site name, location, project no.; sample name/number and location; sample type and matrix; time and date; sampler's identity).
- Field observations and measurements (sample setting, appearance of substrate, sampling method, and photograph descriptions).
- Additional remarks, as appropriate.

Record all observations in the Field Logbook as described in SOP F202. Complete field sheets for the collected samples.

7.0 References

Brower, 1977. James E. Brower and H. Jerrold Zar. *Field and Laboratory Methods for General Ecology*. Wm. C. Brown Company Publishers. 1977.

Ricker, 1971. Ricker, W.E. *Methods for Assessment of Fish Production in Fresh Waters*. International Biological Programme Handbook No. 3. 1971.

U.S. EPA, 1987. U.S. Environmental Protection Agency. *A Compendium of Superfund Field Operations Methods*. Office of Emergency and Remedial Response, Office of Waste Programs Enforcement. December 1987.

U.S. EPA, 1989. Warren-Hicks, William, Parkhurst, Benjamin R., Baker, Samuel S. Jr. *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference*. U.S. EPA, Environmental Research Laboratory, Corvallis, OR 97333. March 1989.

STANDARD OPERATING PROCEDURE

Fish Population Sampling Using Gill Net Procedures

I. Purpose

The purpose of this SOP is to provide general reference information and technical guidance on the procedure to sample and characterize fish communities using gill net procedures. The collected samples provide information used in the determination of population statistics of the fish community and can be used to collect fish samples for chemical analysis of tissues. This information will be used in the assessment of risks to human health and the environment.

II. Scope

This guideline provides information on proper sampling equipment and techniques for the collection of fish in streams, ponds, and nearshore areas of lakes, impoundments, bays, and estuaries, and the ocean shoreline. This technique is most effective in slow moving streams and rivers, and open areas in lakes and impoundments. Swift moving water bodies tend to tangle the nets.

Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The technique described should be followed whenever applicable, noting that site-specific conditions or project-specific plans may require adjustments in methods.

III. Definitions

Abiotic	Non-biological components of the environment, including water body structure and natural or manmade disturbances.
Bow	The front of a boat.
Biotic	Biological components of the environment, including organisms and vegetation.
Reach	The designated portion of a stream or river.
Riffles	A stretch of water flowing over, rocks, debris, or shallow sediments causing a disturbance of the water.
Riparian	Along the bank of a river or lake.
Stern	The back of a boat.
Runs	A stretch of water flowing without any disturbances.

IV. Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures that deviate from those presented herein.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the specific sampling techniques and equipment to be used, and documenting these in the Sampling and Analysis Plan. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager.

V. Procedures

The primary consideration for collecting fish using gill nets is identifying sampling locations where there is a steady traffic of fish. Accurate and timely deployment and retrieval of the gill nets is a key variable in the success of the fish collection effort. Detailed procedures for conducting fish populations utilizing gill nets are described in the sections to follow.

A. Equipment

The following list is an example of the type of equipment that generally must be on hand when collecting fish samples with gill net:

- Sampling boat
- Gill nets (the size mesh is dependent on the size fish desired for collection)
- Flotation and weights to properly set the nets
- Fish Measuring Board
- 0-16 oz scale, 1-4 lb scale, 1-15 lb scale
- Live Well (large tub) with overflow pipe to outside of boat
- Appropriate sampling keys for species to be sampled, and any required instruments to aid in the identification
- Field sampling data sheets
- Glass jars for storage of fish
- Formalin
- Black Permanent Marker
- Camera
- Required Personal Protective Equipment
- Portable Air Pumps
- Field log book
- Fish scale envelopes

- Tweezers
- Additional line and couplings
- Tools (pliers, variable wrench, hammer)

B. Preliminary Activities

Apply-for- and receive applicable scientific collection permits as required by the state. Contact local fish or game officials and inform them of your activities.

Collect and determine all information pertinent to the fish sampling project, including water depth, station locations, nearby boat access locations, known sediment contamination, tidal variation, any waterway obstructions or inconsistencies (e.g. shallow or grassy areas, low structures, pipe crossings), any other biological studies previously conducted on or near the site, species used locally for human consumption and the degree of such consumption species most likely present, and the most appropriate sampling method for the species of interest that is permitted by law.

Before sampling occurs, conduct a site reconnaissance using a site map. The objective of this exercise is to categorize habitats, and map dividing lines and descriptors identifying the various types of habitats available. Make notations on the map depicting the "abiotic" characteristics of the reach including features such as pools, riffles, runs, substrate, water depth, channel shape, degree of bank erosion, shade/sun exposure, and relative current velocity and direction. Also make notations on the site map to show "biotic" characteristics of the reach including fish species observed, evidence of fisherman use, and aquatic and riparian vegetation including wetlands. In addition, identify station locations at this point, along with the total area to be sampled. Choose the station locations, where possible, to represent ecologically similar aquatic environments.

Ensure adequate number of sample collection jars and volume of Formalin for entire trip.

Set up a continuous flow through water system using the live wells and the pumps. Place the overflow pipes about five inches from the top of the well. Attach a mesh/screen over the inlet of the overflow pipe to prevent loss of small fish species.

C. Operating Procedure

Determine the area to be sampled, and mark it with flagging, if possible. Field personnel that are setting the net should be standing on the platform on the bow of the boat. Place one end of the gill net with a weight attached to the bottom and a buoy attached to the top into the water, stretch the gill net (do not leave slack) across the area to be sampled by pulling it along with the boat. If there is a discernible flow, the net will be set in the upstream direction.

The net should remain in the sample location for 8 to 12 hours before retrieving. Field personnel that are collecting the fish should be standing on the platform on the bow of the boat. The net should be pulled slowly from the water and the collected fish removed as the net is being removed from the water. Place the collected fish into the live wells.

Conduct sampling in areas that will ensure adequate qualitative and/or quantitative representation of the fish community, whichever is necessary. These areas should include riffles/runs, shorelines, snags, natural fish holding areas, vegetation beds and other habitats.

Upon retrieval of a gill net, identify, measure, weigh and release the specimens. Collect fish scales for aging. Record the proportion of individuals as hybrids and the proportion of individuals with disease, tumors, fm damage, skeletal anomalies, and any other pertinent information on a field data sheet.

To the extent possible, process all species in the field and return them to the stream alive. If specimens present taxonomic difficulties, or are too numerous for effective field processing, preserve them in 10% Formalin, and transport them to the office or lab for taxonomic work and measurements.

At a minimum, preserve one representative fish from each species in 10% Formalin as a voucher specimen. Record the station location, date sampled, and species name on the label.

VI. Quality Assurance Records

Quality assurance records will be maintained for each sample that is collected. The following information will be recorded in the field logbook:

- Sample identification (site name, location, project no.; sample name/number and location; sample type and matrix; time and date; sampler's identity).
- Field observations and measurements (sample setting, appearance of substrate, sampling method, and photograph descriptions).
- Additional remarks, as appropriate.

Record all observations in the field logbook. Complete field sheets for the collected samples.

VII. References

Brower, 1977. James E. Brower and H. Jerrold Zar. *Field and Laboratory Methods for General Ecology*. Wm. C. Brown Company Publishers. 1977.

Ricker, 1971. Ricker, W.E. *Methods for Assessment of Fish Production in Fresh Waters*, International Biological Programme Handbook No. 3. 1971.

U.S. EPA, 1987. U.S. Environmental Protection Agency. *A Compendium of Superfund Field Operations Methods*. Office of Emergency and Remedial Response, Office of Waste Programs Enforcement. December 1987.

U.S. EPA, 1989. Warren-Hicks, William, Parkhurst, Benjamin R., Baker, Samuel S. Jr. *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference*. U.S. EPA, Environmental Research Laboratory, Corvallis, OR 97333. March 1989.

STANDARD OPERATING PROCEDURE

Qualitative Terrestrial Vegetation Sampling

I. Purpose

To provide a general guideline for conducting a qualitative terrestrial plant community survey.

II. Scope

A standard terrestrial plant community survey method is provided. Site-specific details are discussed in related sections of the field sampling plan.

III. Equipment and Materials

- Topographic and site area maps
- Aerial photographs
- Compass
- Data sheets
- Hand lens
- Field guides or keys
- Species list, if available
- DBH (diameter at breast height) tape
- Tape measure
- Appropriate safety equipment
- Camera
- Site Health and Safety Plan
- Field log book

IV. Procedures and Guidelines

1. Subjectively select a representative sample point within each major plant community of the site. These points may be located along preestablished transects or simply by initially cruising the site area. Selected sample points should be no closer than 50 ft. from the nearest perceptible change in the plant community.

2. Establish an appropriate size sample plot. In forested areas a sample plot of approximately 30 ft in radius will be sufficient. Other size plots may be used depending on characteristics of the community being sampled.

3. Identify the dominant species in each strata or size class as follows:

   Trees - >10 cm dbh and >20 ft tall.

   Saplings - <10 cm dbh and >20 ft tall.

   Shrubs - <20 ft. tall.

   Herbaceous plants - nonwoody plants and ground covers.

4. Estimate the percent areal cover of saplings, shrubs, and herbaceous plants at each sample point. Determine the dbh of tree species.

5. Record information on prepared data sheets and plot the location of the sample point on a map of the site.

6. Record any signs of plant stress or other effects of possible contaminants such as wilting, discoloration, abnormal growth form or shape.

7. Photograph major plant community types and any observed signs of plant stress.

V. Attachments

None.

VI. Key Checks and Items

- Record signs of plant stress or other effects of possible site contaminants on vegetation.
- Have appropriate keys and field guides for plant identification.

STANDARD OPERATING PROCEDURE

Qualitative Mammalian Species Survey

I. Purpose

To provide a general guideline for conducting a qualitative mammal community survey.

II. Scope

A standard procedure for conducting a qualitative terrestrial mammal community survey. Site specific details are discussed in related sections of the SAP.

III. Equipment and Materials

- Topographic and site area maps
- Aerial photographs
- Compass
- Data sheets
- Hand lens
- Field guides or keys
- Species list, if available
- Appropriate safety equipment
- Camera
- Binoculars
- Site Health and Safety Plan
- Field log book

IV. Procedures and Guidelines

1. Proceed along a series of preestablished sample transects over the site, being sure to include every major plant community or habitat type.

2. Search additional areas or locations that may provide areas of mammal concentration or opportunities for observation of mammal signs such as tracks.

3. Record direct observations of mammals and any signs of mammal activity on the site including but not limited to the following:

   Tracks or foot prints

   Scats, droppings or other fecal material

   Burrows or holes in stream banks, hill sides or den trees

Leave, grass, or stick nests on the ground or in trees

Ridges, mounds, or tunnels in the ground or in vegetation

Trails or runways through the study area

Signs of grazing, browsing, rubbing, or clawing on trees, shrubs, or other vegetation

4. Photograph representative signs of mammal activity and plot the location of nests, burrow, etc., on a map of the site.

V. Attachments

None

VI. Key Checks and Items

- Look for mammal signs on the ground, in trees and other vegetation, and along wetlands and water bodies.

STANDARD OPERATING PROCEDURE

Qualitative Herpetofauna Community Survey

I. Purpose

To provide a general guideline for conducting a qualitative herpetofauna community survey.

II. Scope

A standard procedure for conducting a qualitative herpetofauna survey. Site-specific details are discussed in the SAP.

III. Equipment and Materials

- Topographic and site area maps
- Aerial photographs
- Compass
- Data sheet
- Hand trowel, hand rake, or other tool to over turn rocks and logs
- Hand lens
- Field guides or keys
- Species list, if available
- Appropriate safety equipment
- Camera
- Portable tape player and prerecorded tape recording of regional herpetofauna vocalizations
- Site Health and Safety Plan

IV. Procedures and Guidelines

1. Proceed along a series of preestablished transects over the site. Be sure transects occur within each major plant community or habitat on the site.
2. Search areas that provide specific habitats and/or opportunities for reptile and amphibian observations such as wetlands, stream banks, and pond

borders.

3. Search for herpetofauna by overturning rocks, logs, and other objects, being sure to carefully replace the objects.

4. Record direct observations of amphibians and reptiles including their sign such tracks, burrows, tunnels, etc.

5. Record observations on premade data sheets and plot significant sittings on maps of the site.

6. Schedule special observation periods following precipitation events and at evening hours to record herpetofauna vocalizations.

V. Attachments

None

VI. Key Checks and Items

- Possess appropriate field guides and keys.
- Record herpetofauna vocalizations.

STANDARD OPERATING PROCEDURE

Avian Community Survey

I. Purpose

To provide a general guideline for conducting a qualitative avian species community survey.

II. Scope

A standard avian community sampling procedure is provided. Site specific details are discussed in related sections of the SAP.

III. Equipment and Materials

- Topographic and site area maps
- Aerial photographs
- Binoculars
- Data sheets
- Species code list
- Compass
- Field guides or keys
- Species list, if available
- Appropriate safety equipment
- Camera
- Site Health and Safety Plan
- Field log book

IV. Procedures and Guidelines

1. Conduct avian surveys at preestablished sample points over the site. Sample points should be located in each major plant community or habitat type of the survey area and should be far enough apart to avoid counting the same birds twice.

2. Record all birds heard or seen from the sample point for a period of approximately 20 minutes. Shorter time intervals may be used under some circumstances.

3. Scan for birds at all levels of vegetation and take care not to record the same bird more than once.

4. Record the species, number, sex, and age if possible for all birds observed. If birds occur in flocks to large to be counted estimate the number of birds by

counting the number of birds in a portion of the group and estimating the number of portions in the entire flock.

5. Record the activity, habitat, and type of observation (i.e., seen, heard, or both) using the codes on the data sheet.

6. Birds flying over the site but not actually landing within a specific habitat type should be recorded as "fly overs." If, however, a bird flies through an area and never lands, but the observer feels it is using the particular habitat type, then record that type.

7. Record bird species using the appropriate AOU four letter code. Unidentifiable birds should be recorded with an "unknown code."

8. Surveys should be conducted between daybreak and 9:30 a.m., if possible. Surveys should not be conducted in high winds, heavy rains, or heavy fog. Weather conditions at the time of survey should be recorded on the data sheets.

9. Record other signs of bird use of the site such as stick nests, nest or roost cavities, droppings or pellets, tracks, and signs of foraging.

V. Attachments

- Standard abbreviations for common names of birds.

VI. Key Checks and Items

- Avoid counting the same bird more than once.
- Record all birds even those that cannot be identified accurately
- Record signs of bird use of the site such as nests in trees and cavities, droppings or pellets, and tracks.

STANDARD ABBREVIATIONS FOR COMMON NAMES OF BIRDS

LOONS

1	COLO	'Common Loon'	(Gavia immer)
2	YBLO	'Yellow-billed Loon'	(Gavia adamsii)
3	ARLO	'Arctic Loon'	(Gavia arctica)
4	RTLO	'Red-throated Loon'	(Gavia stellata)

GREBES

5	RNGR	'Red-necked Grebe'	(Podiceps grisegena)
6	HOGR	'Horned Grebe'	(Podiceps auritus)
7	EAGR	'Eared Grebe'	(Podiceps nigricollis)
8	LEGR	'Least Grebe'	(Tachybaptus dominicus)
9	WEGR	'Western Grebe'	(Aechmorphorus occidentalis)
10	PBGR	'Pied-billed Grebe'	(Podilymbus podiceps)
	UNGR	'Unidentified Grebe'	

ALBATROSSES

11	BFAL	'Black-footed Albatross'	(Diomedea nigripes)
12	LAAL	'Laysan Albatross'	(Diomedea immutabilis)

SHEARWATERS

13	NOFU	'Northern Fulmar'	(Fulmarus glacialis)
14	GRSH	'Greater Shearwater'	(Puffinus gravis)
15	SOSH	'Sooty Shearwater'	(Puffinus griseus)
16	MASH	'Manx Shearwater'	(Puffinus puffinus)
17	COSH	'Cory's Shearwater'	(Calonectris diomedea)
18	PFSH	'Pink-footed Shearwater'	(Puffinus creatopus)
19	STSH	'Short-tailed Shearwater'	(Puffinus tenuirostris)
20	BLSH	'Buller's Shearwater'	(Puffinus bulleri)
21	AUSH	'Audubon's Shearwater'	(Puffinus lherminieri)
22	BEPE	'Bermuda Petrel'	(Pterodroma cahow)
23	BOPE	'Bonin Petrel'	(Pterodroma hypoleuca)

STORM-PETRELS

24	FTSP	'Fork-tailed Storm-Petrel'	(Oceanodroma furcata)
25	LSPE	'Leach's Storm-Petrel'	(Oceanodroma leucorhoa)
26	ASPE	'Ashy Storm-Petrel'	(Oceanodroma homochroa)
27	BSPE	'Black Storm-Petrel'	(Oceanodroma melania)
28	LTPE	'Least Storm-Petrel'	(Oceanodroma microsoma)
29	WSPE	'Wilson's Storm-Petrel'	(Oceanites oceanicus)

TROPICBIRDS

30	RBTR	'Red-billed Tropicbird'	(Phaethon aethereus)
31	WTTR	'White-tailed Tropicbird'	(Phaethon lepturus)
32	RTTR	'Red-tailed Tropicbird'	(Phaethon rubricauda)

PELICANS

33	AWPE	'American White Pelican'	(Pelecanus erythrorhynchos)
34	BRPE	'Brown Pelican'	(Pelecanus occidentalis)

BOOBIES, GANNETS

35	MABO	'Masked Booby'	(Sula dactylatra)
36	BLBO	'Blue-footed Booby'	(Sula nebouxii)
37	BRBO	'Brown Booby'	(Sula leucogaster)
38	RFBO	'Red-footed Booby'	(Sula sula)
39	NOGA	'Northern Gannet'	(Sula bassanus)

CORMORANTS

40	GRCO	'Great Cormorant'	(Phalacrocorax carbo)
41	DCCO	'Double-crested Cormorant'	(Phalacrocorax auritus)
42	OLCO	'Olivaceous Cormorant'	(Phalacrocorax olivaceus)
43	BNCO	'Brandt's Cormorant'	(Phalacrocorax penicillatus)
44	PECO	'Pelagic Cormorant'	(Phalacrocorax pelagicus)
45	RFCO	'Red-faced Cormorant'	(Phalacrocorax urile)

ANHINGAS

46	ANHI	'Anhinga'	(Anhinga anhinga)

FRIGATEBIRDS

47	MAFR	'Magnificent Frigatebird'	(Fregata magnificens)
48	GRFR	'Great Frigatebird'	(Fregata minor)
49	LEFR	'Lesser Frigatebird'	(Fregata ariel)

HERONS

50	GBHE	'Great Blue Heron'	(Ardea herodias)
51	GRHE	'Green-backed Heron'	(Butorides striatus)
52	LBHE	'Little Blue Heron'	(Egretta caerulea)
53	CAEG	'Cattle Egret'	(Bubulous ibis)
54	REEG	'Reddish Egret'	(Egretta rufescens)
55	GREG	'Great Egret'	(Casmerodius albus)
56	SNEG	'Snowy Egret'	(Egretta thula)
57	TRHE	'Tricolored Heron'	(Egretta tricolor)
58	BCNH	'Black-Crowned Night Heron'	(Nycticorax nycticorax)
59	YCNH	'Yellow-Crowned Night Heron'	(Nycticorax violaceus)
60	LEBI	'Least Bittern'	(Ixobrychus exilis)
61	AMBI	'American Bittern'	(Botaurus lentiginosus)
	UNHE	'Unidentified Heron/Egret'	

STORKS

62	WOST	'Wood Stork'	(Mycteria americana)

IBISES

63	GLIB	'Glossy Ibis'	(Plegadis falcinellus)
64	WFIB	'White-faced Ibis'	(Plegadis chihi)
65	WHIB	'White Ibis'	(Eudocimus albus)
66	SCIB	'Scarlet Ibis'	(Eudocimus ruber)
67	ROSP	'Roseate Spoonbill'	(Ajaia ajaja)

FLAMINGOS

68	GAFL	'Greater American Flamingo'	(Phoenicopterus ruber)

WATERFOWL

69	MUSW	'Mute Swan'	(Cygnus olor)
70	WPSW	'Whooper Swan'	(Cygnus cygnus)
71	BESW	'Bewick's Swan'	(Cygnus columbianus bewickii)
72	TUSW	'Tundra Swan'	(Cygnus columbianus)
73	TPSW *	'Trumpeter Swan'	(Cygnus buccinator)
74	CAGO	'Canada Goose'	(Branta canadensis)
75	BRAN	'Brant'	(Branta bernicla)
76	BAGO	'Barnacle Goose'	(Branta leucopsis)
77	EMGO	'Emperor Goose'	(Chen canagica)
78	GWFG	'Greater White-fronted Goose'	(Anser albifrons)
79	SNGO	'Snow Goose'	(Chen caerulescens)
80	ROGO	'Ross' Goose'	(Chen rossii)
81	BBWD	'Black-bellied Whistling-Duck'	(Dendrocygna autumnalis)
82	FWDU	'Fulvous Whistling-Duck'	(Dendrocygna bicolor)
83	MALL	'Mallard'	(Anas platyrhynchos)
84	ABDU	'American Black Duck'	(Anas rubripes)
85	MODU	'Mottled Duck'	(Anas fulvigula)
86	GADW	'Gadwall'	(Anas strepera)
87	NOPI	'Northern Pintail'	(Anas acuta)
88	GWTE	'Green-winged Teal'	(Anas crecca)
89	BWTE	'Blue-winged Teal'	(Anas discors)
90	CITE	'Cinnamon Teal'	(Anas cyanoptera)
91	GATE	'Garganey Teal'	(Anas querquedula)
92	UNTE	'Unidentified Teal'	
93	EUWI	'Eurasian Widgeon'	(Anas penelope)
94	AMWI	'American Widgeon'	(Anas americana)
95	NOSH	'Northern Shoveler'	(Anas clypeata)
96	WODU	'Wood Duck'	(Aix sponsa)
97	REDH	'Redhead'	(Aythya americana)
98	RNDU	'Ring-necked Duck'	(Aythya collaris)
99	CANV	'Canvasback'	(Aythya valisineria)
100	GRSC	'Greater Scaup'	(Aythya marila)
101	LESC	'Lesser Scaup'	(Aythya affinis)
102	COGO	'Common Goldeneye'	(Bucephala clangula)
103	BWGO *	'Barrow's Goldeneye'	(Bucephala islandica)
104	BUFF	'Bufflehead'	(Bucephala albeola)
105	OLDS	'Oldsquaw'	(Clangula hyemalis)
106	HADU	'Harlequin Duck'	(Histrionicus histrionicus)

108	COEI	'Common Eider'	(Somateria mollissima)
109	KIEI	'King Eider'	(Somateria spectabilis)
110	SPEI	'Spectacled Eider'	(Somateria fischeri)
111	WWSC	'White-winged Scoter'	(Melanitta fusca)
112	SUSC	'Surf Scoter'	(Melanitta perspicillata)
113	BLSC	'Black Scoter'	(Melanitta nigra)
114	RUDU	'Ruddy Duck'	(Oxyura jamaicensis)
115	MADU	'Masked Duck'	(Oxyura dominica)
116	HOME	'Hooded Merganser'	(Lophodytes cucullatus)
117	COME	'Common Merganser'	(Mergus merganser)
118	RBME	'Red-breasted Merganser'	(Mergus serrator)
	UNDU	'Unidentified Duck'	

VULTURES

119	TUVU	'Turkey Vulture'	(Cathartes aura).
120	BLVU	'Black Vulture'	(Coragyps atratus)
121	CACO	'California Condor'	(Gymnogyps californianus)

KITES, HAWKS

122	WTKI	'White-tailed Kite'	(Elanus caeruleus)
123	ASTK	'American Swallow-tailed Kite'	(Elanoides forficatus)
124	MIKI	'Mississippi Kite'	(Ictinia mississippiensis)
125	SNKI	'Snail Kite'	(Rostrhamus sociabilis)
126	NOGO	'Northern Goshawk'	(Accipiter gentilis)
127	SSHA	'Sharp-shinned Hawk'	(Accipiter striatus)
128	COHA	'Cooper's Hawk'	(Accipiter cooperii)
129	RTHA	'Red-tailed Hawk'	(Buteo jamaicensis)
130	RSHA	'Red-shouldered Hawk'	(Buteo lineatus)
131	BWHA	'Broad-winged Hawk'	(Buteo platypterus)
132	SWHA	'Swainson's Hawk'	(Buteo swainsoni)
133	ZTHA	'Zone-tailed Hawk'	(Buteo albonotatus)
134	WTHA	'White-tailed Hawk'	(Buteo albicaudatus)
135	STHA	'Short-tailed Hawk'	(Buteo brachyurus)
136	RLHA	'Rough-legged Hawk'	(Buteo lagopus)
137	FEHA	'Ferruginous Hawk'	(Buteo regalis)
138	GRHA	'Gray Hawk'	(Buteo nitidus)
139	HAHA	'Harris' Hawk'	(Parabuteo unicinctus)
140	CBHA	'Common Black Hawk'	(Buteogallus anthracinus)
141	GOEA	'Golden Eagle'	(Aquila chrysaetos)
142	BAEA	'Bald Eagle'	(Haliaeetus leucocephalus)
143	NOHA	'Northern Harrier'	(Circus cyaneus)
	UNHA	'Unidentified Hawk'	

OSPREY

144	OSPR	'Osprey'	(Pandion haliaetus)

FALCONS

145	CRCA	'Crested Caracara'	(Polyborus plancus)
146	GYRF	'Gyrfalcon'	(Falco rusticolus)
147	PRFA	'Prairie Falcon'	(Falco mexicanus)
148	PEFA	'Peregrine Falcon'	(Falco peregrinus)
149	APFA	'Aplomado Falcon'	(Falco femoralis)
150	MERL	'Merlin'	(Falco columbarius)
151	AMKE	'American Kestrel'	(Falco sparverius)
	UNFA	'Unidentified Falcon'	

CHACHALACA

152	PLCH	'Plain Chachalaca'	(Ortalis vetula)

GROUSE, PTARMIGAN

153	BUGR	'Blue Grouse'	(Dendragapus obscurus)
154	SPGR	'Spruce Grouse'	(Dendragapus canadensis)
155	RUGR	'Ruffed Grouse'	(Bonasa umbellus)
156	WIPT	'Willow Ptarmigan'	(Lagopus lagopus)
157	ROPT	'Rock Ptarmigan	(Lagopus mutus)
158	WTPT	'White-tailed Ptarmigan'	(Lagopus leucurus)
159	GPCH	'Greater Prairie-Chicken'	(Tympanuchuscupido)
160	LPCH	'Lesser Prairie-Chicken'	(Tympanuchus pallidicinctus)
161	STGR	'Sharp-tailed Grouse'	(Tympanuchus phasianellus)
162	SAGR	'Sage Grouse'	(Centrocercus urophasianus)

QUAIL, PHEASANT

163	NOBO	'Northern Bobwhite'	(Colinus virginianus)
164	MABW	'Masked Bobwhite'	(Colinus virginianus ridgwayi)
165	SCQU	'Scaled Quail'	(Callipepla squamata)
166	CAQU	'California Quail'	(Callipepla californica)
167	GAQU	'Gambel's Quail'	(Callipepla gambelii)
168	MOQU	'Mountain Quail'	(Oreortyx pictus)
169	MZQU	'Montezuma Quail'	(Cyrtonyx montezumae)
170	RNPH	'Ring-necked Pheasant'	(Phasianus colchicus)
171	CHUK	'Chukar'	(Alectoris chukar)
172	GRPA	'Gray Partridge'	(Perdix perdix)
173	BLFR	'Black Francolin'	(Francolinus francolinus)

TURKEY

174	WITU	'Wild Turkey'	(Meleagris gallopavo)

CRANES

175	WHCR	'Whooping Crane'	(Grus americana)
176	GSCR	'Greater Sandhill Crane'	(Grus canadensis tabida)
177	SACR	'Sandhill Crane'	(Grus canadensis)

LIMPKIN

178	LIMP	'Limpkin'	(Aramus guarauna)

RAILS, GALLINULES, COOTS

179	KIRA	'King Rail'	(Rallus elegans)
180	CLRA	'Clapper Rail'	(Rallus longirostris)
181	VIRA	'Virginia Rail'	(Rallus limicola)
182	SORA	'Sora'	(Porzana carolina)
183	YERA	'Yellow Rail'	(Coturnicops noveboracensis)
184	BLRA	'Black Rail'	(Laterallus jamaicensis)
185	PUGA	'Purple Galinule'	(Porphyrula martinica)
186	COMO	'Common Moorhen'	(Gallinula chloropus)
187	AMCO	'American Coot'	(Fulica americana)

JACANA

188	NOJA	'Northern Jacana'	(Jacana spinosa)

OYSTERCATCHERS

189	AMOY	'American Oystercatcher'	(Haematopus palliatus)
190	ABOY	'American Black Oystercatcher'	(Haematopus bachmani)

PLOVERS

191	NOLA	'Northern Lapwing'	(Vanellus vanellus)
192	CRPL	'Common Ringed Plover'	(Charadrius hiaticula)
193	SEPL	'Semipalmated Plover'	(Charadrius semipalmatus)
194	PIPL	'Piping Plover'	(Charadrius melodus)
195	SNPL	'Snowy Plover'	(Charadrius alexandrinus)
196	WIPL	'Wilson's Plover'	(Charadrius wilsonia)
197	KILL	'Killdeer'	(Charadrius vociferus)
198	MOPL	'Mountain Plover'	(Charadrius montanus)
199	LGPL	'Lesser Golden-Plover'	(Pluvialis dominica)
200	BBPL	'Black-bellied Plover'	(Pluvialis squatarola)
201	SURF	'Surfbird'	(Aphriza virgata)
202	RUTU	'Ruddy Turnstone'	(Arenaria interpres)
203	BLTU	'Black Turnstone'	(Arenaria melanocephala)
	UNPL	'Unidentified Plover'	

SANDPIPERS

204	AMWO	'American Woodcock'	(Scolopax minor)
205	COSN	'Common Snipe'	(Gallinago gallinago)
206	LBCU	'Long-billed Curlew'	(Numenius americanus)
207	WHIM	'Whimbrel'	(Numenius phaeopus)
208	BTCU	'Bristle-thighed Curlew'	(Numenius tahitiensis)
209	UPSA	'Upland Sandpiper'	(Bartramia longicauda)
210	SPSA	'Spotted Sandpiper'	(Actitis macularia)
211	SOSA	'Solitary Sandpiper'	(Tringa solitaria)
212	WATA	'Wandering Tattler'	(Heteroscelus incanus)

213	WILL	'Willet'	(Catoptrophorus semipalmatus)
214	GRYE	'Greater Yellowlegs'	(Tringa melanoleuca)
215	LEYE	'Lesser Yellowlegs'	(Tringa flavipes)
216	REKN	'Red Knot'	(Calidris canutus)
217	PUSA	'Purple Sandpiper'	(Calidris maritima)
218	ROSA	'Rock Sandpiper'	(Calidris ptilocnemis)
219	SHSA	'Sharp-tailed Sandpiper'	(Calidris acuminata)
220	PESA	'Pectoral Sandpiper'	(Calidris melanotos)
221	WRSA	'White-rumped Sandpiper'	(Calidris fuscicollis)
222	BASA	'Baird's Sandpiper'	(Calidris bairdii)
223	LESA	'Least Sandpiper'	(Calidris minutilla)
224	CUSA	'Curlew Sandpiper'	(Calidris ferruginea)
225	DUNL	'Dunlin'	(Calidris alpina)
226	SBDO	'Short-billed Dowitcher'	(Limnodromus griseus)
227	LBDO	'Long-billed Dowitcher'	(Limnodromus scolopaceus)
228	STSA	'Stilt Sandpiper'	(Calidris himantopus)
229	SESA	'Semipalmated Sandpiper'	(Calidris pusilla)
230	WESA	'Western Sandpiper'	(Calidris mauri)
231	BBSA	'Buff-breasted Sandpiper'	(Tryngites subruficollis)
232	MAGO	'Marbled Godwit'	(Limosa fedoa)
233	BTGO	'Bar-tailed Godwit'	(Limosa lapponica)
234	HUGO	'Hudsonian Godwit'	(Limosa haemastica)
235	BKGO	'Black-tailed Godwit'	(Limosa limosa)
236	RUFF	'Ruff'	(Philomachus pugnax)
237	SAND	'Sanderling'	(Calidris alba)
	UNSA	'Unidentified Sandpiper'	

AVOCET, STILT

238	AMAV	'American Avocet'	(Recurvirostra americana)
239	BNST	'Black-necked Stilt'	(Himantopus mexicanus)

PHALAROPES

240	REPH	'Red Phalarope'	(Phalaropus fulicaria)
241	WIPH	'Wilson's Phalarope'	(Phalaropus tricolor)
242	RDPH	'Red-necked Phalarope'	(Phalaropus lobatus)

JAEGERS, SKUAS

243	POJA	'Pomerine Jaeger'	(Stercorarius pomarinus)
244	PAJA	'Parasitic Jaeger'	(Stercorarius parasiticus)
245	LTJA	'Long-tailed Jaeger'	(Stercorarius longicaudus)
246	GRSK	'Great Skua'	(Catharacta skua)
247	SPSK	'South Polar Skua'	(Catharacta maccormicki)

GULLS, TERNS

248	GLGU	'Glaucous Gull'	(Larus hyperboreus)
249	ICGU	'Iceland Gull'	(Larus glaucoides)
250	KUGU	'Kumlien's Gull'	(Larus glaucoides kumlieni)
251	GWGU	'Glaucous-Winged Gull'	(Larus glaucescens)
252	GBBG	'Great Black-backed Gull'	(Larus marinus)

254	LBBG	'Lesser Black-backed Gull'	(Larus fuscus)
255	HEGU	'Herring Gull'	(Larus argentatus)
256	THGU	'Thayer's Gull'	(Larus thayeri)
257	CAGU	'California Gull'	(Larus californicus)
258	RBGU	'Ring-billed Gull'	(Larus delawarensis)
259	MEGU	'Mew Gull'	(Larus canus)
260	CBHG	'Common Black-headed Gull'	(Larus ridibundus)
261	LAGU	'Laughing Gull'	(Larus atricilla)
262	FRGU	'Franklin's Gull'	(Larus pipixcan)
263	BOGU	'Boneparte's Gull'	(Larus philadelphia)
264	LIGU	'Little Gull'	(Larus minutus)
265	HMGU	'Heermann's Gull'	(Larus heermanni)
266	IVGU	'Ivory Gull'	(Pagophila eburnea)
267	BLKI	'Black-legged Kittiwake'	(Rissa tridactyla)
268	RLKI	'Red-legged Kittiwake'	(Rissa brevirostris)
269	ROGU	'Ross' Gull'	(Rhodostethia rosea)
270	SAGU	'Sabine's Gull'	(Xema sabini)
271	GBTE	'Gull-billed Tern'	(Sterna nilotica)
272	FOTE	'Forster's Tern'	(Sterna forsteri)
273	COTE	'Common Tern'	(Sterna hirundo)
274	ARTE	'Arctic Tern'	(Sterna paradisaea)
275	RSTE	'Roseate Tern'	(Sterna dougallii)
276	ALTE	'Aleutian Tern'	(Sterna aleutica)
277	SOTE	'Sooty Tern'	(Sterna fuscata)
278	BRTE	'Bridled Tern'	(Sterna anaethetus)
279	LETE	'Least Tern'	(Sterna antillarum)
280	ROTE	'Royal Tern'	(Sterna maxima)
281	ELTE	'Elegant Tern'	(Sterna elegans)
282	SATE	'Sandwich Tern'	(Sterna sandvicensis)
283	CATE	'Caspian Tern'	(Sterna caspia)
284	BLTE	'Black Tern'	(Chlidonias niger)
285	WWBT	'White-winged Black Tern'	(Chlidonias leucopterus)
286	BRNO	'Brown Noddy'	(Anous stolidus)
287	BLNO	'Black Noddy'	(Anous minutus)
288	HYTE	'Hybrid Tern'	(Sterna spp)
	UNGU	'Unidentified Gull/Tern'	

SKIMMER

289	BLSK	'Black Skimmer'	(Rynchops niger)

ALCIDS

290	RAZO	'Razorbill'	(Alca torda)
291	COMU	'Common Murre'	(Uria aalge)
292	TBMU	'Thick-billed Murre'	(Uria lomvia)
293	DOVE	'Dovekie'	(Alle alle)
294	BLGU	'Black Guillemot'	(Cepphus grylle)
295	MAGU	'Mandt's Guillemot'	(Cepphus grylle mandti)
296	PIGU	'Pigeon Guillemot'	(Cepphus columba)
297	MAMU	'Marbled Murrelet'	(Brachyramphus marmoratus)
298	KIMU	'Kittlitz's Murrelet'	(Brachyramphus brevirostris)
299	XAMU	'Xantus' Murrelet'	(Synthliboramphus hypoleucus)
300	CRMU	'Craveri's Murrelet'	(Synthliboramphus craveri)

301	ANMU	'Ancient Murrelet'	(Synthliboramphus antiquus)
302	CAAU	'Cassin's Auklet'	(Ptychoramphus aleuticus)
303	PAAU	'Parakeet Auklet'	(Cyclorrhynchus psittacula)
304	CRAU	'Crested Auklet'	(Aethia cristatella)
305	LEAU	'Least Auklet'	(Aethia pusilla)
306	WHAU	'Whiskered Auklet'	(Aethia pygmaea)
307	RHAU	'Rhinoceros Auklet'	(Cerorhinca monocerata)
308	ATPU	'Atlantic Puffin'	(Fratercula arctica)
309	HOPU	'Horned Puffin'	(Fratercula corniculata)
310	TUPU	'Tufted Puffin'	(Fratercula cirrhata)

PIGEONS, DOVES

311	WCPI	'White-crowned Pigeon'	(Columba leucocephala)
312	BTPI	'Band-tailed Pigeon'	(Columba fasciata)
313	RBPI	'Red-billed Pigeon'	(Columba flavirostris)
314	ZEDO	'Zenaida Dove'	(Zenaida aurita zenaida)
315	WWDO	'White-winged Dove'	(Zenaida asiatica)
316	MODO	'Mourning Dove'	(Zenaida macroura)
317	RODO	'Rock Dove'	(Columba livia)
318	SPDO	'Spotted Dove'	(Streptopelia chinensis)
319	RTDO	'Ringed Turtle Dove'	(Streptopelia risoria)
320	CGDO	'Common Ground Dove'	(Columbina passerina)
321	RGDO	'Ruddy Ground Dove'	(Columbina talpacoti)
322	INDO	'Inca Dove'	(Columbina inca)
323	WTDO	'White-tipped Dove'	(Leptotila verreauxi)
324	KWQD	'Key West Quail Dove'	(Oreopeleia chrysia)
325	RQDO	'Ruddy Quail Dove'	(Oreopeleia montana montana)
	UNDO	'Unidentified Dove'	

PARROT

326	CWPA	'Canary-winged Parakeet'	(Brotogeris versicolurus)

CUCKOOS, ROADRUNNER, ANIS

327	MACU	'Mangrove Cuckoo'	(Coccyzus minor)
328	YBCU	'Yellow-billed Cuckoo'	(Coccyzus americanus)
329	BBCU	'Black-billed Cuckoo'	(Coccyzus erythropthalmus)
330	GRRO	'Greater Roadrunner'	(Geococcyx californianus)
331	SBAN	'Smooth-billed Ani'	(Crotophaga ani)
332	GBAN	'Groove-billed Ani'	(Crotophaga sulcirostris)

BARN OWL

333	CBOW	'Common Barn Owl'	(Tyto alba)

TYPICAL OWLS

334	ESOW	'Eastern Screech-Owl'	(Otus asio)
335	WSOW	'Western Screech-Owl'	(Otus kennicottii)
336	WHOW	'Whiskered Owl'	(Otus trichopsis)
337	FLOW	'Flammulated Owl'	(Otus flammeolus)
338	GHOW	'Great Horned Owl'	(Bubo virginianus)

339	SNOW	'Snowy Owl'	(Nyctea scandiaca)
340	NHOW	'Northern Hawk-Owl'	(Surnia ulula)
341	NPOW	'Northern Pygmy-Owl'	(Glaucidium gnoma)
342	FPOW	'Feruginous Pygmy-Owl'	(Glaucidium brasilianum)
343	ELOW	'Elf Owl'	(Micrathene whitneyi)
344	BUOW	'Burrowing Owl'	(Athene cunicularia)
345	BDOW	'Barred Owl'	(Strix varia)
346	SPOW	'Spotted Owl'	(Strix occidentalis)
347	GGOW	'Great Gray Owl'	(Strix nebulosa)
348	LEOW	'Long-eared Owl'	(Asio otus)
349	SEOW	'Short-eared Owl'	(Asio flammeus)
350	BOOW	'Boreal Owl'	(Aegolis funereus)
351	NSWO	'Northern Saw-whet Owl'	(Aegolius acadicus)
	UNOW	'Unidentified Owl'	

GOATSUCKERS

352	CWWI	'Chuck-will's-widow'	(Caprimulgus carolinensis)
353	WPWI	'Whip-poor-will'	(Caprimulgus vociferus)
354	CPWI	'Common Poor-will'	(Phalaenoptilus nuttallii)
355	COPA	'Common Pauraque'	(Nyctidromus albicollis)
356	CONI	'Common Nighthawk'	(Chordeiles minor)
357	LENI	'Lesser Nighthawk'	(Chordeiles acutipennis)
	UNGO	'Unidentified Goatsucker'	

SWIFTS

358	BLSW	'Black Swift'	(Cypseloides niger)
359	CHSW	'Chimney Swift'	(Chaetura pelagica)
360	VASW	'Vaux's Swift'	(Chaetura vauxi)
361	WTSW	'White-throated Swift'	(Aeronautes saxatalis)

HUMMINGBIRDS

362	LUHU	'Lucifer Hummingbird'	(Calothorax lucifer)
363	RTHU	'Ruby-throated Hummingbird'	(Archilochus colubris)
364	BCHU	'Black-chinned Hummingbird'	(Archilochus alexandri)
365	COHU	'Costa's Hummingbird'	(Calypte costae)
366	ANHU	'Anna's Hummingbird'	(Calypte anna)
367	BRHU	'Broad-tailed Hummingbird'	(Selasphorus platycercus)
368	RUHU	'Rufous Hummingbird'	(Selasphorus rufus)
369	ALHU	'Allen's Hummingbird'	(Selasphorus sasin)
370	CAHU	'Calliope Hummingbird'	(Stellula calliope)
371	RIHU	'Rivoli's Hummingbird'	(Eugenes fulgens)
372	BUHU	'Blue-throated Hummingbird'	(Lampornis clemenciae)
373	BFHU	'Buff-bellied Hummingbird'	(Amazilia yucatanensis)
374	BBHU	'Broad-billed Hummingbird'	(Cynanthus latirostis)
	UNHU	'Unidentified Hummingbird'	

TROGON

KINGFISHERS

376	BEKI	'Belted Kingfisher'	(Ceryle alcyon)
377	RIKI	'Ringed Kingfisher'	(Ceryle torquata)
378	GNKI *	'Green Kingfisher'	(Chloroceryle americana)

WOODPECKERS

379	NOFL	'Northern Flicker'	(Colaptes auratus)
380	PIWO	'Pileated Woodpecker'	(Dryocopus pileatus)
381	RBWO	'Red-bellied Woodpecker'	(Melanerpes carolinus)
382	GFWO	'Golden-fronted Woodpecker'	(Melanerpes aurifrons)
383	GIWO	'Gila Woodpecker'	(Melanerpes uropygialis)
384	RHWO	'Red-headed Woodpecker'	(Melanerpes erythrocephalus)
385	ACWO	'Acorn Woodpecker'	(Melanerpes formicivorus)
386	LEWO	'Lewis' Woodpecker'	(Melanerpes lewis)
387	YBSA	'Yellow-bellied Sapsucker'	(Sphyrapicus varius)
388	RBSA	'Red-breasted Sapsucker'	(Sphyrapicus ruber)
389	WISA	'Williamson's Sapsucker'	(Sphyrapicus thyroideus)
390	HAWO	'Hairy Woodpecker'	(Picoides villosus)
391	DOWO	'Downy Woodpecker'	(Picoides pubescens)
392	LBWO	'Ladder-backed Woodpecker'	(Picoides scalaris)
393	NUWO	'Nuttall's Woodpecker'	(Picoides nuttallii)
394	ARWO	'Arizona Woodpecker'	(Picoides stricklandi)
395	RCWO	'Red-cockaded Woodpecker'	(Picoides borealis)
396	WHWO	'White-headed Woodpecker'	(Picoides albolarvatus)
397	BBWO	'Black-backed Woodpecker'	(Picoides arctus)
398	TTWO	'Three-toed Woodpecker'	(Picoides tridactylus)
399	IBWO	'Ivory-billed Woodpecker'	(Campephilus principalis)
	UNWO	'Unidentified Woodpecker'	

COTINGA

400	RTBE	'Rose-throated Becard'	(Pachyramphus aglaiae)

TYRANT FLYCATCHERS

401	EAKI	'Eastern Kingbird'	(Tyrannus tyrannus)
402	GRKI	'Gray Kingbird'	(Tyrannus dominicensis)
403	TRKI	'Tropical Kingbird'	(Tyrannus melancholicus)
404	WEKI	'Western Kingbird'	(Tyrannus verticalis)
405	CAKI	'Cassin's Kingbird'	(Tyrannus vociferans)
406	TBKI	'Thick-billed Kingbird'	(Tyrannus crassirostris)
407	FTFL	'Fork-tailed Flycatcher'	(Tyrannus savana)
408	STFL	'Scissor-tailed Flycatcher'	(Tyrannus forficatus)
409	KIFL	'Greater Kiskadee'	(Pitangus sulphuratus)
410	SBFL	'Sulfur-bellied Flycatcher'	(Myiodynastes luteiventris)
411	GCFL	'Great Crested Flycatcher'	(Myiarchus crinitus)
412	BCFL	'Brown Crested Flycatcher'	(Myiarchus tyrannulus)
413	ATFL	'Ash-throated Flycatcher'	(Myiarchus cinerascens)
414	DCFL	'Dusky-capped Flycatcher'	(Myiarchus tuberculifer)
415	EAPH	'Eastern Phoebe'	(Sayornis phoebe)
416	BLPH	'Black Phoebe'	(Sayornis nigricans)

417	SAPH	'Say's Phoebe'	(Sayornis saya)
418	YBFL	'Yellow-bellied Flycatcher'	(Empidonax flaviventris)
419	ACFL	'Acadian Flycatcher'	(Empidonax virescens)
420	WIFL	'Willow Flycatcher'	(Empidonax traillii)
421	ALFL	'Alder Flycatcher'	(Empidonax alnorum)
422	LEFL	'Least Flycatcher'	(Empidonax minimus)
423	HAFL	'Hammond's Flycatcher'	(Empidonax hammondii)
424	DUFL	'Dusky Flycatcher'	(Empidonax oberholseri)
425	GRFL	'Gray Flycatcher'	(Empidonax wrightii)
426	WEFL	'Western Flycatcher'	(Empidonax difficilis)
427	BBFL	'Buff-breasted Flycatcher'	(Empidonax fulvifrons)
	EMFL	'Unidentified Empidonax Flycatcher'	
428	COFL	'Coues' Flycatcher'	(Contopus pertinax)
429	EWPE	'Eastern Wood-Pewee'	(Contopus virens)
430	WWPE	'Western Wood-Pewee'	(Contopus sordidulus)
431	OSFL	'Olive-sided Flycatcher'	(Contopus borealis)
432	VEFL	'Vermillion Flycatcher'	(Pyrocephalus rubinus)
433	NBTY	'Northern Beardless Tyrannulet'	(Camptostoma imberbe)
434	UNFL	'Unidentified Flycatcher'	

LARKS

435	EUSK	'Eurasian Skylark'	(Alauda arvensis)
436	HOLA	'Horned Lark'	(Eremophila alpestris)

SWALLOWS

437	VGSW	'Violet-green Swallow'	(Tachycineta thalassina)
438	TRSW	'Tree Swallow'	(Tachycineta bicolor)
439	BKSW	'Bank Swallow'	(Riparia riparia)
440	NRWS	'Northern Rough-winged Swallow'	(Stelgidopteryx serripennis)
441	BASW	'Barn Swallow'	(Hirundo rustica)
442	CLSW	'Cliff Swallow'	(Hirundo pyrrhonota)
443	CASW	'Cave Swallow'	(Hirundo fulva)
444	PUMA	'Purple Martin'	(Progne subis)
	UNSW	'Unidentified Swallow'	

JAYS, MAGPIES, CROWS

445	GRJA	'Gray Jay'	(Perisoreus canadensis)
446	BLJA	'Blue Jay'	(Cyanocitta cristata)
447	STJA	'Steller's Jay'	(Cyanocitta stelleri)
448	SCJA	'Scrub Jay'	(Aphelocoma coerulescens)
449	GBJA	'Gray-breasted Jay'	(Aphelocoma ultramarina)
450	GEJA	'Green Jay'	(Cyanocorax yncas)
451	BBMA	'Black-billed Magpie'	(Pica pica)
452	YBMA	'Yellow-billed Magpie'	(Pica nuttalli)
453	CORA	'Common Raven'	(Corvus corax)
454	CHRA	'Chihuahua Raven'	(Corvus cryptoleucus)
455	AMCR	'American Crow'	(Corvus brachyrhynchos)
456	NOCR	'Northwestern Crow'	(Corvus caurinus)
457	FICR	'Fish Crow'	(Corvus ossifragus)
	UNCR	'Unidentified Crow'	
458	PIJA	'Pinyon Jay'	(Gymnorhinus cyanocephalus)

459	CLNU	'Clark's Nutcracker'	(Nucifraga columbiana)

TITMICE, VERDIN, BUSHTIT

460	BCCH	'Black-capped Chickadee'	(Parus atricapillus)
461	CACH	'Carolina Chickadee'	(Parus carolinensis)
462	MECH	'Mexican Chickadee'	(Parus sclateri)
463	MOCH	'Mountain Chickadee'	(Parus gambeli)
464	SITI	'Siberian Tit'	(Parus cinctus)
465	BOCH	'Boreal Chickadee'	(Parus hudsonicus)
466	CBCH	'Chestnut-backed Chickadee'	(Parus rufescens)
467	TUTI	'Tufted Titmouse'	(Parus bicolor)
468	BCTI	'Black-crested Titmouse'	Tufted race
469	PLTI	'Plain Titmouse'	(Parus inornatus)
470	BRTI	'Bridled Titmouse'	(Parus wollweberi)
471	VERD	'Verdin'	(Auriparus flaviceps)
472	BUSH	'Bushtit'	(Psaltriparus minimus)

NUTHATCHES

473	WBNU	'White-breasted Nuthatch'	(Sitta carolinensis)
474	RBNU	'Red-breasted Nuthatch'	(Sitta canadensis)
475	BHNU	'Brown-headed Nuthatch'	(Sitta pusilla)
476	PYNU	'Pygmy Nuthatch'	(Sitta pygmaea)

CREEPER

477	BRCR	'Brown Creeper'	(Certhia americana)

WRENTIT

478	WREN	'Wrentit'	(Chamaea fasciata)

BULBUL

479	RWBU	'Red-whiskered Bulbul'	(Pycnonotus jocosus)

DIPPER

480	AMDI	'American Dipper'	(Cinclus mexicanus)

WRENS

481	HOWR	'House Wren'	(Troglodytes aedon)
482	WIWR	'Winter Wren'	(Troglodytes troglodytes)
483	BEWR	'Bewick's Wren'	(Thryomanes bewickii)
484	CAWR	'Carolina Wren'	(Thryothorus ludovicianus)
485	CTWR	'Cactus Wren'	(Campylorhynchus brunneicapillus)
486	MAWR	'Marsh Wren'	(Cistothorus palustris)
487	SEWR	'Sedge Wren'	(Cistothorus platensis)
488	CNWR	'Canyon Wren'	(Catherpes mexicanus)
489	ROWR	'Rock Wren'	(Salpinctes obsoletus)
	UNWR	'Unidentified Wren'	

MOCKINGBIRDS, THRASHERS

490	NOMO	'Northern Mockingbird'	(Mimus polyglottus)
491	GRCA	'Gray Catbird'	(Dumetella carolinensis)
492	BRTH	'Brown Thrasher'	(Toxostoma rufum)
493	LBTH	'Long-billed Thrasher'	(Toxostoma longirostre)
494	GRTH	'Gray Thrasher'	(Toxostoma cinereum)
495	BETH	'Bendire's Thrasher'	(Toxostoma bendirei)
496	CBTH	'Curve-billed Thrasher'	(Toxostoma curvirostre)
497	CATH	'California Thrasher'	(Toxostoma redivivum)
498	LCTH	'LeConte's Thrasher'	(Toxostoma lecontei)
499	CRTH	'Crissal Thrasher'	(Toxostoma dorsale)
500	SATH	'Sage Thrasher'	(Oreoscoptes montanus)
	UNTH	'Unidentified Thrasher'	

THRUSHES

501	AMRO	'American Robin'	(Turdus migratorius)
502	FIEL	'Fieldfare'	(Turdus pilaris)
503	CCRO	'Clay-colored Robin'	(Turdus grayi)
504	VATH	'Varied Thrush'	(Ixoreus naevius)
505	WOTH	'Wood Thrush'	(Hylocichla mustelina)
506	HETH	'Hermit Thrush'	(Catharus guttatus)
507	SWTH	'Swainson's Thrush'	(Catharus ustulatus)
508	GCTH	'Gray-cheeked Thrush'	(Catharus minimus)
509	VEER	'Veery'	(Catharus fuscescens)
510	EABL	'Eastern Bluebird'	(Sialia sialis)
511	WEBL	'Western Bluebird'	(Sialia mexicana)
512	MOBL	'Mountain Bluebird'	(Sialia curruoides)
513	EMBL	'Eastern/Mountain Blueb.Hybrid'	(Sialia spp)
514	NOWH	'Northern Wheatear'	(Oenanthe oenanthe)
515	BLUE	'Bluethroat'	(Luscinia svecica)
516	TOSO	'Townsend's Solitaire'	(Myadestes townsendi)
	UNTU	'Unidentified Thrush'	

OLD WORLD WARBLERS, GNATCATCHERS, KINGLETS

517	ARWA	'Arctic Warbler'	(Phylloscopus borealis)
518	BGGN	'Blue-gray Gnatcatcher'	(Polioptila caerulea)
519	BCGN	'Black-capped Gnatcatcher'	(Polioptila nigriceps)
520	BTGN	'Black-tailed Gnatcatcher'	(Polioptila melanura)
	UNGN	'Unidentified Gnatcatcher'	
521	GCKI	'Golden-crowned Kinglet'	(Regulus satrapa)
522	RCKI	'Ruby-crowned Kinglet'	(Regulus calendula)

WAGTAILS, PIPITS

523	WHWA	'White Wagtail'	(Motacilla alba)
524	YLWA ▲	'Yellow Wagtail'	(Motacilla flava)
525	WAPI	'Water Pipit'	(Anthus spinoletta)
526	RTPI	'Red-throated Pipit'	(Anthus cervinus)
527	SPPI	'Sprague's Pipit'	(Anthus spragueii)

WAXWINGS

528	BOWA	'Bohemian Waxwing'	(Bombycilla garrulus)
529	CEWA	'Cedar Waxwing'	(Bombycilla cedrorum)

SILKY FLYCATCHER

530	PHAI	'Phainopepla'	(Phainopepla nitens)

SHRIKES

531	NRSH	'Northern Shrike'	(Lanius excubitor)
532	LOSH	'Loggerhead Shrike'	(Lanius ludovicianus)

STARLING

533	EUST	'European Starling'	(Sturnus vulgaris)

VIREOS

534	BCVI	'Black-capped Vireo'	(Vireo atricapillus)
535	WEVI	'White-eyed Vireo'	(Vireo griseus)
536	HUVI	'Hutton's Vireo'	(Vireo huttoni)
537	BEVI	'Bell's Vireo'	(Vireo bellii)
538	GRVI	'Gray Vireo'	(Vireo vicinior)
539	YTVI	'Yellow-throated Vireo'	(Vireo flavifrons)
540	SOVI	'Solitary Vireo'	(Vireo solitarius)
541	BWVI	'Black-whiskered Vireo'	(Vireo altiloquus)
542	REVI	'Red-eyed Vireo'	(Vireo olivaceus)
543	YGVI	'Yellow-green Vireo'	(Vireo olivaceus flavoviridis)
544	PHVI	'Philadelphia Vireo'	(Vireo philadelphicus)
545	WAVI	'Warbling Vireo'	(Vireo gilvus)
	UNVI	'Unidentified Vireo'	

WOOD WARBLERS

546	BAWW	'Black-and-white Warbler'	(Mniotilta varia)
547	POWA	'Prothonotary Warbler'	(Protonotaria citrea)
548	SWWA	'Swainson's Warbler'	(Limnothlypis swainsonii)
549	WEWA	'Worm-eating Warbler'	(Helmitheros vermivorus)
550	GWWA	'Golden-winged Warbler'	(Vermivora chrysoptera)
551	BWWA	'Blue-winged Warbler'	(Vermivora pinus)
552	BRWA	'Brewster's Warbler'	Golden-winged/Blue-winged Hybrid
553	LAWA	'Lawrence's Warbler'	Golden-winged/Blue-winged Hybrid
554	BAWA	'Bachman's Warbler'	(Vermivora bachmanii)
555	TEWA	'Tennessee Warbler'	(Vermivora peregrina)
556	OCWA	'Orange-crowned Warbler'	(Vermivora celata)
557	NAWA	'Nashville Warbler'	(Vermivora ruficapilla)
558	VIWA	'Virginia's Warbler'	(Vermivora virginiae)
559	CLWA	'Colima Warbler'	(Vermivora crissalis)
560	LUWA	'Lucy's Warbler'	(Vermivora luciae)
561	NOPA	'Northern Parula'	(Parula americana)
562	TRPA	'Tropical Parula'	(Parula pitiayumi)

563	OLWA	'Olive Warbler'	(Peucedramus taeniatus)
564	YEWA	'Yellow Warbler'	(Dendroica petechia)
565	MAWA	'Magnolia Warbler'	(Dendroica magnolia)
566	CMWA	'Cape May Warbler'	(Dendroica tigrina)
567	BTBW	'Black-throated Blue Warbler'	(Dendroica caerulescens)
568	YRWA	'Yellow-rumped Warbler'	(Dendroica coronata)
569	BGWA	'Black-throated Gray Warbler'	(Dendroica nigrescens)
570	TOWA	'Townsend's Warbler'	(Dendroica townsendi)
571	BTGW	'Black-throated Green Warbler'	(Dendroica virens)
572	GCWA	'Golden-cheeked Warbler'	(Dendroica chrysoparia)
573	HEWA	'Hermit Warbler'	(Dendroica occidentalis)
574	CRWA	'Cerulean Warbler'	(Dendroica cerulea)
575	BLWA	'Blackburnian Warbler'	(Dendroica fusca)
576	YTWA	'Yellow-throated Warbler'	(Dendroica dominica)
577	SUWA	'Sutton's Warbler'	(Dendroica potomac)
578	GRWA	'Grace's Warbler'	(Dendroica graciae)
579	CSWA	'Chestnut-sided Warbler'	(Dendroica pensylvanica)
580	BBWA	'Bay-breasted Warbler'	(Dendroica castanea)
581	BPWA	'Blackpoll Warbler'	(Dendroica striata)
582	PIWA	'Pine Warbler'	(Dendroica pinus)
583	KIWA	'Kirtland's Warbler'	(Dendroica kirtlandii)
584	PRWA	'Prairie Warbler'	(Dendroica discolor)
585	PAWA	'Palm Warbler'	(Dendroica palmarum)
586	OVEN	'Ovenbird'	(Seiurus aurocapillus)
587	NOWA	'Northern Waterthrush'	(Seiurus noveboracesis)
588	LOWA	'Louisiana Waterthrush'	(Seiurus motacilla)
589	KEWA	'Kentucky Warbler'	(Oporornis formosus)
590	COWA	'Connecticut Warbler'	(Oporornis agilis)
591	MOWA	'Mourning Warbler'	(Oporornis philadelphia)
592	MGWA	'MacGillivray's Warbler'	(Oporornis tolmiei)
593	COYE	'Common Yellowthroat'	(Geothlypis trichas)
594	GRCH	'Ground Chat'	(Geothlypis poliocephala)
595	YBCH	'Yellow-breasted Chat'	(Icteria virens)
596	RFWA	'Red-faced Warbler'	(Cardellina rubrifrons)
597	HOWA	'Hooded Warbler'	(Wilsonia citrina)
598	WIWA	'Wilson's Warbler'	(Wilsonia pusilla)
599	CAWA	'Canada Warbler'	(Wilsonia canadensis)
600	AMRE	'American Redstart'	(Setophaga ruticilla)
601	PARE	'Painted Redstart'	(Myioborus pictus)
	UNWA	'Unidentified Warbler'	

WEAVER FINCHES

602	HOSP	'House Sparrow'	(Passer domesticus)
603	ETSP	'Eurasian Tree Sparrow'	(Passer montanus)

MEADOWLARKS, BLACKBIRDS, ORIOLES

604	BOBO	'Bobolink'	(Dolichonyx oryzivorus)
605	EAME	'Eastern Meadowlark'	(Sturnella magna)
606	WEME	'Western Meadowlark'	(Sturnella neglecta)
607	YHBL	'Yellow-headed Blackbird'	(Xanthocephalus xanthocephalus)
608	RWBL	'Red-winged Blackbird'	(Agelaius phoeniceus)
609	TRBL	'Tricolored Blackbird'	(Agelaius tricolor)

610	ORDR	'Orchard Oriole'	(Icterus spurius)
611	AUOR	'Audubon's Oriole'	(Icterus graduacauda)
612	SBOR	'Spotted-breasted Oriole'	(Icterus pectoralis)
613	STOR	'Streak-backed Oriole'	(Icterus pustulatus)
614	HOOR	'Hooded Oriole'	(Icterus cucullatus)
615	ALOR	'Altamira Oriole'	(Icterus gularis)
616	SCOR	'Scott's Oriole'	(Icterus parisorum)
617	NOOR	'Northern Oriole'	(Icterus galbula)
	UNOR	'Unidentified Oriole'	
618	RUBL	'Rusty Blackbird'	(Euphagus carolinus)
619	BRBL	'Brewer's Blackbird'	(Euphagus cyanocephalus)
620	GTGR	'Great-tailed Grackle'	(Quiscalus mexicanus)
621	BTGR	'Boat-tailed Grackle'	(Quiscalus major)
622	COGR	'Common Grackle'	(Quiscalus quiscula)
623	BHCO	'Brown-headed Cowbird'	(Molothrus ater)
624	BRCO	'Bronzed Cowbird'	(Molothrus aeneus)
625	UNBL	'Unidentified Blackbird'	

TANAGERS

626	WETA	'Western Tanager'	(Piranga ludoviciana)
627	SCTA	'Scarlet Tanager'	(Piranga olivacea)
628	HETA	'Hepatic Tanager'	(Piranga flava)
629	SUTA	'Summer Tanager'	(Piranga rubra)
	UNTA	'Unidentified Tanager'	

GROSBEAKS, FINCHES, SPARROWS, BUNTINGS

630	NOCA	'Northern Cardinal'	(Cardinalis cardinalis)
631	PYRR	'Pyrrhuloxia'	(Cardinalis sinuatus)
632	RBGR	'Rose-breasted Grosbeak'	(Pheucticus ludovicianus)
633	BHGR	'Black-headed Grosbeak'	(Pheucticus melanocephalus)
634	BLGR	'Blue Grosbeak'	(Guiraca caerulea)
	UNGR	'Unidentified Grosbeak'	
635	INBU	'Indigo Bunting'	(Passerina cyanea)
636	LABU	'Lazuli Bunting'	(Passerina amoena)
637	VABU	'Varied Bunting'	(Passerina versicolor)
638	PABU	'Painted Bunting'	(Passerina ciris)
639	DICK	'Dickcissel'	(Spiza americana)
640	EVGR	'Evening Grosbeak'	(Coccothraustes vespertinus)
641	PUFI	'Purple Finch'	(Carpodacus purpureus)
642	CAFI	'Cassin's Finch'	(Carpodacus cassinii)
643	HOFI	'House Finch'	(Carpodacus mexicanus)
644	WCSE	'White-collared Seedeater'	(Sporophila torqueola)
645	PIGR	'Pine Grosbeak'	(Pinicola enucleator)
646	ROFI	'Rosy Finch'	(Leucosticte arctoa)
647	EUGO	'European Goldfinch'	(Carduelis carduelis)
648	HORE	'Hoary Redpoll'	(Carduelis hornemanni)
[illegible]	[illegible]	'Common Redpoll'	(Carduelis flammea)
650	PISI	'Pine Siskin'	(Carduelis pinus)
651	AMGO	'American Goldfinch'	(Carduelis tristis)

653	LAGO	Lawrence's Goldfinch	(Carduelis lawrencei)
654	RECR	Red Crossbill	(Loxia curvirostra)
655	WWCR	'White-winged Crossbill'	(Loxia leucoptera)
656	OLSP	'Olive Sparrow'	(Arremonops rufivirgatus)
657	GTTO	'Green-tailed Towhee'	(Pipilo chlorurus)
658	RSTO	'Rufous-sided Towhee'	(Pipilo erythrophthalmus)
659	BRTO	'Brown Towhee'	(Pipilo fuscus)
660	ABTO	'Abert's Towhee'	(Pipilo aberti)
661	LXBU	'Lark Bunting'	(Calamospiza melanocorys)
662	SASP	'Savannah Sparrow'	(Passerculus sandwichensis)
663	GRSP	'Grasshopper Sparrow'	(Ammodramus savannarum)
664	BDSP	'Baird's Sparrow'	(Ammodramus bairdii)
665	LCSP	'LeConte's Sparrow'	(Ammodramus leconteii)
666	HESP	'Henslow's Sparrow'	(Ammodramus henslowii)
667	STSP	'Sharp-tailed Sparrow'	(Ammodramus caudacutus)
668	SESP	'Seaside Sparrow'	(Ammodramus maritimus)
669	VESP	'Vesper Sparrow'	(Pooecetes gramineus)
670	LASP	'Lark Sparrow'	(Chondestes grammacus)
671	FSSP	'Five-striped Sparrow'	(Amphispiza quiquestriata)
672	RWSP	'Rufous-winged Sparrow'	(Aimophila carpalis)
673	RCSP	'Rufous-crowned Sparrow'	(Aimophila ruficeps)
674	BASP	'Bachman's Sparrow'	(Aimophila aestivalis)
675	BOSP	'Botteri's Sparrow'	(Aimophila botterii)
676	CASP	'Cassin's Sparrow'	(Aimophila cassinii)
677	BTSP	'Black-throated Sparrow'	(Amphispiza bilineata)
678	SGSP	'Sage Sparrow'	(Amphispiza belli)
679	DEJU	'Dark-eyed Junco'	(Junco hyemalis)
680	YEJU	'Yellow-eyed Junco'	(Junco phaeonotus)
681	ATSP	'American Tree Sparrow'	(Spizella arborea)
682	CHSP	'Chipping Sparrow'	(Spizella passerina)
683	CCSP	'Clay-colored Sparrow'	(Spizella pallida)
684	BRSP	'Brewer's Sparrow'	(Spizella breweri)
685	FISP	'Field Sparrow'	(Spizella pusilla)
686	BCSP	'Black-chinned Sparrow'	(Spizella atrogularis)
687	HASP	'Harris' Sparrow'	(Zonotrichia querula)
688	WCSP	'White-crowned Sparrow'	(Zonotrichia leucophrys)
689	GCSP	'Golden-crowned Sparrow'	(Zonotrichia atricapilla)
690	WTSP	'White-throated Sparrw'	(Zonotrichia albicollis)
691	FOSP	'Fox Sparrow'	(Passerella iliaca)
692	LISP	'Lincoln's Sparrow'	(Melospiza lincolnii)
693	SWSP	'Swamp Sparrow'	(Melospiza georgiana)
694	SOSP	'Song Sparrow'	(Melospiza melodia)
695	MCLO	'McCown's Longspur'	(Calcarius mccownii)
696	LALO	'Lapland Longspur'	(Calcarius lapponicus)
697	SMLO	'Smith's Longspur'	(Calcarius pictus)
698	CCLO	'Chestnut-collared Longspur'	(Calcarius ornatus)
699	SNBU	'Snow Bunting'	(Plectrophenax nivalis)
700	MCBU	'McKay's Bunting'	(Plectrophenax hyperboreus)
701	UNSP	'Unidentified Sparrow'	

UNIDENTIFIED BIRDS

UNBI	'Unidentified Birds'

STANDARD OPERATING PROCEDURE

Electroshocker Fish Sampling

I. Purpose and Scope

To provide a general guideline for conducting fish community surveys using electroshocking equipment.

II. Equipment and Materials

- Backpack electroshocker
- Boat-mounted electroshocker
- Seines
- Dip nets
- Personal protective equipment
- Measuring board
- Weighing equipment
- Coolers, ice, dry ice
- Water buckets
- Equipment operation manuals
- Gasoline

III. Procedures and Guidelines

1. Fish in the lagoon will be collected with a boat-mounted electrofishing unit.

2. Sample intervals will consist of approximately 30 minutes of shocking time or until no new fish species are collected in 10 minutes of shocking. Actual shocking time is to be recorded for each sample.

3. Fish will be collected

4. Information on species, size, location, and physical condition will be recorded for each fish captured, with a long-handled dip net and placed in a live tank or bucket. Any physical abnormalities will be noted.

5. Select fish (target species) of the size that would be retained by fishermen will be retained for tissue analysis. Target species of interest will be species such as White Sucker or Carp. These species feed on invertebrates associated with the bottom material, would most likely uptake contaminants of concern, and could be utilized as a food resource by higher vertebrates, including man. Where possible, those specimens that are about the same size (length and weight) will be retained.

6. Select fish (target species) will be retained for whole fish analysis. The target species will be those that are bottom feeders which would most likely uptake contaminants of concern, and could be used as a food resource by higher vertebrates.

7. Sampling equipment, including the fish measuring board, will be decontaminated according to the procedures outlined in SOP 6 between samples.

8. Information on habitat condition of the lagoon will be recorded, including water depth, substrate type, shoreline profile or vegetation and degree of shading.

IV. Attachments

None

V. Key Checks

- Follow recommended safety precautions in operating the fish electroshocking equipment.
- Clean sample equipment between sample stations.

STANDARD OPERATING PROCEDURE

Fish Sample Collection Procedures

I. Purpose and Scope

To provide general guidelines on collecting, preserving, and shipping fish samples for chemical analysis. Fish samples will be collected using an electroshocker. Selected fish will be analyzed as whole fish or edible tissues for parameters of interest at the site.

II. Equipment and Materials

- Sample containers: teflon baggies, sample jars, aluminum foil
- Stainless steel knife
- Stainless steel tray, fillet board
- Personal protective equipment
- Coolers
- Dry ice
- Buckets
- Labels
- Masking tape

III. Procedures and Guidelines

After being collected, fish will be placed in a live-well or equivalent until they can be processed. Processing of fish includes identification, measuring weight and length, and determining if they will be retained for analysis. Fish retained for analysis will be killed by suffocation.

Fish will be collected for both whole fish and selected tissue analysis. Fish selected for tissue analysis will be evaluated using Attachment 1 to determine if the skin should be removed. The fish will be filleted according to the attached procedure. Wastes generated during filleting will be disposed of as potentially hazardous materials. Between each fillet, the sample handling equipment will be decontaminated according to SOP Decontamination of Personnel and Equipment.

Samples for organics will be wrapped in aluminum foil with the shiny side out. The aluminum foil will be taped shut using masking tape. The samples for inorganic analysis will be sealed in a teflon baggie. All of the samples will be stored and shipped to the analytical laboratories on dry ice.

IV. Attachments

- Standard edible portions of fish.

- Fillet guidelines.

V. Key Checks

- Decontaminate fillet equipment between samples.
- Samples should be stored on dry ice after they are killed.

STANDARD OPERATING PROCEDURE

Aquatic Macroinvertebrate Sampling

I. Purpose

To provide a general guideline for sampling benthic macroinvertebrate communities.

II. Scope

A standard benthic macroinvertebrate sampling procedure is described. Site-specific details are discussed in related sections of the field sampling plan.

III. Equipment and Materials

- Data sheets
- Petite Ponar or Ekman grab sampler
- Benthic wash buckets or U.S Standard No. 30 screens
- Standard No. 30 dip net
- Hip boots or chest waders
- Outer and inner rubber gloves
- Plastic bottles or containers with labels
- Rinse bottles
- Cooler
- Water buckets
- Brushes
- Large wash tub
- Suber sampler
- Site Health and Safety Plan
- Alcohol solution
- Field log book
- Metered line

IV. Procedures and Guidelines

1. Identify appropriate sample station locations in ponds, wetlands, and creek habitats and map these locations.

2. Collect samples starting from downstream locations, when sampling in flowing systems.

3. Select the appropriate sampling device (i.e. petite Ponar, Ekman, Surber, etc.) and collect five replicate samples at each station.

4. Sieve the contents of the sampler through a U.S. Standard No. 30 mesh screen or bucket with screened bottom.

5. Characterize the contents of the sample by species, if possible, and relative abundance and record this information on a appropriate data sheet.

6. Transfer contents of the screen to a labeled sample container and fix with alcohol or formalin solution.

7. Areas of wetland or stream habitat may be sampled with a dip net (U.S. Standard No. 30 mesh). Sweep the net in a standardized motion through rooted vegetation or stream areas to collect a single composite invertebrate sample. Follow procedures for other methods described above.

8. Characterize substrate conditions including color, odor, relative organic content, and physical condition.

9. Wash and rinse sampling equipment between stations to avoid contamination.

10. Photograph sample stations to supplement written descriptions.

V. Attachments

None

VI. Key Checks and Items

- Wash and rinse sampling equipment between sample stations.

Final

Master Quality Assurance Project Plan

St. Juliens Creek Annex
Chesapeake, Virginia

Contract Task Order 15

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Abbreviations and Acronyms

ASTM	American Society for Testing and Materials
BOA	Basic Ordering Agreement
BTAG	Biological Technical Assistance Group
CLP	Contract Laboratory Program
CoC	Chain-of-Custody
DO	dissolved oxygen
DQOs	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
GC/MS	gas chromatograph/mass spectrometer
HASP	health and safety plan
IDWMP	Investigation Derived Waste Management Plan
ILM03	EPA CLP SOW for multimedia, multiconcentration inorganic analysis
LANTDIV	U.S. Navy Naval Facilities Engineering Command, Atlantic Division
LEL	Lower Explosive Limit
LQAP	Laboratory Quality Assurance Plan
MCL	Maximum Contaminant Level
MDL	method detection limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
µg/L	micrograms per liter
µg/mg	micrograms per milligram
NFEC	Naval Facilities Engineering Command
NFESC	Naval Facilities Engineering Service Center
OLC02	EPA analytical method for organic low-concentration water
OLM03	EPA CLP SOW for multimedia, multiconcentration organic analysis
OVA	Organic Vapor Analyzer
OVM	Organic Vapor Monitor

Abbreviations and Acronyms, Continued

PA	Preliminary Assessment
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
%R	Percent Recovery
PCB	polychlorinated biphenyl
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SMC	System Monitoring Compound
SOP	Standard Operating Procedure
SOW	Statement Of Work
SSA	Site Screening Area
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
VOA	volatile organic analysis
VOC	volatile organic compound
WP	Work Plan

1. Introduction

This master Quality Assurance Project Plan (QAPP) has been developed for the field investigation activities at the St. Juliens Creek Annex to Naval Base, Norfolk (St. Juliens Creek Annex), Chesapeake, Virginia. This Master QAPP describes the general Quality Assurance and Quality Control (QA/QC) procedures used for conducting groundwater, surface water, sediment, soil, waste liquids and solids, and biota sampling at sites under investigation at the base. This includes sampling activities at sites to be investigated as part of future Preliminary Assessment (PA), Remedial Investigation (RI), or Feasibility Study (FS) actions as well as initial investigations at Site Screening Areas (SSAs). This QAPP is intended to encompass most analytical methodologies that may be used in investigations at St. Juliens Creek Annex. Not all analytical methods will be utilized at all sites; however, this Master QAPP is intended to be comprehensive such that any analyses that might be performed for future investigations are included herein. This document will be reviewed and updated at least once every three years as required by the U. S. Environmental Protection Agency (USEPA), Region III. Unforeseen occurrences such as the addition of analytical parameters and changes in methodologies will be provided as addenda to the Master QAPP.

QA/QC procedures for specific sites or SSAs will be described in the site-specific QAPPs, submitted under separate cover. Information to be provided in site-specific QAPPs is outlined on the QAPP site-specific checklist, located in Attachment A of the Master Work Plan (WP). Sample collection procedures are provided in the Master Field Sampling Plan (FSP) or in the Standard Operating Procedures (SOPs).

Field sampling and laboratory analyses will be conducted in accordance with the *Navy Installation Restoration Laboratory Quality Assurance Guide,* Interim Guidance Document (Naval Facilities Engineering [NFESC], February 1996).

2. Project Description

St. Juliens Creek Annex is located at the confluence of St. Juliens Creek (to the south of the Base) and the South Branch of the Elizabeth River (to the East of the Base), in Chesapeake, Virginia. The Base includes approximately 490 acres, 221 buildings, 653 feet of wharf, numerous non-operational buildings and miscellaneous structures. The facility is bordered to the north by Norfolk and Western Railroad, the City of Portsmouth, and residential areas, and to the west by residential areas. A general description of the base and its environmental history are discussed in the Master WP. Site-specific historical information or plans for investigation will be provided in the site-specific work plans, which will be developed as each site or group of sites is investigated.

Studies at St. Juliens Creek Annex are intended to characterize the potential human and ecological effects associated with past activities at the facility. Goals of the studies include:

- Obtaining data to determine the nature and extent of contamination at each of the sites and SSAs.
- Identifying potential sources, migration pathways, and receiving media.
- Obtaining data to assess the potential human health risks and ecological effects associated with contamination.
- Obtaining data to support the selection and development of remedial alternatives.

The scope and specific objectives of the studies to be conducted at St. Juliens Creek are presented in the Master WP and will be updated in each site-specific work plan.

Environmental contractors for St. Juliens Creek will use subcontractors to perform laboratory analysis, data validation, drilling, monitoring well construction, investigative-derived waste disposal, and surveying. Specific subcontractors have not yet been identified.

The objectives of the sampling work to be performed are not the same for all the sampling events. Most sampling results are expected to be used for:

- Determining the nature and extent of contamination.
- Assessing ecological and human health risks.
- Screening
- Assessing engineering and water quality parameters
- Characterizing wastes generated by site activities

The quality of the data must be very high to meet the first two objectives. The USEPA Contract Laboratory Program (CLP) Statement of Work (SOW) for organic and inorganic analytical methods outlines rigorous QC with full documentation. The CLP methods combined with the highest level of EPA-guided data validation provides the highest level of data quality. The CLP methods are to be used when available for risk assessment and evaluation of remedial alternatives

Data quality does not need to be as stringent for the remaining objectives. Screening provides the lowest data quality but the most rapid results. It is often used for health and safety monitoring at the site, preliminary comparison to ARARs, initial site characterization to locate areas for subsequent and more accurate analyses, and for engineering screening of alternatives (bench-scale tests). These types of data include those generated onsite through the use of an Organic Vapor Monitor (OVM), pH, conductivity, and other real-time monitoring equipment at the site. Results from parameters such as total organic carbon (TOC), total dissolved solids (TDS), and total suspended solids (TSS) will be used to evaluate process options and determine general water quality. Waste products will be analyzed by the Toxicity Characteristic Leaching Procedure (TCLP) and for Resource Conservation and Recovery Act (RCRA) characteristics (reactivity, ignitability, and corrosivity) to determine disposal options described in the Master Investigation-Derived Waste Management Plan (IDWMP).

Whenever appropriate, samples will be analyzed for the full EPA suite of compounds according to the CLP SOW protocols for organic and inorganic compounds. The Target Compound List (TCL) for organics includes volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). Groundwater samples whose results will be used for risk assessment may be analyzed using CLP SOW protocols for low-concentration organics and/or inorganics. The individual compounds in each group are listed in Section 8, Table 8-2. The Target Analyte List (TAL) for inorganic analytes includes 24 metals and cyanide and also is in Table 8-2.

Additional analyses will be necessary for some sites. The parameters will be analyzed by USEPA SW-846 methods.

2.1 Project Schedule

Sample collection events will be planned to maximize efficiency while maintaining field quality control. A detailed schedule will be included in the site-specific work plans.

3. Project Organization

The environmental contractor's activity manager will serve as the primary contact and will assume primary responsibility for ensuring that the work is performed in a manner that is acceptable to the U. S. Navy Facilities Engineering Command, Atlantic Division (LANTDIV). With the activity manager's oversight, the various project managers will be responsible for such activities as budget and schedule review and tracking, preparation and review of invoices, personnel-resource planning and allocation, and coordination with LANTDIV, the Base, and subcontractors. Senior reviewers and the quality control officer for the environmental contractor will review documents and procedures. Technical performance of the investigations to be conducted at St. Juliens Creek Annex and key personnel responsible for quality assurance throughout its duration are presented in Section 5.0 of the Master WP. Management personnel will be identified for each site in the site-specific addenda to the Master WP. Figure 3-1 shows the project organization and lines of authority.

The field investigation tasks will be performed by the environmental contractor, who will notify St. Juliens Creek Annex and LANTDIV before initiating field activities. A field task manager will be assigned to lead field activities. That person will be responsible for maintaining the field log book, ensuring that the Sampling and Analysis plan (SAP) is being followed, monitoring the site for releases, and other activities. The responsibilities of the field staff will include collecting the samples in accordance with the SAP, supervising subcontractors, completing sample paperwork, and shipping samples.

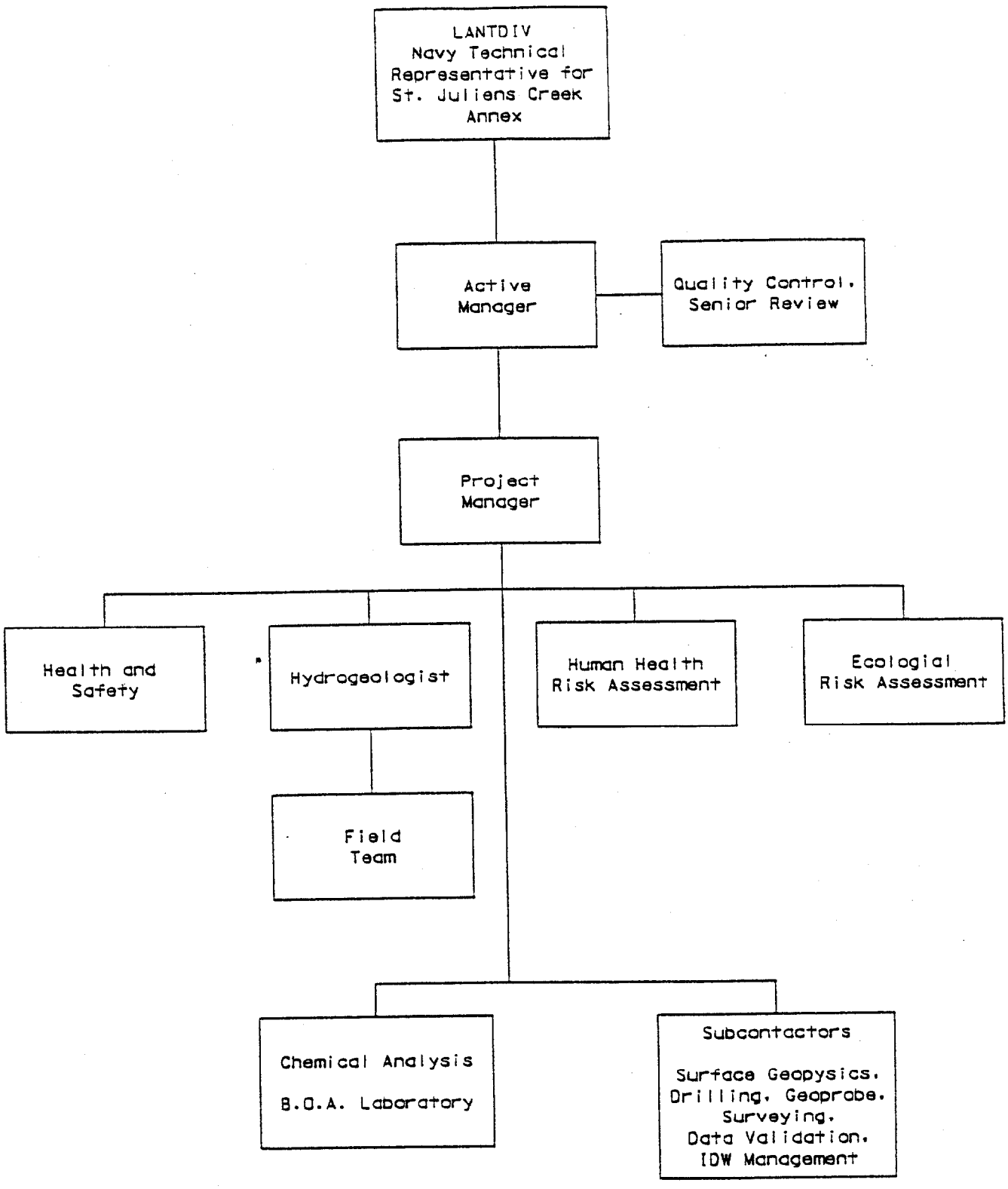

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FIGURE 3-1
PROJECT ORGANIZATION

4. Quality Assurance Objectives

Data Quality Objectives (DQOs) will be established for each major sample collection effort as specified in the Guidance for the *Data Quality Objectives Process*, EPA, September 1994. DQOs are the quantitative and qualitative descriptions of the quality of data required to support an environmental decision or action. As target values for data quality, they are not necessarily criteria for acceptance or rejection of individual analytical results. DQOs for a site vary according to the end use of the data. Everyone, from the data gatherer to the analytical laboratory, is involved in the DQO development process from the beginning.

The following fundamental mechanisms will be used to achieve quality goals:

- Prevention of errors through planning, documented instructions and procedures, and careful selection and training of personnel
- Assessment of data through field and laboratory audits and data validation of the analytical results
- Correction of errors through a corrective-action program.

The three documents in the Master SAP (QAPP, Field Sampling Plan [FSP], and IDWMP) contain the plans and procedures for safe, competent sampling and for effective management of the data. Each laboratory providing analytical data for the sampling efforts has developed its own Laboratory Quality Assurance Plan (LQAP). The SAP and the LQAP must address the elements of the Navy QA Program.

Audits in the field and in the laboratories will determine how the QA/QC procedures are being implemented. Discrepancies, if any, will be addressed through the corrective action programs described in the SAP and the LQAP.

4.1 High Level DQOs

The higher level DQOs for this project as described in Section 2 are to reliably determine the nature and extent of contamination and to assess the ecological and human health risks. Risk assessments involve comparing detected concentrations of contaminants with standards and toxicological or biological criteria.

The detection limits achieved by the EPA's CLP TCL organics and TAL inorganics analyses are adequate to meet the DQOs except for groundwater.

A few of the drinking water standards are set below the detection limits for these methods. For example, the maximum contaminant level (MCL) for vinyl chloride is 2 micrograms per liter (µg/L), and the CLP VOC contract required quantitation limit for vinyl chloride is 10 µg/L. As a tool for ecological assessments, the Region III Biological Technical Assistance Group (BTAG) has developed screening levels for surface water and sediment. These screening levels are several orders of magnitude below the standard detection limits

achieved by standard CLP methods. For example, the screening level for silver in surface water is 0.0001 µg/L for fauna, but the CLP detection limit for silver is 10 µg/L.

No extra value or information is gained for the additional costs of most low-concentration analyses. Therefore, soil, surface water, and sediment will be analyzed using standard CLP TCL organic and TAL inorganic protocols. EPA or the State may require low-concentration methods for comparison to human health or biota standards that are below the detection limits achieved by regular methods.

The groundwater can be analyzed by *CLP Statement of Work (SOW) for Organics Analysis Low Concentration Water (OLC02)* at very little additional cost and no change in sampling technique. OLC02 includes VOCs, SVOCs, pesticides, and PCBs. The same laboratory instrumentation is used, although the compound list is slightly longer for VOCs (see the compound lists in Table 8-2), and the QC requirements are modified. The matrix spike/matrix spike duplicate (MS/MSD) analysis is not part of the protocol in OLC02, because matrix interferences are not expected in drinking water samples. For this project, extra volume for MS/MSDs will be submitted because matrix effects are expected. The laboratory will be informed that the samples first should be screened so that the proper dilution factor can be selected.

Data validation for this project will be performed using the Region III Modifications to the National Functional Guidelines and will ensure that the data obtained under the EPA protocols will be acceptable.

4.2 Low Level DQOs

Analyses of engineering and water quality parameters or waste disposal characteristics do not require the level of quality control and documentation needed for risk assessment. In the field, all instruments will be calibrated according to the SOPs and site-specific FSPs and documented in the log books. When appropriate, equipment blanks will be collected and analyzed, and matrix influences will be determined. The laboratories will follow the procedures of the EPA methods selected, and submit documentation to substantiate the analyses.

Data evaluation will be conducted by the data management staff of the environmental contractor. The Chain of Custody (CoC) forms, laboratory case narratives, and log books will be checked against sample results, blank results, and percent recoveries (where applicable).

4.3 PARCC

DQOs are measured by the degree of precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data that is required for the project. The project's precision and accuracy objectives for laboratory analysis are in Table 4-1. Site-specific quality objectives will be provided on the QAPP checklist in the site-specific SAPs.

Table 4-1
Precision, Accuracy, and Completeness of Objectives

Parameter	Precision (RPD)	Accuracy (%R)	Intended Data Use
Groundwater and Surface Water			
TCL Organic Compounds	< ±20	80-120	Determine extent of contamination. Human and ecological risk assessment.
Low-concentration Organic Compounds	< ±20	80-120	Determine extent of contamination. Human and ecological risk assessment.
Organophosphorus Pesticides	< ±25	85-125	Determine extent of contamination Human and ecological risk assessment.
Chlorinated Herbicides	< ±25	85-125	Determine extent of contamination Human and ecological risk assessment.
TAL Metals and Cyanide	< ±20	80-120	Determine extent of contamination Human and ecological risk assessment.
Low-concentration Metals and Cyanide	< ±20	80-120	Determine extent of contamination Human and ecological risk assessment.
TOC	85-115	--	Evaluate process options
TSS, TDS	--	--	Evaluate process options
Alkalinity	--	--	Evaluate process options and determine water quality
Hardness	--	--	Evaluate process options and determine water quality
Soil and Sediment			
TCL Organics	< ±25	75-125	Determine extent of contamination Human and ecological risk assessment.
Organophosphorus Pesticides	< ±30	70-130	Determine extent of contamination Human and ecological risk assessment.
Chlorinated Herbicides	< ±30	70-130	Determine extent of contamination Human and ecological risk assessment.
TAL Metals and Cyanide	< ±30	70-130	Determine extent of contamination Human and ecological risk assessment.
Grain Size	--	--	Characterize soil or sediment
TCLP Organics and Inorganics	--	--	Determine disposal options
RCRA Parameters (Reactivity, Ignitability, Corrosivity)	--	--	Determine disposal options

RPD = Relative Percent Difference
%R = Percent Recovery
TCL = Target Compound List
TOC = Total Organic Carbon
TSS = Total Suspended Solids
TDS = Total Dissolved Solids
TCLP = Toxicity Characteristic Leaching Procedure
RCRA = Resource Conservation and Recovery Act

4.3.1 Accuracy and Precision

Accuracy is a measure of the agreement between an experimental result and the true value of the parameter. Analytical accuracy can be determined by using known reference materials or matrix spikes. Spiking of reference materials into the actual sample matrix is the preferred technique because it quantifies the effects of the matrix on the analytical accuracy. Accuracy can be expressed as percent recovery (%R) determined by the following equation:

$$\% R = \frac{SSR - SR}{SA} \times 100$$

where: SSR = spiked sample result
SR = sample result (native)
SA = spike added

Precision is the measure of the agreement or repeatability of a set of duplicate results obtained from repeat determinations made under the same conditions. The precision of a duplicate determination can be expressed as the relative percent difference (RPD), which is determined by the following equation:

$$RPD = \frac{|X1 - X2|}{X1 + X2} \times 200$$

where: X1 = first duplicate value
X2 = second duplicate value

For a given laboratory analysis, the duplicate RPD values are tabulated, and the mean and standard deviations of the RPD are calculated. Control limits for precision usually are plus or minus two standard deviations from the mean.

Accuracy and precision will be monitored by using field duplicate, MS, and MSD samples. These data alone cannot be used to evaluate the accuracy and precision of individual samples but will be used to assess the long-term accuracy and precision of the analytical method.

4.3.2 Completeness

Completeness is defined as the percentage of analytical measurements that are judged to be valid, validity being defined by the DQOs. Percent completeness is calculated as the number of analyses meeting all quality criteria divided by the total number of analyses performed multiplied by 100. The completeness goal for the project is 85 percent.

4.3.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent parameter variations at a sampling point. Representativeness is a measure of how closely the measured results reflect the actual distribution and concentration of certain chemical compounds in the medium sampled. The Master FSP and the SOPs describe the procedures to be used for collecting samples. This process will generate samples that are as

representative as possible. Documentation of laboratory and field procedures, as described in the FSP, will be used to verify that protocols have been followed and that sample identification and integrity have been maintained.

4.3.4 Comparability

"Comparability" is the term that describes the confidence with which one data set can be compared with another. Comparability refers to such issues as using standard field and analytical techniques, following the same QA/QC procedures, and reporting data in the same units. This criterion becomes important if more than one field team is collecting samples or more than one laboratory is analyzing samples. Consistency in sampling and laboratory procedures will be maintained throughout the project. (See the Master FSP and the SOPs in Appendix A of the Master WP for a discussion of sampling procedures.) In addition, accepted methodologies will be used for sample analysis, and these methods will not be changed during the project.

5. Sample Collection Procedures

Descriptions of sampling procedures are provided in the Master FSP and in the SOPs. Procedures are included that describe the following, at a minimum:

- Sampling methods
- Sample packing, handling, and shipment, including time considerations
- Preparation and use of trip blanks, field blanks, equipment blanks, and duplicate samples
- Documentation of sampling activities

Site-specific sampling procedures, sampling point selection, special conditions for sample container preparation, or special time requirements will be addressed in the site-specific SAPs.

6. Sample Custody

Essential to a sampling and analysis program is maintaining the integrity of the sample, from collection to data reporting. This requires tracking the possession and handling of samples from the time of collection, through analysis, to final disposal. This documentation is referred to as chain-of-custody (CoC). Figure 6-1 shows an example of a CoC form. The essential components of the CoC are described in the FSP and summarized below.

6.1 Field Custody

The field team leader is responsible for the care and custody of samples until they are shipped or otherwise delivered to the laboratory custodian.

6.2 Transfer of Custody

The CoC form must be completed before samples are shipped. The persons involved in relinquishing and receiving the samples will sign, date, and note the time of sample receipt on the CoC form. The first such transfer may occur between the field sampler and the sample carrier. Another transfer may occur between the sample carrier and the laboratory's sample custodian. Each sample shipment will be accompanied by a CoC record that identifies the contents of the shipment.

6.3 Laboratory Custody

Laboratory custody procedures are detailed in each laboratory's LQAP. The laboratory custodian will verify that the custody seals on the sample shipment or the containers are intact and that the information on the CoC matches the actual contents. The laboratory custodian also will note anomalies, such as broken bottles, elevated temperatures, and missing labels. The project-specific procedures for sample custody are described fully in the FSP.

6.4 Sample Disposal

Unless otherwise instructed, the analytical laboratory will dispose of unused sample portions, according to RCRA regulations and the LQAP, after the analyses have been completed and outstanding issues between the contractor and the laboratory have been resolved.

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

13135 Lee Jackson Memorial Hwy., Suite 200
Fairfax, Va 22033
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FAX: (703) 968-0915

CHAIN OF CUSTODY RECORD

PROJECT ID.	FIELD TEAM LEADER	LABORATORY AND ADDRESS	DATE SHIPPED
PROJECT NAME/LOCATION		LAB CONTRACT:	AIRBILL NO.

MEDIA TYPE
1. Surface Water
2. Groundwater
3. Leachate
4. Field QC
5. Soil/Sediment
6. Oil
7. Waste
8. Other_____

PRESERVATIVES
1. HCl, pH <2
2. HNO3, pH <2
3. NaOH, pH >12
4. H2SO4, pH <2
5. Zinc Acetate, pH >9
6. Ice Only
7. Not Preserved
8. Other_____

SAMPLE TYPE
G = Grab
C = Composite

SAMPLE LOCATION NO.	LABORATORY SAMPLE NUMBER	PRESER-VATIVES ADDED	MEDIA TYPE	SAMPLE TYPE	19__ DATE	TIME SAMPLED	ANALYSES (List no. of containers submitted)								REMARKS (Note if MS/MSD)
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															

SAMPLER SIGNATURES:

RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME	RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME
RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME	RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME

COMMENTS:

DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory. Pink copy retained by samplers.

1/98

Figure 6-1.
Chain of Custody

7. Equipment Calibration

Various instruments will be used in the field and in the laboratory to collect data and monitor site conditions. Proper calibration, maintenance, and use of the instruments is important for collecting high-quality data. A record of calibration and maintenance activities is as important as the data record itself for verifying the delivery of high-quality data.

7.1 Field Equipment Calibration

The following field equipment to be used during this investigation will require calibration:

- pH meter
- conductivity meter
- organic vapor monitor (OVM)
- organic vapor analyzer (OVA)
- explosimeter
- turbidity meter
- dissolved oxygen (DO) meter

The meters used for field measurement will be calibrated before and during each day's use according to procedures and schedules outlined in the Health and Safety Plan (HASP) or SOPs. The standards that will be used to calibrate these instruments are shown in Table 7-1. Standards will be purchased as necessary from appropriate vendors.

If an individual suspects an equipment malfunction, the meter will be removed from service and tagged so that it is not inadvertently used, and the equipment manager will be notified so that a substitute piece of equipment can be used. Some backup equipment will be available in the field for use in case of a malfunction.

Equipment that fails calibration or becomes inoperable during use will be removed from service and tagged so that it is not used inadvertently. Such equipment will be repaired and satisfactorily recalibrated. Equipment that cannot be repaired will be replaced.

The results of activities performed using equipment that has failed recalibration will be evaluated. If the results are adversely affected, the outcome of the evaluation will be documented and the task manager will be notified.

7.2 Laboratory Equipment Calibration

The laboratory itself is responsible for equipment and instrument calibration and maintenance. Manufacturer's guidance shall be followed for general upkeep. Laboratory calibration procedures are outlined in the LQAP.

Table 7-1
Calibration Standards

Instrument	Calibration Standard	Span	Reading	Method
OVM (11.7 eV)	100 ppm isobutylene	RF = 0.68	68 ppm	1.5 L/min reg: T-tubing
OVA	100 ppm methane	RF = 1.00	100 ppm	1.5 L/min reg: T-tubing
pH Meter	pH 4 and 7 Buffers	N/A	N/A	N/A
Conductivity Meter	EC 225 and 1,000 µS/cm	N/A	N/A	N/A
Explosimeter	75% LEL Pentane	N/A	50% ±5% LEL Oxygen	1.5 L/min: Direct tubing
Turbidity Meter	Per instrument instructions	N/A	N/A	Per instrument instructions
DO meter	N/A	N/A	> 0.1 ppm	Adjust for temperature, altitude, and salinity

LEL = Lower Explosive Limit
RF = Response Factor
ppm = parts per million
L/min = Liters per minute

8. Analytical Procedures

All laboratory analyses will be performed by a laboratory approved by NFESC. The laboratories will be procured using Basic Ordering Agreements (BOAs). Table 8-1 lists analytical procedures that may be used for samples collected at the Base. Other analyses may be required and will be discussed in the site-specific SAP. Table 8-2 lists the chemicals analyzed by each method and the reporting limits.

Table 8-1
Analytical Procedures

Analysis	Methodology
TCL VOCs, SVOCs, and Pesticides/PCBs	U.S. EPA CLP Organics SOW OLM03 or latest version [a]
Low-concentration VOCs, SVOCs, and Pesticides/PCBs (for groundwater samples)	U.S. EPA CLP SOW for Low-concentration Water OLC02 (8/94) [b]
Organophosphorus pesticides	SW-846 Method 8140
Chlorinated pesticides	SW-846 Method 8150
TAL Metals and Cyanide	U.S. EPA CLP Inorganics SOW IML03 or latest version [c]
TOC	EPA Method 415.1
TDS	EPA Method 160.1
TSS	EPA Method 160.2
Hardness	EPA Method 130.2
Alkalinity	EPA Method 310.1
Grain Size	ASTM 0421-58/0422-63
TCLP	SW-846 Method 1311
Corrosivity	SW-846 Method 9040
Ignitability	SW-846 Method 1010
Reactivity	SW-846 Methods 9010 and 9030

[a] Actual analytical methods will be determined during scoping of individual site-specific work plans.

[b] The laboratory may analyze organic samples under another U.S. EPA CLP organics SOW if the reporting limits on Table 8-2 can be met and verified by MDL studies. The requested reporting limit for pentachlorophenol is 5 µg/L.

[c] Lower detected limits may be needed for some metals analyses. In these cases, antimony must be analyzed by the graphite furnace method to meet the reporting limit on Table 8-2. Note the lower reporting limit of 2 µg/L for thallium.

OLM03 = EPA CLP SOW for multimedia, multiconcentration organic analysis
OLC02 = EPA analytical method for organic low-concentration water
IML03 = EPA CLP SOW for multimedia, multiconcentration inorganic analysis
MDL = Method Detection Limit
µg/L = micrograms per liter

Table 8-2
Analytical Parameters and Reporting Limits

Volatile Organic Compounds on Target Compound List (TCL) (Method OLM03)

Analyte	Water µg/l	Soil/ Sediment µg/kg	Analyte	Water µg/l	Soil/ Sediment µg/kg
Acetone	10	10	1,2-Dichloropropane	10	10
Benzene	10	10	cis-1,3-Dichloropropene	10	10
Bromoform	10	10	trans-1,3-Dichloropropene	10	10
Bromodichloromethane	10	10	Ethylbenzene	10	10
Bromomethane	10	10	2-Hexanone	10	10
2-Butanone	10	10	4-Methyl-2-pentanone	10	10
Carbon disulfide	10	10	Methylene chloride	10	10
Carbon tetrachloride	10	10	Styrene	10	10
Chlorobenzene	10	10	1,1,2,2-Tetrachloroethane	10	10
Chloroethane	10	10	Tetrachloroethene	10	10
Chloroform	10	10	Toluene	10	10
Chloromethane	10	10	1,1,1-Trichloroethane	10	10
Dibromochloromethane	10	10	1,1,2-Trichloroethane	10	10
1,1-Dichloroethane	10	10	Trichloroethene	10	10
1,2-Dichloroethane	10	10	Vinyl chloride	10	10
1,1-Dichloroethene	10	10	Xylenes (total)	10	10
1,2-Dichloroethene (total)	10	10			

Low-Concentration Volatile Organic Compounds (Method OLC02)

Analyte	Water µg/l	Analyte	Water µg/l
Acetone	5	1,1-Dichloroethene	1
Benzene	1	cis-1,2-Dichloroethene	1
Bromoform	1	trans-1,2-Dichloroethene	1
Bromochloromethane	1	1,2-Dichloropropane	1
Bromodichloromethane	1	cis-1,3-Dichloropropene	1
Bromomethane	1	trans-1,3-Dichloropropene	1
2-Butanone	5	1,2,4-Trichlorobenzene	1
Carbon disulfide	1	Ethylbenzene	1
Carbon tetrachloride	1	2-Hexanone	5
Chlorobenzene	1	4-Methyl-2-pentanone	5
Chloroethane	1	Methylene chloride	2
Chloroform	1	Styrene	1
Chloromethane	1	1,1,2,2-Tetrachloroethane	1
1,2-Dibromo-3-chloropropane	1	Tetrachloroethene	1
Dibromochloromethane	1	Toluene	1
1,2-Dibromoethane	1	1,1,1-Trichloroethane	1
1,2-Dichlorobenzene	1	1,1,2-Trichloroethane	1
1,3-Dichlorobenzene	1	Trichloroethene	1
1,4-Dichlorobenzene	1	Vinyl chloride	1
1,1-Dichloroethane	1	Xylenes (total)	1
1,2-Dichloroethane	1		

Table 8-2
Analytical Parameters and Reporting Limits

TCLP Volatile Organic Compounds(CODE VTCLP)

Analyte	Water µg/l	Analyte	Water µg/l
Benzene	10	1,1-Dichloroethene	10
Carbon tetrachloride	10	Tetrachloroethene	10
Chlorobenzene	10	Trichloroethene	10
Chloroform	10	2-Butanone	10
1,2-Dichloroethane	10	Vinyl chloride	10

Semivolatile Organic Compounds on Target Compound List (TCL) (Method OLM03)

Analyte	Water µg/l	Soil/ Sediment µg/kg	Analyte	Water µg/l	Soil/ Sediment µg/kg
1,2-Dichlorobenzene	10	330	2,4-Dinitrophenol	25	800
1,3-Dichlorobenzene	10	330	4-Nitrophenol	25	800
1,4-Dichlorobenzene	10	330	Dibenzofuran	10	330
Phenol	10	330	2,4-Dinitrotoluene	10	330
bis-(2-Chloroethyl)ether	10	330	Diethylphthalate	10	330
2-Chlorophenol	10	330	4-Chlorophenyl-phenylether	10	330
2-Methylphenol	10	330	Fluorene	10	330
2,2′-oxybis(1-Chloropropane)	10	330	4-Nitroaniline	25	800
4-Methylphenol	10	330	4,6-Dinitro-2-methylphenol	25	800
N-Nitroso-di-n-propylamine	10	330	N-Nitrosodiphenylamine	10	330
Hexachloroethane	10	330	4-Bromophenyl-phenylether	10	330
Nitrobenzene	10	330	Hexachlorobenzene	10	330
Isophorone	10	330	Pentachlorophenol	25	800
2-Nitrophenol	10	330	Phenanthrene	10	330
2,4-Dimethylphenol	10	330	Anthracene	10	330
bis-(2-Chloroethoxy)methane	10	330	Di-n-butylphthalate	10	330
2,4-Dichlorophenol	10	330	Carbazole	10	330
1,2,4-Trichlorobenzene	10	330	Fluoranthene	10	330
Naphthalene	10	330	Pyrene	10	330
4-Chloroaniline	10	330	Butylbenzylphthalate	10	330
Hexachlorobutadiene	10	330	3,3′-Dichlorobenzidine	10	330
4-Chloro-3-methylphenol	10	330	Benzo(a)anthracene	10	330
2-Methylnaphthalene	10	330	Chrysene	10	330
Hexachlorocyclopentadiene	10	330	bis-(2-Ethylhexyl)phthalate	10	330
2,4,6-Trichlorophenol	10	330	Di-n-octylphthalate	10	330
2,4,5-Trichlorophenol	25	800	Benzo(b)fluoranthene	10	330
2-Chloronaphthalene	10	330	Benzo(k)fluoranthene	10	330
2-Nitroaniline	25	800	Benzo(a)pyrene	10	330
Dimethylphthalate	10	330	Indeno(1,2,3-cd)pyrene	10	330
Acenaphthylene	10	330	Dibenz(a,h)anthracene	10	330
2,6-Dinitrotoluene	10	330	Benzo(g,h,i)perylene	10	330
3-Nitroaniline	25	800	Acenaphthene	10	330

Table 8-2
Analytical Parameters and Reporting Limits

TCLP Semivolatile Organic Compounds (Method STCLP)

Analyte	Water µg/l	Analyte	Water µg/l
Methylphenols (total; same as total cresols)	40	2,4,6-Trichlorophenol	40
		2,4,5-Trichlorophenol	100
Hexachlorobenzene	40	2,4-Dinitrotoluene	40
Hexachlorobutadiene	40	Pentachlorophenol	100
Hexachloroethane	40	Pyridine	40
Nitrobenzene	40	1,4-Dichlorobenzene	40

Pesticides and PCBs on Target Compound List (TCL) (Method OLM03)

Analyte	Water µg/l	Soil/ Sediment µg/kg	Analyte	Water µg/l	Soil/ Sediment µg/kg
alpha-BHC	0.05	1.7	4,4'-DDT	0.10	3.3
beta-BHC	0.05	1.7	Methoxychlor	0.50	17.0
delta-BHC	0.05	1.7	Endrin ketone	0.10	3.3
gamma-BHC (Lindane)	0.05	1.7	Endrin aldehyde	0.10	3.3
Heptachlor	0.05	1.7	alpha-Chlordane	0.05	1.7
Aldrin	0.05	1.7	gamma-Chlordane	0.05	1.7
Heptachlor epoxide	0.05	1.7	Toxaphene	5.0	170
Endosulfan I	0.05	1.7	Aroclor-1016	1.0	33.0
Dieldrin	0.10	3.3	Aroclor-1221	2.0	67.0
4,4'-DDE	0.10	3.3	Aroclor-1232	1.0	33.0
Endrin	0.10	3.3	Aroclor-1242	1.0	33.0
Endosulfan II	0.10	3.3	Aroclor-1248	1.0	33.0
4,4'-DDD	0.10	3.3	Aroclor-1254	1.0	33.0
Endosulfan sulfate	0.10	3.3	Aroclor-1260	1.0	33.0

TCLP Pesticides (Code PTCLP)

Analyte	Water µg/l	Analyte	Water µg/l
alpha-Chlordane	0.05	gamma-BHC (Lindane)	0.05
gamma-Chlordane	0.05	Methoxychlor	0.05
Endrin	0.05	Toxaphene	0.05
Heptachlor(and Heptachlor epoxide)	0.05		

Table 8-2
Analytical Parameters and Reporting Limits

Metals and Cyanide on the Target Analyte List (TAL) (Method ILM03)

Analyte	Water µg/l	Soil/ Sediment µg/kg	Analyte	Water µg/l	Soil/ Sediment µg/kg
Aluminum	200	40	Lead	3	0.6
Antimony	60	12	Magnesium	5,000	1,000
Arsenic	10	2	Manganese	15	3
Barium	200	40	Mercury	0.2	0.2
Beryllium	5	1	Nickel	40	8
Cadmium	5	1	Potassium	5,000	1,000
Calcium	5,000	1,000	Selenium	5	1
Chromium	10	2	Silver	10	2
Cobalt	50	10	Sodium	5,000	1,000
Copper	25	5	Thallium	10	2
Cyanide	10	2	Vanadium	50	10
Iron	100	20	Zinc	20	4

TCLP Metal (Code MTCLP)

Analyte	Water µg/l	Analyte	Water µg/l
Arsenic	2	Lead	3
Barium	10,000	Mercury	0
Cadmium	4	Selenium	4
Chromium	7	Silver	4

9. Data Reduction, Validation, and Reporting

Data reduction and reporting are steps in the overall management and use of both field and laboratory data, and data validation is a step in the overall management and use of laboratory data. Figure 9-1 shows the flow of information and sample-tracking forms.

9.1 Data Reduction

Data reduction, validation, and reporting will ensure that all documents for the investigations can be accounted for when they are completed. Documents requiring accountability include logbooks, field data records, correspondence, CoC records, analytical reports, data packages, and reports.

9.2 Definition

Collected analytical data will be computerized. Electronic data will be requested for all TCL and TAL analyses from the laboratory in a format agreed upon by the data manager. Other types of analytical data will be entered and then verified by spot-checking procedures. The sample manager will handle data entries that are unverified.

9.3 Background Data

Background data produced for internal records and not reported as part of the analytical data include the following: laboratory worksheets, laboratory notebooks, sample-tracking system forms, maintenance records, calibration records, and associated QC records. These sources will be available for inspection and for determining the data validation.

9.4 Data Validation

Validation of analytical data will be in accordance with NFESC QA guidance and EPA QA/QC requirements. Analytical results requiring high level DQOs will be validated using the EPA Region III Modifications to the National Functional Guidelines for Organic and Inorganic Data Review. Data validation will be performed by a subcontractor to the environmental contractor. The project, its objectives, and the intended use of the data will be discussed with the data validation personnel. Analytical results with low level DQOs will be evaluated for completeness and applicable precision, accuracy, and blank contamination.

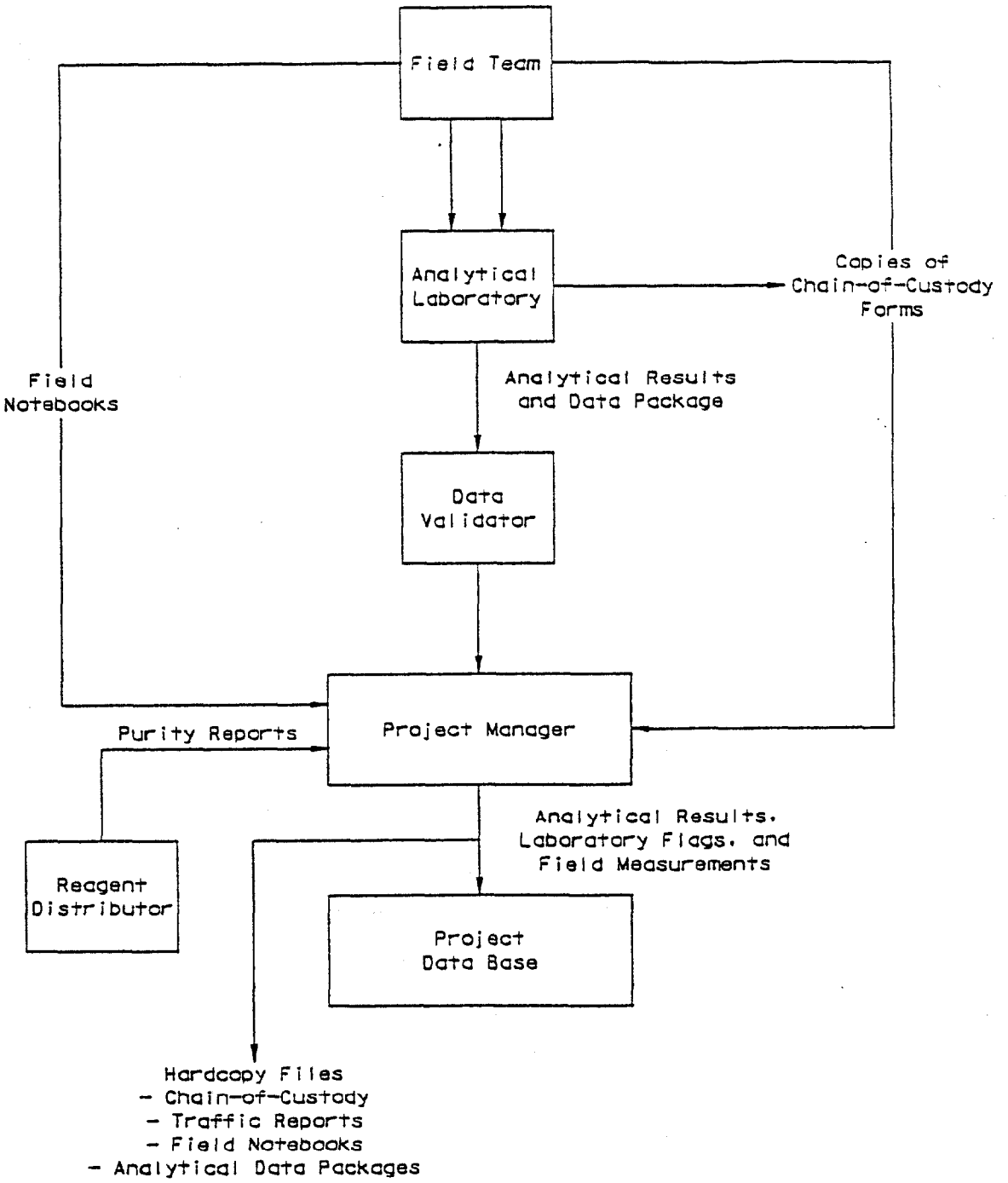

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FIGURE 9-1
FLOW OF FORMS AND SAMPLE AND ANALYSIS INFORMATION

9.5 Data Records

The following procedures will be used for maintaining the project records:

- The task manager will determine the records to be generated before the start of work. The records will be listed in the site-specific work plans and sampling and analysis plans.
- Records of field activities that support the integrity of samples will be entered on bound and numbered pages. Such records will be dated and signed or otherwise authenticated on the day of entry.
- Records retained on file will be indexed. The indexing system will include the locations of records within the indexing system. (The indexing system will be in alphabetical, chronological, or numerical order or as otherwise indicated in written procedures.)
- There will be sufficient information in records to permit identification between the record and the item(s) or activity to which it applies. Identification of records will be by means that permit traceability.
- The record-storage system will provide for accurate retrieval of records without undue delay.
- The format for electronic deliverable data is currently being developed by CH2M HILL for use with Navy GIS. When the format is finalized and tested the format will be included with next revision or site-specific work plans.

10. Quality Control Checks

A number of QA/QC samples will be collected to check the adequacy of sample collection and analysis and to monitor laboratory performance. Duplicates, blanks, and spiked samples are used to determine if the sampling technique affects the analytical results, to measure the internal consistency of the samples, and estimate variances or biases in the analytical process. The field and laboratory QA/QC sampling procedures are described below.

10.1 Field Sampling QC Procedures

QC duplicate samples and blanks are used to provide a measure of the internal consistency of the samples and an estimate of variance and bias. Table 10-1 shows the number of each type of field QC sample that should be collected for the number of investigative samples collected. The number and kinds of QC samples to be collected for each sampling event will be listed in each site-specific SAP.

Table 10-1
Summary of QC Collection Frequencies

Type of QC Sample	Frequency Collected
Field Duplicate	One per 10 samples per matrix
Trip Blank	One per cooler containing samples for VOC analysis
Field Blank	One per sampling event, and at least one per week (if very windy or dusty, collect one per day)
Equipment Blank	One each day per matrix.
Temperature Blank	One per cooler.
MS/MSD	One per matrix for each group of up to 20 samples sent to a single laboratory.

One duplicate sample will be obtained for every 10 field samples collected. The sampling station from which the duplicate is taken will be selected with a bias toward locations where measurable concentrations are expected. Each duplicate sample will be split evenly into two sample containers and submitted for analysis as two independent samples.

MS/MSDs will be collected at the rate of 1 for every 20 field samples collected. MS/MSD samples give an indication of the laboratory's analysis accuracy and precision within the sample matrix.

Blanks provide a measure of cross-contamination sources, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. Three types of blanks can be generated during sampling activities: trip blanks, field blanks, and equipment rinsate blanks.

One trip blank will be included in each cooler used for the daily shipment of VOC samples. If more than one cooler is being sent on a given day, all of the VOC samples should be placed in one cooler, if possible, to minimize the number of trip blanks needed. The trip blanks will be prepared before each sampling event, shipped or transported to the field with the sampling bottles, and returned unopened for analysis. Trip blanks will indicate if there is contamination during shipment to the field, from storage in the field, or from shipment from the field to the analytical laboratory.

One equipment blank per sample medium will be obtained for each day of sampling. Equipment blanks will give an indication of the efficiency of decontamination procedures.

One field blank will be collected per sampling event. If sampling events extend beyond one week (five working days) or for windy and dusty field conditions, the number of field blanks should be increased. Field blanks are used to determine the chemical quality of water used for such procedures as decontamination and blank collection.

EPA has recently requested that a temperature blank be included in each cooler containing samples for CLP analyses so that the laboratory can record the temperature without disturbing the samples. The temperature blank will not be given a sample number nor listed as a sample on the CoC.

10.2 Laboratory Analytical QC Procedures

The analytical laboratory will use the QC elements, including method or laboratory blanks, initial and continuing calibrations, MS/MSDs, and surrogate spike standards as specified in the laboratory LQAP and in *Navy Installation Restoration Laboratory Quality Assurance Guide, Interim Guidance Document*, February, 1996.

Method blanks monitor potential contamination introduced during analysis. Calibration standards are used to calibrate the instrumentation, thereby controlling the accuracy of the results. Once an instrument has been calibrated, calibration is confirmed periodically by monitoring the instrument response to internal standards. For some analyses, such as those performed by gas chromatograph/mass spectrometer (GC/MS), a sample and a blank are spiked with a surrogate compound or a system-monitoring compound (SMC) chosen for properties similar to those of the analyte of interest. The surrogate spikes or SMCs evaluate the efficiency of the analytical procedure in recovering the true amount of a known compound. Laboratory duplicates are performed in certain instances (especially for inorganic analyses) to evaluate the reproducibility of the method.

MS/MSDs are spiked by the laboratory in two separate aliquots of a sample selected by the sampler from each batch of 20 field samples. The MS/MSDs will be used to assess accuracy and precision. The MSD is identical to the MS; both are analyzed to determine the reproducibility of the results. The sampler will collect a triple volume of one sample to give the laboratory enough material for analyzing the sample, the spiked sample, and the spiked sample duplicate.

11. Performance and Systems Audits

Both field and laboratory audits will be conducted.

11.1 Laboratory Performance and Systems Audits

The analytical laboratories will conduct internal QC checks as indicated in each laboratory's LQAP. The laboratories are subject to external audits by the Navy and the environmental contractor.

11.2 Field Team Performance and Systems Audits

The project manager or designee will conduct a performance audit as needed during the sampling activities to verify that the proper sampling and documentation procedures presented in the QAPP and the FSP are followed and that subsequent sample data are valid. The audit will focus on the details of the QA program. The audit checklist is the guide for performing audits for field procedures and is shown in Figure 11-1. The audit will evaluate the following:

- Project responsibilities
- Sample-collection and sample-preservation procedures
- Equipment-decontamination procedures
- Field equipment-calibration procedures
- Sample-custody procedures
- Document control
- Sample-identification system
- QC corrective-action procedures

An audit report summarizing results and corrections will be prepared and filed in the project files. Significant variances from established procedures will be reported to the project manager.

Figure 11-1
FIELD PERFORMANCE AUDIT CHECKLIST

Project Responsibilities

Project No.: _____ Date: _____

Project Location: _____ Signature: _____

Team Members: _____

Yes __ No __ 1) Was a SAP Prepared?
Comments _____
_____
_____

Yes __ No __ 2) Was a briefing held for project participants?
Comments _____
_____
_____

Yes __ No __ 3) Were additional instructions given to project participants?
Comments _____
_____
_____

Yes __ No __ 4) Is the current approved SAP being used?
Comments _____
_____
_____

Figure 11-1
FIELD PERFORMANCE AUDIT CHECKLIST
(Continued)

Sample Collection

Yes __ No __ 1) Is there a written list of sampling locations and descriptions?
Comments _____

Yes __ No __ 2) Are samples collected as stated in the FSP?
Comments _____

Yes __ No __ 3) Are samples collected in the type of containers specified in the FSP?
Comments _____

Yes __ No __ 4) Are samples preserved as specified in the FSP?
Comments _____

Yes __ No __ 5) Are the number, frequency, and type of samples collected as specified in the FSP?
Comments _____

Yes __ No __ 6) Are quality assurance checks performed as specified in the FSP?
Comments _____

Yes __ No __ 7) Are photographs taken and documented as specified in the FSP?
Comments _____

Figure 11-1
FIELD PERFORMANCE AUDIT CHECKLIST
(Continued)

Document Control

Yes __ No __ 1) Have any accountable documents been lost?
Comments _____

Yes __ No __ 2) Have any accountable documents been voided?
Comments _____

Yes __ No __ 3) Have any accountable documents been disposed of?
Comments _____

Yes __ No __ 4) Are the samples identified with sample tags?
Comments _____

Yes __ No __ 5) Are blank and duplicate samples properly identified?
Comments _____

Yes __ No __ 6) Are samples listed on a chain-of-custody record?
Comments _____

Yes __ No __ 7) Is chain-of-custody documented and maintained?
Comments _____

12. Preventive Maintenance

Routine maintenance procedures and schedules for sampling equipment are described in the manufacturer's instruction manuals. All records of inspection and maintenance will be dated and documented in the field notebook.

Maintenance procedures and schedules for all field and laboratory analytical instruments will follow the recommendations of the equipment manufacturers. Routine laboratory equipment maintenance will be performed by laboratory personnel as needed or as indicated in the LQAP. All records of inspection and maintenance will be dated and documented in laboratory record books.

Critical spare parts for the pH, the OVM, the OVA, the conductivity meter, DO meter, and the explosimeter include batteries, electrodes, and membranes. They will be included in the sampling kits to minimize downtime. In addition, backup meters will be available, if needed. Spare parts will be purchased from accepted vendors.

13. Data Assessment Procedures

The precision and accuracy of data will be assessed routinely to ensure that they meet the requirements of the DQOs.

All data will be validated before interpretation by a subcontractor. The validation will be performed according to *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review,* February 1994, and *USEPA Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses,* January 1993, and the *Region III Modifications to National Functional Guidelines for Organic Data Review Multi-Media, Multi-Concentration, September 1994, and for Evaluating Inorganic Analyses, April 1993.* (Region III Modifications).

Data with high level DQOs will be validated by an independent contractor. NFESC guidance does not allow the environmental contractor to validate data collected by its own staff. Data that should be qualified will be flagged with the appropriate symbol according to the Region III Modifications.

Data with low level DQOs will be evaluated by the environmental contractor. The results for field and equipment blanks will be reviewed if available, and the data will be qualified if necessary. The data set as a whole will be examined for completeness, consistency, anomalous results, and reasonableness.

14. Corrective Actions

Anyone who determines that there is a problem will initiate the corrective action process by consulting the project manager. Corrective action will include problem identification, investigation-responsibility assignment, action for eliminating the problem, increased monitoring of the effectiveness of the corrective action, and verification that the problem has been eliminated.

Documenting the problem is important to the overall QA program. A memorandum to file will be written for a problem associated with sample collection. A copy will be sent to the laboratory, if appropriate, to document corrections to sample identification. The memo will be written by the person discovering the QA problem or the person responsible for the problem. The memo should identify the problem, establish possible causes, and designate the person responsible for action. The responsible person will be either the project manager or the field team leader. The responsible person will verify that initial action has been taken and appears to be effective and, at an appropriate later date, will recheck to see if the problem has been resolved fully.

Examples of corrective actions include, but are not limited to, correcting CoC forms, analysis reruns (if holding-time criteria permit), recalibration with fresh standards, replacement of sources of blank contamination, examination of calculation procedures, additional training in sample preparation and analysis, reassignment of analytical responsibilities using a different batch of containers, and recommending an audit of laboratory procedures. Additional approaches may include the following:

- Resampling and analyzing
- Evaluating and amending procedures for sampling and analysis

Accepting the data and acknowledging the level of uncertainty or inaccuracy by flagging the data and providing an explanation for the qualification.

15. Quality Assurance Reports

A QA report will be completed at the end of the field activity to summarize the QA/QC status of the project and problems, if any. The report will be an assessment of the measured QA parameters (for example, precision and accuracy), the results of performance audits, reported nonconformance, and significant QA problems and the recommended solutions. A change in the QAPP will be summarized in a report or a letter and will be sent to LANTDIV and distributed to the environmental contractor's project team.

Final

Master Investigation-Derived Waste Management Plan

St. Juliens Creek Annex
Chesapeake, Virginia

Contract Task Order 15

July 2000

Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Under the

LANTDIV CLEAN II Program
Contract N62470-95-D-6007

Prepared by

AΓ

Submitted by

CH2MHILL

Herndon, Virginia

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Abbreviations and Acronyms

IDW	Investigation-Derived Waste
IDWMP	Investigation-Derived Waste Management Plan
PPE	Personal Protective Equipment
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SOP	Standard Operating Procedure
SSA	Site Screening Area
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	U. S. Environmental Protection Agency

SECTION 1.0

Introduction

The Remedial Investigation (RI) and, potentially, Site Screening Area (SSA) activities at St. Juliens Creek Annex to Naval Base, Norfolk (St. Juliens Creek Annex) will produce investigation-derived waste (IDW). IDW will subsequently require waste management and disposal in a manner that minimizes potential hazards to the public. This Master Investigation Derived Waste Management Plan (IDWMP) describes methodologies and procedures that environmental contractor's field personnel will implement to handle, manage, and dispose of IDW at St. Juliens Creek Annex.

Procedures for managing, handling, and disposing of site-specific IDW will be addressed in the site-specific IDWMP. Other information to be included in site-specific IDWMPs is outlined on the IDWMP site-specific checklist, located in Attachment A of the Master Work Plan. Some examples of IDW that may be generated during field activities on Base include:

- Soil cuttings generated during drilling
- Groundwater extracted during well development and sampling procedures
- Residual soil and wastewater generated during the decontamination of field equipment
- Non-soil solids including used personal protective equipment (PPE) and disposable sampling equipment

SECTION 2.0

Waste Handling

This section describes the waste handling procedures to be followed during the RI/FS and SSA activities on the Base. Site-specific procedures and methodologies for managing and handling IDW will be provided on the IDW checklist in the site-specific SAPs. The checklist will also reference the appropriate Standard Operating Procedures (SOP)s to follow when managing and handling IDW at the site.

2.1 Solid IDW

Solid wastes, including soils, soil cuttings, and non-soil wastes will be produced during field investigations. All IDW will be managed and disposed in accordance with this Master IDWMP and the SOPs. Different types of solid IDW are discussed below.

2.1.1 Soils and Soil Cuttings

Soil cuttings generated during field activities will be contained in 55-gallon drums, roll-off containers, or other types of approved containers if the existence of contamination at the site has either been confirmed or suggested from previous investigations, or if no previous site investigation has taken place. Soil to be contained includes the soil cuttings generated during any intrusive activity, and any soil that accumulates in the decontamination pad from the washing of drilling equipment. Drums will be sealed and appropriately labeled.

If previous investigations have confirmed that contamination does not exist at the site, soil cuttings generated during the field activities mentioned above will be returned to the borehole from which they were removed. Excess soil cuttings will be spread on the ground near the boring from which they were removed and graded and seeded as necessary. If the boring is located in an area with a maintained lawn, asphalt, or concrete surface, excess soil cuttings will be spread on the ground and graded and seeded at a location designated by the Navy.

At the conclusion of a drilling event, drums filled with potentially contaminated soil cuttings will be temporarily stockpiled at a location designated by Navy personnel. This location will be identified in the site-specific IDWMP. The Navy will then verify whether or not the site contains listed hazardous wastes, as specified in 40 CFR 261.

If the site does contain listed hazardous waste, the waste management subcontractor will dispose of the drummed soil as hazardous waste at a regulated hazardous

waste landfill. If the site does not contain listed hazardous wastes, the waste management subcontractor will collect composite soil samples from the drums and submit the samples to an approved laboratory for the waste characterization analyses required by the proposed disposal facility. The drums will remain at the temporary location until the waste management subcontractor and the environmental contractor receive the characterization sampling analytical results. The wastes must be handled and disposed of within 90 days of being

stockpiled at the temporary location. For planning purposes, IDW will be stored at the Base for a maximum of 60 days in order to ensure compliance with the 90-day accumulation time.

Upon the receipt of these results, the environmental contractor will formulate a preliminary assessment of any potential hazards posed by the IDW and submit waste management recommendations to the Navy and, if requested by the Navy, to the U. S. Environmental Protection Agency (USEPA) and Virginia state regulators. Recommendations will be based on the analytical results of soil and groundwater sampling conducted during field activities and on the results of characterization sampling. If the site's soil and groundwater sampling analytical results are "clean", and if the characterization sampling results do not contain listed hazardous wastes and are below Toxicity Characteristic Leaching Procedure (TCLP) and Resource Conservation and Recovery Act (RCRA) characteristic regulatory limits, the environmental contractor will recommend that the waste management subcontractor dispose of the soil at a non-hazardous waste disposal facility.

If the composite soil samples from the drums contain contaminant concentrations above the regulatory limits, the drummed soil will be considered hazardous. The waste management subcontractor will ship the hazardous waste to a regulated hazardous waste landfill where it will be either treated or stockpiled, as appropriate, and as directed by the Navy.

The proposed steps for accumulating, handling, and disposing of IDW soils and soil cuttings are as follows:

1. If the existence of contamination at the site has either been confirmed or suggested from previous investigations, or if no previous site investigation has taken place, shovel soils and soil cuttings from the boring into 55-gallon drums.

2. If previous investigations have confirmed that contamination does not exist at the site, return soils and soil cuttings directly into the boring from which they were removed. Excess cuttings will be spread on the ground surface near the boring from which they were removed or shoveled into 55-gallon drums if the boring is located in an area with a maintained lawn, asphalt, or concrete surface.

3. Stockpile drums in the area(s) designated by the Navy.

4. Verify with the Navy whether or not the site contains listed hazardous wastes, as specified in 40 CFR 261. If the site does contain listed hazardous wastes, as specified in 40 CFR 261, refer to step 9.

5. Upon completion of field activities, if the site does not contain listed hazardous wastes, as specified in 40 CFR 261, notify the waste management subcontractor that drums are ready to be sampled for waste characterization.

6. The subcontractor will collect composite samples from the drums and submit them to an approved off-site laboratory for the analyses required by the proposed disposal facility.

7. Upon receipt of characterization results, write a memorandum to the Navy recommending whether to handle the soil as hazardous or non-hazardous waste.

8. If the waste is considered non-hazardous, upon receipt of concurrence by the Navy, the waste management subcontractor will dispose of the soil in a non-hazardous landfill.

9. If the waste is considered hazardous, upon receipt of concurrence by the Navy, the waste management subcontractor will dispose of the waste at a regulated hazardous waste landfill where it will either be treated or stockpiled, as designated by the Navy. The Navy will be responsible for signing all manifests.

2.1.2 Non-soil Solids

The disposable personal protective equipment used by the environmental contractor's field personnel and their subcontractors will be placed in 55-gallon steel drums. Examples of PPE to be contained include nitrile gloves, tyveks, rubber boots, and respirator cartridges. Any expendable items that were used during sampling will also be contained in drums, such as in-line water filters, C-flex tubing, and paper towels. Drums will be sealed and labeled appropriately.

The PPE will be bagged and drummed pending receipt of sampling analytical results. If the sampling analytical results indicate that the site's soil and groundwater are non-hazardous, the PPE and sampling expendable items will be placed in marked bags and discarded in dumpsters. If sampling analytical results indicate that the site's soil and groundwater are hazardous, the handling and disposal procedures of PPE and sampling expendable items will be identical to those that apply for hazardous soils and soil cuttings.

2.2 Liquid IDW

Groundwater as IDW will be produced during monitoring well development and groundwater purging and sampling. Groundwater will be contained in 55-gallon drums, bladders, or other types of approved containers if previous investigations have either confirmed or suggested the existence of contamination at the site, or if investigations have not yet been conducted at the site. In addition, water generated during decontamination processes and excessive liquids that separated from soil cuttings will be added to drums containing groundwater IDW. Drums will be sealed and appropriately labeled.

If groundwater is extracted from a background location where contamination is not expected, or if previous investigations have confirmed that contamination does not exist at the site, the groundwater will not be contained during field activities.

At the conclusion of field activities, drums containing liquid IDW will be temporarily stockpiled at a location designated by Navy personnel. The contained wastes must be disposed of within 90 days of being stockpiled at the temporary location. For planning purposes, IDW will be stored at the Base for a maximum of 60 days in order to ensure compliance with the 90-day accumulation time.

The Navy will then verify whether or not the site contains listed hazardous wastes, as specified in 40 CFR 261. If the site does contain listed hazardous waste, the waste management subcontractor will dispose of the liquid IDW as hazardous waste at a regulated hazardous wastewater treatment facility where it will be treated until it meets standards for disposal as appropriate, and as directed by the Navy.

If the site does not contain listed hazardous wastes, the environmental contractor will formulate a preliminary assessment of any potential hazards posed by the IDW and submit waste management recommendations to the Navy and, if requested by the Navy, to the EPA. Recommendations will be based on the analytical results of groundwater sampling conducted during field activities. If the site's groundwater sampling analytical results are "clean", the environmental contractor will recommend that the liquid IDW be discharged to the industrial wastewater treatment facility.

If the groundwater sampling results contain contaminant concentrations above regulatory limits, the drummed water will be considered hazardous. The waste management subcontractor will ship the liquid IDW to a regulated hazardous wastewater treatment facility where it will be treated until it meets standards for disposal as appropriate, and as directed by the Navy.

The proposed steps for accumulating, handling, and disposing of IDW liquids are as follows:

1. If previous investigations have either confirmed or suggested the existence of contamination at the site, or if investigations have not yet been conducted at the site, groundwater will be contained in 55-gallon drums. In addition, water generated during decontamination processes and excessive liquids that separated from soil cuttings will be added to drums containing groundwater IDW. The drums will be sealed and appropriately labeled.

2. If groundwater is extracted from a background location where contamination is not expected, or if previous investigations have confirmed that contamination does not exist at the site, groundwater will not be contained during field activities.

3. Stockpile drums in the area(s) designated by the Navy.

4. Verify with the Navy whether or not the site contains listed hazardous wastes, as specified in 40 CFR 261. If the site does contain listed hazardous wastes, refer to step 7.

5. If the site does not contain listed hazardous wastes, the environmental contractor will write a memorandum to the Navy recommending whether to handle the drummed water as hazardous or non-hazardous waste. The recommendations will be based on results of groundwater sampling conducted during field activities.

6. If the waste is considered non-hazardous, upon receipt of concurrence by the Navy, the waste management subcontractor will haul the liquid IDW to the industrial wastewater treatment facility.

7. If the waste is considered hazardous, upon receipt of concurrence by the Navy, the waste management subcontractor will haul the liquid IDW to a regulated hazardous wastewater treatment facility where it will be treated until it meets standards for disposal as appropriate, and as directed by the Navy. The Navy will be responsible for signing all manifests.

SECTION 3.0

General Considerations

General considerations pertinent to the generation and handling of IDW are documented below. These include the minimization of waste volume, drum labeling and storage, and disposal and manifesting protocol. LANTDIV EIC, the SJCA Regional Engineer, the SJCA Base Civil Engineer, and SJCA security will be notified of the number, content, and location of drums on the Annex.

3.1 Minimization of IDW Volume

To minimize the volume of IDW soil generated during drilling, cuttings will be used to backfill the boreholes from which they were removed when previous investigations have confirmed that contamination does not exist at the site. Only excess cuttings will then be contained as IDW.

IDW soil generated during trenching will be minimized by backfilling the trench pits with soil that was extracted from them during the excavation process. Excess soil will be graded with a backhoe in the vicinity of the filled trench.

To minimize the volume of IDW groundwater, only the minimum volume of discharge purge water necessary to stabilize the pH, conductivity, temperature, and other parameters, will be purged from wells. In addition, groundwater will not be contained if extracted from a background location where contamination is not expected, or if previous investigations have confirmed that contamination does not exist at the site.

3.2 Labeling Drums

Each 55-gallon drum containing IDW will be labeled with the following information: the type of IDW (groundwater, soil, PPE, etc.), the date the drum was filled and sealed, a brief warning not to handle the drum or its contents without permission from St. Juliens Creek Annex, and the name and phone number of the LANTDIV Navy Technical Representative for SJCA. The following is an example of the information to be included on each drum:

Investigation Derived Wastes
Purge Water from Site 2 - MW1
4-8-99
Do Not Handle - Analysis Pending
Mr. Tim Reisch, LANTDIV Code 1822
(757) 322-4758

3.3 Storing IDW

Drums containing IDW will be stockpiled at an on-site location designated by Navy personnel, pending the receipt of characterization and sampling analytical results. This location will be identified in the site-specific IDWMP. The drums must be covered and stored on pallets. The contained wastes must be disposed of within 90 days of being stockpiled at the temporary location. For planning purposes, IDW will be stored at the Annex for a maximum of 60 days in order to ensure compliance with the 90-day accumulation time.

3.4 Waste Disposal and Manifesting

Upon the receipt of characterization and sampling analytical results, the environmental contractor will assess the potential hazards posed by the IDW and submit waste management recommendations to the Navy. If the test results indicate that the IDW is not a listed or characteristic hazardous waste, the environmental contractor will recommend that soil be disposed of at a non-hazardous landfill, that water be disposed of at an industrial wastewater treatment plant, and that PPE and sampling expendable items be disposed of in a trash dumpster for disposal with other non-hazardous trash generated at the Annex.

If the test results or the Navy indicates that the IDW is generated from a site that contains a listed or characteristic hazardous waste, the environmental contractor will recommend that the soil, water, and PPE be manifested, handled, treated, and disposed of as a hazardous waste by a waste management subcontractor. The waste management subcontractor will prepare manifests for a completeness review by the environmental contractor. The Navy will be responsible for signing all manifests.

Final

Master Health and Safety Plan

St. Juliens Creek Annex
Chesapeake, Virginia

Contract Task Order 15

July 2000

Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Under the

LANTDIV CLEAN II Program
Contract N62470-95-D-6007

Prepared by

CDM Federal Programs Corporation

Submitted by

CH2MHILL

Herndon, Virginia

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Introduction

The health and safety of site personnel and the public are a primary concern during investigative and remedial activities at potentially hazardous sites. This Master Health and Safety Plan (HASP) presents the conditions and hazards known or anticipated to be present at the RI/FS and, potentially, SSA sites at St. Juliens Creek Annex to Naval Base, Norfolk (St. Juliens Creek Annex). This Master HASP will be used by CDM Federal to identify and mitigate potential site and task-specific hazards and to select appropriate health and safety protective measures to be used during future tasks and operations on Base.

This Master HASP has been developed based on available information pertaining to St. Juliens Creek Annex and contains information pertinent to the general conditions on the Base such as general site information, hazard evaluation and control, personnel responsibilities and requirements, a general description of personal protective equipment, customary decontamination procedures, and emergency response procedures. A site-specific HASP will be written each time task orders and field activities are initiated at an area of investigation. The site-specific HASP will address specific sites and incorporate new information in the areas of site tasks, environmental hazards, site control procedures, personal protective equipment (PPE), and environmental monitoring. Information to be included in the site-specific HASP is outlined in the HASP site-specific checklist, located in Attachment A of the Master WP. As field programs proceed, this Master HASP will be periodically evaluated (every one year at a minimum) against current information and Base concerns. As significant changes are presented, this Master HASP will be updated.

Policy

On-site hazardous waste management activities will be performed in conformance with both the Master HASP and a site-specific HASP. Both documents are written based on the anticipated hazards and expected work conditions and apply to field activities to be performed under this Contract. Applicability of this Master HASP and the site-specific HASP extends to all CDM Federal employees and visitors entering the site. CH2M HILL subcontractors must follow an established health and safety plan; in most cases either adopting this master plan with appropriate site-specific HASP (e.g. surveyor), or adopting same and amending both with safety and/or health requirements specific to their work (e.g. driller). Subcontractor-authored HASPs must be reviewed by the Project Health and Safety Officer (PHSO) before commencing on-site work. This information will then become part of the site-specific HASP. On-site personnel must review the Master HASP and the site-specific HASP and sign an agreement to comply with its provisions prior to commencing on-site work. The Master HASP and site-specific HASP are considered operational documents which are subject to revisions in response to various site-specific conditions which may be encountered. However, they may be modified/updated only with the approval of the PHSO and Project Manager. Proper notification will be given to the Atlantic Division, Naval Facilities Engineering Command (LANTDIV) Navy Technical Representative (NTR) when significant changes to the HASPs are implemented.

This Master HASP, in combination with each site-specific HASP will, at a minimum, meet the requirements under OSHA Standard 29 Code of Federal Regulations (CFR) 1910.120 (Hazardous Waste Operations and Emergency Response).

Pre-Entry Requirements

During site mobilization, the Site Health and Safety Officer (SHSO) or delegate will perform a reconnaissance of each site as identified in the site-specific Work Plan (WP) to evaluate and determine the chemical, physical, and environmental hazards; establish or confirm emergency points of contact and procedures; and review any other issues deemed necessary to address site safety and health. The SHSO, or delegate, will then conduct a health and safety briefing with the site personnel to discuss data obtained from the previous site reconnaissance, provisions outlined in this Master HASP and site-specific HASP, and appropriate safety and health related procedures and protocols.

MASTER HEALTH AND SAFETY PLAN

This HASP will be kept on the site with the site-specific addendum during field activities and will be reviewed and updated as necessary. The plan adopts, by reference, the standards of practice (SOP) in the *CDM Federal Program Corporation Corporate Health and Safety Program,* March 1995 (or most recent revision). The site safety coordinator (SSC) is to be familiar with this program and the content of the HASP and the site-specific addendum. Site personnel must sign Attachment 1.

1 PROJECT INFORMATION AND DESCRIPTION

REFER TO THE SITE-SPECIFIC HASP FOR ADDITIONAL INFORMATION

CLIENT OR OWNER: Department of the Navy Atlantic Division **PROJECT NO:**

CH2M HILL PROJECT MANAGER: M. Tilchin **OFFICE:** WDC

SITE NAME: St. Juliens Creek Annex

SITE ADDRESS: Chesapeake, Virginia

DATE HEALTH AND SAFETY PLAN PREPARED: October, 1998

DATE (S) OF SITE WORK: Dates of site work will be supplied in site-specific work plans

SITE ACCESS: All sites at St. Juliens Creek Annex are accessed through the Main Gate of the Base.

SITE SIZE: St. Juliens Creek Annex is located on 490 acres of land at the confluence of St. Juliens Creek and the South Branch of the Elizabeth River.

SITE TOPOGRAPHY: The facility is bordered to the north by the Norfolk and Western Railroad, the City of Portsmouth, and residential areas, to the west by residential areas, to the south by St. Juliens Creek, and to the east by the south branch of the Elizabeth River. According to the U. S. Geological Survey (USGS) Norfolk South Quadrangle topographic map, in 1982 a large industrial waste pond was located adjacent to the property boundary in the northeast portion of the Annex. Most of the surrounding areas are developed, and include residences, schools, recreational areas, and shipping facilities for several large industries. The Norfolk Naval Shipyard is located approximately three miles north. Some undeveloped areas are located in various areas surrounding the facility.

PREVAILING WEATHER: The Chesapeake region is situated in a humid Mesothermal Forest climate that is characterized by long, hot summers and mild winters. Summer temperatures average in the high 80s during the day and high 60s during the night. Precipitation averages 48 inches annually and is distributed evenly over the year; relative humidity averages 72%. Thunderstorms occur approximately 40 days per year, primarily during the summer months. The average annual snowfall is 8.8 inches. Winds are generally northeasterly and moderate, averaging 10 miles per hour.

SITE DESCRIPTION AND HISTORY: The St. Juliens Creek Annex was originally an ammunitions facility. Activity at the Annex has decreased in conjunction with present

national peacetime conditions. The current primary mission of the St. Juliens Creek Annex facility is to provide a radar testing range and various administrative and warehousing facilities for the nearby Norfolk Naval Shipyard and other local Navy activities.

The St. Juliens Creek Annex began operations as a naval facility in 1849. At that time, the area, known as Fort Norfolk, was transferred from the War Department to the Navy Department for use as a storage facility for ordnance and materials. The facility was renamed Magazine, Fort Norfolk. In 1896, the facility gained an additional 48 acres to accommodate additional magazines, wharves, housing, and administration buildings. In 1898, ordnance material and equipment were moved from Craney Island to the Magazine; the facility was renamed U.S. Arsenal, St. Juliens Creek.

In 1902, the name was changed to U.S. Naval Magazine, St. Juliens Creek. The Magazine was at that time fully operational and provided critical support to the fleet during the end of the Spanish-American War.

In 1915, manually operated machines were replaced by modernized motor-powered machines. In 1917, the facility installed equipment for loading MARK VI mines. The facility's name was changed again, to Naval Ammunition Depot (NAD), St. Juliens Creek, and operated under the Commandant Fifth Naval District.

Between World War I and World War II, the facility assumed a peacetime mission of supplying ammunition to the fleet.

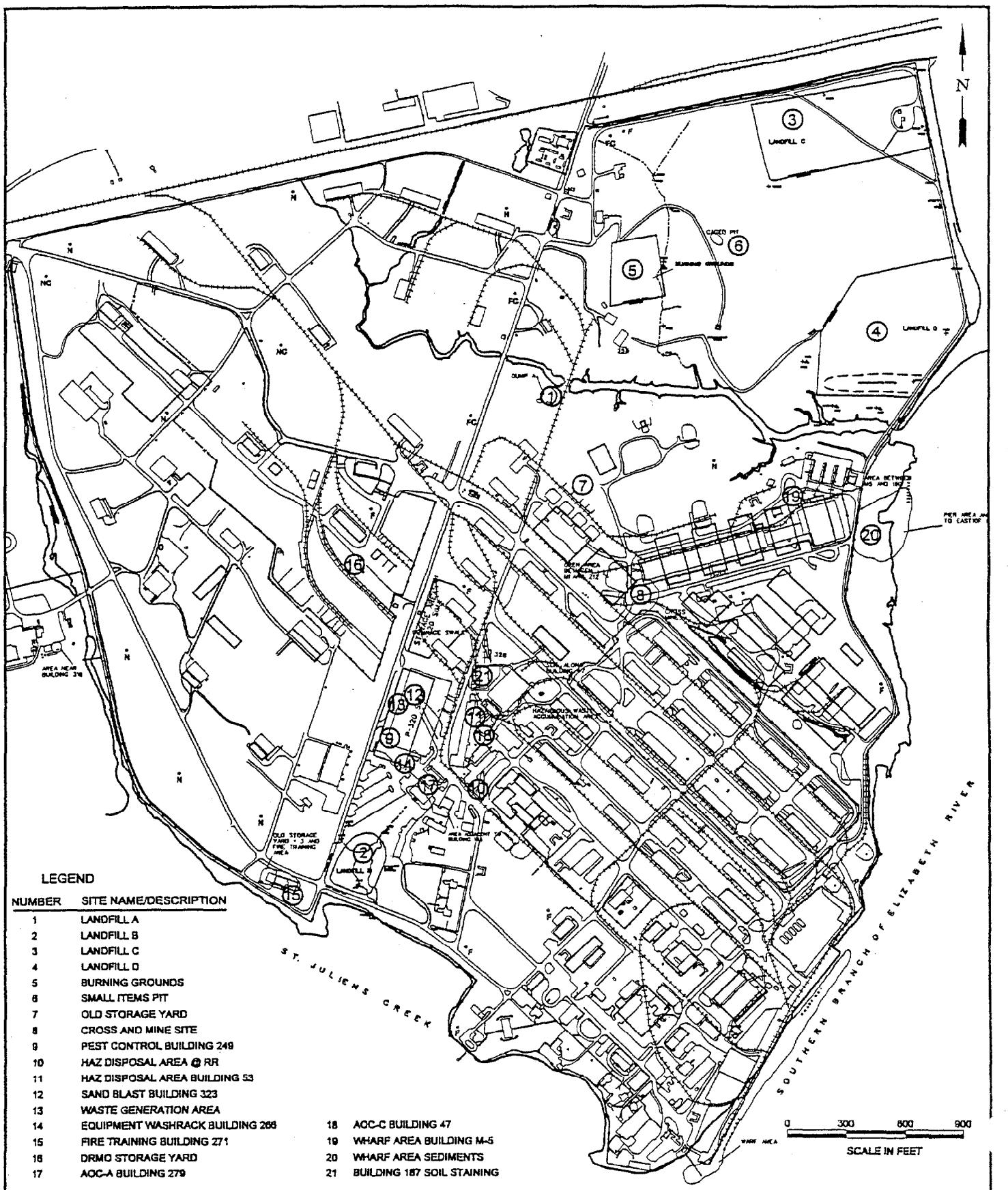
The facility operated at its peak level from 1942 to 1944, during World War II. An additional 119 acres of land were purchased, and additional magazines, filling houses, and other facilities were constructed. A fence was erected to secure the facility. The mission of NAD St. Juliens Creek during World War II included loading, assembling, issuing, and receiving naval gun ammunition. The depot also served as the principal experimental and test loading facility for new ammunition types for the Bureau of Ordnance.

The depot also supplied ammunition during the Korean War. After the war, the depot again resumed its mission of peacetime service to the fleet. In 1964, the depot was the prime source of gun ammunition for Navy and Marine Corps operations in Southeast Asia.

In October 1969, after 50 years as an independent facility, NAD St. Juliens Creek was disestablished under the Department of Defense "Project 703", and was consolidated as an annex to the Naval Weapons Station, Yorktown, Virginia. On October 1, 1977, the Annex was transferred to the Norfolk Naval Shipyard.

The Norfolk Naval Shipyard transferred the Annex to Naval Base, Norfolk in July 1995. The Class II property on the Annex was transferred from Naval Base to Naval Station in April 1996.

Currently, the St. Juliens Creek Annex provides administrative offices, light industrial shops and storage facilities for tenant naval commands, and a radar testing range for the nearby Norfolk Naval Shipyard and other local Navy activities.



LEGEND

NUMBER	SITE NAME/DESCRIPTION
1	LANDFILL A
2	LANDFILL B
3	LANDFILL C
4	LANDFILL D
5	BURNING GROUNDS
6	SMALL ITEMS PIT
7	OLD STORAGE YARD
8	CROSS AND MINE SITE
9	PEST CONTROL BUILDING 249
10	HAZ DISPOSAL AREA @ RR
11	HAZ DISPOSAL AREA BUILDING 53
12	SAND BLAST BUILDING 323
13	WASTE GENERATION AREA
14	EQUIPMENT WASHRACK BUILDING 266
15	FIRE TRAINING BUILDING 271
16	DRMO STORAGE YARD
17	AOC-A BUILDING 279
18	AOC-C BUILDING 47
19	WHARF AREA BUILDING M-5
20	WHARF AREA SEDIMENTS
21	BUILDING 187 SOIL STAINING

CDM Federal Programs Corporation

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SITE MAP
ST. JULIENS CREEK ANNEX
St. Juliens Creek Annex

2 PROJECT ORGANIZATION AND TASKS TO BE PERFORMED UNDER THIS PLAN

2.1 PROJECT ORGANIZATION

REFER TO SITE-SPECIFIC HASP FOR ADDITIONAL INFORMATION

CLIENT: Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

CDM FEDERAL: Project Manager: Dave Schroeder
Field Team Leader:
Field Staff:

CONTRACTORS and SUBCONTRACTORS: To be included in site-specific addendum to this master HASP.

2.2 DESCRIPTION OF TASKS

Refer to site-specific addenda (i.e., work plan, field sampling plan) for detailed task information. A health and safety risk analysis has been performed for each task and is incorporated in the site-specific addendum to this plan through task-specific hazard controls and requirements for monitoring and protection. Tasks in addition to those listed below and in the site-specific addendum require an approved amendment before additional work begins. Refer to Section 10.2 for procedures related to tasks that do not involve hazardous waste operations and emergency response (Hazwoper).

2.2.1 HAZWOPER-REGULATED TASKS

- Test pit and excavation
- Soil boring installation
- Geoprobe boring
- Geophysical surveys
- Hand augering
- Subsurface soil sampling
- Surface soil sampling
- Soil gas surveys
- Sediment sampling
- Monitoring well/drive point installation
- Monitoring well abandonment
- Groundwater sampling
- Aquifer testing
- Hydrologic measurements
- Surface water sampling
- Biota sampling
- Investigation-derived waste (drum) sampling and disposal
- Observation of loading of material for offsite disposal
- Oversight of remediation and construction

2.2.2 NON-HAZWOPER-REGULATED TASKS

Under specific circumstances, the training and medical monitoring requirements of federal or state Hazwoper regulations are not applicable. It must be demonstrated that the tasks can be performed without the possibility of exposure in order to use non-Hazwoper-trained personnel. **Prior approval from the HSM is required before these tasks are conducted on regulated hazardous waste sites.**

TASK	RESTRICTIVE CONDITIONS
• Electrical installation	THESE TASKS ARE NOT CURRENTLY PLANNED, AND MUST BE ADDRESSED IN THE SITE-SPECIFIC HASP.
• Iron work (installing rebar)	
• Masonry work	
• General heavy equipment work (excavation, grading, etc.)	
• Mechanical installations (equipment, pumps, etc.)	
• Engineering testing/evaluation	
• Building construction	

3 HAZARD EVALUATION AND CONTROL

This section discusses the evaluation and control of some hazards typically associated with St. Juliens Creek Annex. Each new task or area of investigation may introduce other hazards not listed in this HASP.

REFER TO THE SITE-SPECIFIC HASP FOR INFORMATION ON OTHER POTENTIAL HAZARDS

3.1 HEAT AND COLD STRESS (Reference, Section 13, Temperature Extremes, *CDM Federal Programs Corporation, Corporate Health and Safety Program*)

3.1.1 PREVENTING HEAT STRESS

- Drink 16 ounces of water before beginning work, such as in the morning or after lunch. Disposable (e.g., 4-ounce) cups and water maintained at 50° to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Take regular breaks in a cool, preferably air-conditioned, area. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours. Monitor for signs of heat stress.
- Acclimate to site work conditions by slowly increasing workloads; e.g., do not begin site work with extremely demanding activities.
- Use cooling devices, such as cooling vests, to aid natural body ventilation. The devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- During hot weather, conduct field activities in the early morning or evening if possible.
- Provide adequate shelter to protect personnel against radiant heat (sun, flames, hot metal), which can decrease physical efficiency and increase the probability of heat stress.
- In hot weather, rotate shifts of workers.
- Maintain good hygiene standards by frequently changing clothing and by showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should consult medical personnel.

3.1.2 SYMPTOMS AND TREATMENT OF HEAT STRESS

Heat Syncope	Heat Rash (*miliaria rubra*, "prickly heat")	Heat Cramps	Heat Exhaustion	Heat Stroke

3.1.2 SYMPTOMS AND TREATMENT OF HEAT STRESS

Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; and rapid breathing and pulse.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake to 1-2 cups water every 20 minutes.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Call ambulance, and get medical attention immediately! While awaiting the ambulance, cool the victim rapidly by soaking in cool–but not cold–water. Move the victim to a shaded area and remove clothing. If victim is conscious, provide them with small amounts of cool liquids.

3.1.3 HEAT-STRESS MONITORING

For field activities part of ongoing site work activities in hot weather, the following procedures should be used to monitor the body's physiological response to heat and to estimate the work-cycle/rest-cycle when workers are performing moderate levels of work. These procedures should be considered when the ambient air temperature exceeds 70°F, the relative humidity is high(>50%), when workers are wearing semi-impermeable or impermeable clothing, or when the workers exhibit symptoms of heat stress.

The heart rate should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 110 beats/minute at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 110 beats/minute, or 20 beats/minute above resting pulse. Additional methods of monitoring, such as weighing individuals before and after their shift could also be included.

See Section 13, Temperature Extremes, *CDM Federal Programs Corporation, Corporate Health and Safety Program*) for additional monitoring procedures.

3.1.4 PREVENTING COLD STRESS

- Be aware of the symptoms of cold-related disorders, and ***wear proper clothing for the anticipated fieldwork.***
- Consider monitoring the work conditions and adjusting the work schedule, using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).
- ***Wind-Chill Index.*** This measure relates the dry bulb temperature and the wind velocity. It is used only to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index sometimes is limited in its usefulness because the index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it is used only as a guideline to warn workers when they are in a situation that can cause cold-related illnesses. Used in conjunction with the NSC guidelines, the wind-chill index provides a starting point for adjusting work and warm-up schedules.
- ***NSC Guidelines for Work and Warm-Up Schedules.*** The cold-exposure limits recommended by the NSC can be used in conjunction with the wind-chill index to estimate work and warm-up schedules for fieldwork. The guidelines are not absolute; ***workers should be monitored for symptoms of cold-related illness.*** If symptoms are not observed, the work duration can be increased.
- The wind-chill index and the NSC guidelines are found in Section 13 of *CDM Federal Programs Corporation, Corporate Health and Safety Program*) and will be reproduced in the Site specific HASPS as appropriate.

3.1.5 SYMPTOMS AND TREATMENT OF COLD STRESS

	Immersion (Trench) Foot	Frostbite	Hypothermia
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment immediately.	Remove victim to a warm place. Rewarm area quickly in warm– but **not** hot–water. Have victim drink warm fluids, but **not** coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but **not** coffee or alcohol. Get medical attention.

3.2 PROCEDURES FOR LOCATING BURIED UTILITIES

Local Utility Mark-Out Service
Name: Miss Utilities 1-800-552-7001
Mr. Paul Christopher, St. Juliens Creek POC 757-367-8308 (pager)

- Where available, obtain utility diagrams for the facility.
- Review locations of sanitary and storm sewers, electrical conduits, water supply lines, natural-gas lines, and fuel tanks and lines.
- Review proposed locations of intrusive work with facility personnel knowledgeable of locations of utilities. Check locations against information from utility mark-out service.
- Where necessary, clear locations with a utility-locating instrument (e.g., metal detector).
- Where necessary (e.g., uncertainty about utility locations), excavation or drilling of the

upper depth interval should be performed manually.

- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon).
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the SSC should confirm that arrangement.

3.3 GENERAL PHYSICAL (SAFETY) HAZARDS AND CONTROLS

Engineering and administrative controls are to be implemented by the party in control of the site or the hazard (i.e., CH2M HILL, subcontractor, or contractor). CH2M HILL employees and subcontractors must, at a minimum, remain aware of hazards affecting them regardless of who is responsible for controlling the hazards. Specialty subcontractors are responsible for the safe operation of their equipment (e.g., drill rig, heavy equipment). CH2M HILL employees are not to operate, or assist in the operation of, any subcontractor or contractor equipment.

		Tasks									
Hazard (Refer to SOP, or HSP Section)	**Engineering Controls, Administrative Controls, and Work Practices**	**Test Pit and Excavation**	**Drilling, Geoprobe Installation, Well Installation and Abandonment**	**Groundwater Monitoring, Aquifer Testing, and Video Surveying of Wells**	**Surface Water and Sediment Sampling Using a Boat**	**Surface Water and Sediment Sampling from the Shore or Water**	**Hand Augering**	**Surveying**	**IDW Drum Sampling and Disposal[a]**	**Observation of Loading of Material for Offsite Disposal**	**Remediation and Construction Oversight**
Flying debris/objects (HS-07)	Provide shielding and PPE; maintain distance.	X	X		X	X	X		X	X	X
Noise > 85 dBA	Noise protection and monitoring required (equipment producing noise in excess of 85 dBa shall be labeled).	X	X		X					X	X
Gas cylinders (HS-21)	Instruct employees in the safe use of compressed gases. Make certain gas cylinders are properly anchored and chained. Keep cylinders away from ignition sources. Cap cylinders when not in use.	X	X								
Electrical	• Make certain third wire is properly grounded. Do not tamper with electrical wiring unless qualified to do so. Ground as appropriate. • Project field sites should have ground fault circuit interrupters (GFCIs) installed for all wiring, including extension cords. • Heavy equipment (e.g., drill rig) should remain at least 15 feet from overhead power line for power lines of 50 kV or less. For each 10 kV > 50, increase distance by ½ foot. • Operate and maintain equipment according to manufacturer's instructions. • Use only extension cords that are three-wire grounded. Cords passing through work areas must be covered or elevated to protect from damage. • Use only electrical tools and equipment that are either effectively grounded or double-insulated UL approved. • Properly label switches, fuses, and circuit breakers. • Remove cord from an outlet by grasping the plug, not pulling the cord. • Protect all electrical equipment, tools, switches, etc., from elements. • Avoid physical contact with power circuit. • Only qualified electricians are to install and work on electrical circuits and equipment.	X	X	X	X						X
Suspended loads	Work not permitted under suspended loads.	X	X		X					X	X
Buried utilities, drums, tanks, etc. (Section 3.3)	Locate buried utilities, drums, tanks, etc., before digging or drilling and mark location.	X	X				X				X
Slip, trip, fall hazards (e.g., wet/muddy surface, inadequate railing, unstable surface)	Provide slip-resistant surfaces, ropes, and/or other devices to be used. Brace and shore equipment	X	X	X	X	X	X	X	X	X	X
Back injury (HS-29)	Use proper lifting techniques, or provide mechanical lifting aids.	X	X	X	X	X	X		X		X

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		Tasks									
Hazard (Refer to SOP, or HSP Section)	**Engineering Controls, Administrative Controls, and Work Practices**	**Test Pit and Excavation**	**Drilling, Geoprobe Installation, Well Installation and Abandonment**	**Groundwater Monitoring, Aquifer Testing, and Video Surveying of Wells**	**Surface Water and Sediment Sampling Using a Boat**	**Surface Water and Sediment Sampling from the Shore or Water**	**Hand Augering**	**Surveying**	**IDW Drum Sampling and Disposal[a]**	**Observation of Loading of Material for Offsite Disposal**	**Remediation and Construction Oversight**
Working near water, continued	• The boat/barge must be operated according to U.S. Coast Guard regulations (speed, lightning, right-of-way, etc.). • Shut off engine before refueling; do not smoke while refueling.					X					
IDW Drum sampling	Personnel are allowed to handle and/or sample drums containing investigation-derived waste (IDW) only; handling or sampling other drums requires a plan revision or amendment approved by the CH2M HILL HSM. The following control measures will be taken when sampling drums containing IDW: • Minimize transportation of drums. • Minimize number of people involved in the actual sampling. • Sample only labeled drums or drums known to contain IDW. • Use caution when sampling bulging or swollen drums. Relieve pressure slowly. • If drums contain, or potentially contain, flammable materials, use nonsparking tools to open. • Picks, chisels, and firearms may not be used to open drums. • Reseal bung holes or plugs whenever possible. • Avoid mixing incompatible drum contents. • Sample drums without leaning over the drum opening. • If there is evidence of contamination on the lid of the drum, cover the lid with plastic sheeting. • Transfer the content of drums using a method that minimizes contact with material. • Air monitoring and PPE requirements specified in sections 5 and 6 must address drum sampling. • Spill-containment procedures specified in Section 8 must be appropriate for the material to be handled.								X		

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		Tasks									
Hazard (Refer to SOP, or HSP Section)	**Engineering Controls, Administrative Controls, and Work Practices**	**Test Pit and Excavation**	**Drilling, Geoprobe Installation, Well Installation and Abandonment**	**Groundwater Monitoring, Aquifer Testing, and Video Surveying of Wells**	**Surface Water and Sediment Sampling Using a Boat**	**Surface Water and Sediment Sampling from the Shore or Water**	**Hand Augering**	**Surveying**	**IDW Drum Sampling and Disposal[a]**	**Observation of Loading of Material for Offsite Disposal**	**Remediation and Construction Oversight**
Heavy equipment, continued	• Always confirm that the operator is aware of your location, particularly when you approach or pass by equipment. • Do not climb on operating equipment. • Do not stand adjacent to the equipment. • Backup alarm is required for heavy equipment. Do not count on backup alarms always functioning. Look around when alarm sounds. • Do not place yourself between fixed and moving parts or objects. • Stay clear of equipment on cross slopes and unstable terrain. • Stay clear of pile-driving operations. • Stay outside the turning radius of the equipment. • Operators using all-terrain vehicles (ATV) must be trained; other ATV requirements may apply. • Observer must remain in contact with operator and signal safe backup. • Personnel must remain outside the turning radius.	X	X		X					X	X
Working near water	• U.S. Coast Guard-approved personal flotation devices (PFDs–e.g., life jacket) provided for each employee will be worn. • PFDs will be inspected before and after each use. Defective equipment will not be used. • Sampling and other equipment will be used according to the manufacturer's instructions. • A minimum of one life-saving skiff will be provided for emergency rescue. • A minimum of one ring buoy with 90 feet of 3/8-inch solid-braid polypropylene (or equal) rope will be provided for emergency rescue. • Keep nonessential personnel 3 feet from edge of water • Safe means of boarding or leaving a boat or a platform will be provided to prevent slipping and falling. Boat/barge must be equipped with adequate railing. instructions/warnings (e.g., protect from pinch points, sharp objects, rope burns/entanglement). • Work requiring the use of a boat will take place only during daylight hours. • Work requiring the use of a boat will not take place during inclement weather.					X					

3.3 GENERAL PHYSICAL (SAFETY) HAZARDS AND CONTROLS

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		Tasks									
Hazard (Refer to SOP, or HSP Section)	**Engineering Controls, Administrative Controls, and Work Practices**	**Test Pit and Excavation**	**Drilling, Geoprobe Installation, Well Installation and Abandonment**	**Groundwater Monitoring, Aquifer Testing, and Video Surveying of Wells**	**Surface Water and Sediment Sampling Using a Boat**	**Surface Water and Sediment Sampling from the Shore or Water**	**Hand Augering**	**Surveying**	**IDW Drum Sampling and Disposal[a]**	**Observation of Loading of Material for Offsite Disposal**	**Remediation and Construction Oversight**
Drilling	• The drill rig is not to be operated in inclement weather. • The driller is to verify that the rig is properly leveled and stabilized before raising the mast. • Personnel should be cleared from the sides and rear of the rig before the mast is raised. • The driller is not to drive the rig with the mast in the raised position. • The driller must check for overhead power lines before raising the mast. A minimum distance of 15 feet between mast and overhead lines (<50 kV) is recommended. Increased separation may be required for lines greater than 50 kV. • The driller is to verify that the rig is in neutral when the operator is not at the controls • Personnel should stand clear before rig startup. • Become familiar with the hazards associated with the drilling method used (cable tool, air rotary, hollow-stem auger, etc.). • Do not wear loose-fitting clothing, watches, etc., that could get caught in moving parts. • Do not smoke or permit other spark-producing equipment around the drill rig. • The drill rig must be equipped with a kill wire or switch, and personnel are to be informed of its location. • Be aware and stand clear of heavy objects that are hoisted overhead. • The driller is to verify that the rig is properly maintained in accordance with the drilling company's maintenance program. • The driller is to verify that all machine guards are in place while the rig is in operation. • The driller is responsible for housekeeping (maintaining a clean work area). • The drill rig should be equipped with at least one fire extinguisher. • If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig, and stay as far away as possible. Notify emergency personnel immediately.		X								
Heavy equipment	• Become familiar with hazards specific to the equipment being used. • Do not ride equipment not designed for passengers.	X	X		X					X	X

3.3 GENERAL PHYSICAL (SAFETY) HAZARDS AND CONTROLS

Engineering and administrative controls are to be implemented by the party in control of the site or the hazard (i.e., CH2M HILL, subcontractor, or contractor). CH2M HILL employees and subcontractors must, at a minimum, remain aware of hazards affecting them regardless of who is responsible for controlling the hazards. Specialty subcontractors are responsible for the safe operation of their equipment (e.g., drill rig, heavy equipment). CH2M HILL employees are not to operate, or assist in the operation of, any subcontractor or contractor equipment.

		Tasks									
Hazard (Refer to SOP, or HSP Section)	**Engineering Controls, Administrative Controls, and Work Practices**	**Test Pit and Excavation**	**Drilling, Geoprobe Installation, Well Installation and Abandonment**	**Groundwater Monitoring, Aquifer Testing, and Video Surveying of Wells**	**Surface Water and Sediment Sampling Using a Boat**	**Surface Water and Sediment Sampling from the Shore or Water**	**Hand Augering**	**Surveying**	**IDW Drum Sampling and Disposal[a]**	**Observation of Loading of Material for Offsite Disposal**	**Remediation and Construction Oversight**
Confined space entry (Section 9.0)	Space must be evaluated by qualified person. Additional controls and monitoring, training, and an approved entry permit are generally required.	NOT APPROVED									
Trenches/excavations (HS-32)	Make certain trench meets OSHA standard before entering. All excavations > 4 feet deep must be sloped or shored. and have a ladder every 25 feet. Personnel and equipment must remain at least 2 feet from edge of trench at all times.	X									X
Protruding objects	Flag visible objects.	X	X	X	X	X	X	X	X	X	X
Visible lightning	Stop work.	X	X	X	X	X	X	X	X	X	X
Vehicle traffic (HS-24)	Provide temporary traffic controls, including trained flaggers and lookouts. Implement traffic control program when required.									X	X
Stairways, ladders, and scaffolds (HS-25)	Stairways and ladders are generally required when there is a break in elevation of 19 inches or more. Keep access ways clear. Equipment must meet OSHA specifications. Document employee training.		X								X
Elevated work area/falls (HS-31)	Provide guardrail, safety net, floor covers, body harness, and monitoring system, where applicable. Document employee training.	X				X					X
Fire prevention and control (HS-22)	• No spark sources are allowed within exclusion or decontamination zones. • Appropriate firefighting equipment must be available on the site. • Extinguishers are to be inspected visually every month and undergo an annual maintenance check. • Post "Exit" signs over exiting doors, and post "Fire Extinguisher" signs over extinguisher locations. Keep areas near exits and extinguishers clear. Open flames are prohibited in the vicinity of flammable materials. • Combustible materials stored outside should be at least 10 feet from the building. • Unnecessary combustible materials and flammable or combustible liquids must not be allowed to accumulate. • Flammable or combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.	X	X			X			X		X
Inadequate illumination	Site work will be performed during daylight hours whenever possible. Work conducted during hours of darkness will require enough illumination intensity "to read a newspaper without difficulty."	X	X	X	X	X	X	X	X	X	X
Entanglement in rotating equipment	ohibit loose clothing and hair ohibit wearing jewelry		X				X				

3.4 BIOLOGICAL HAZARDS AND CONTROLS

Hazard and Location	Control Measures
Snakes typically are found in underbrush and tall grassy areas.	If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If a person is bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Seek medical attention immediately. **DO NOT** apply ice, cut the wound, or apply a tourniquet. Carry the victim or have him/her walk slowly if the victim must be moved. Try to identify the type of snake: note color, size, patterns, and markings.
Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas.	Become familiar with the identity of these plants. Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.
Exposure to **bloodborne pathogens** may occur when rendering first aid or CPR, or when coming into contact with medical or other potentially infectious material, or when coming into contact with landfill waste or waste streams containing such infectious material.	Training is required before a task involving potential exposure is performed. Exposure controls and personal protective equipment (PPE) are required as specified in CH2M HILL SOP HS-36, *Bloodborne Pathogens*. Hepatitis B vaccination must be offered before the person participates in a task where exposure is a possibility.
Bees and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic.	Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform the SSC and/or the buddy. If a stinger is present, remove it carefully with tweezers. Wash and disinfect the wound, cover it, and apply ice. Watch for allergic reaction; seek medical attention if a reaction develops.

3.5 TICK BITES

Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch in size.

Prevention against tick bites includes avoiding tick areas; wearing tightly woven light-colored clothing with long sleeves and wearing pant legs tucked into boots or socks; spraying **only outside** of clothing with insect repellent containing permethrin or permanone, and spraying skin with DEET; and checking yourself frequently for ticks and showering as soon as possible. To prevent chemical repellents from interfering with sample analyses, exercise care while using repellents during the collection and handling of environmental samples.

If bitten by a tick, carefully remove the tick with tweezers, grasping the tick as close as possible to the point of attachment while being careful not to crush the tick. After removing the tick, wash your hands and disinfect and press the bite area. The removed tick should be saved. Report the bite to human resources personnel.

Look for symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme: a rash that looks like a bullseye with a small welt in the center. RMSF: a rash of red spots under the skin 3 to 10 days after the tick bite. In both cases, chills, fever, headache, fatigue, stiff neck, bone pain may develop. If symptoms appear, seek medical attention.

3.6 RADIOLOGICAL HAZARDS AND CONTROLS

Hazards	Controls
NONE ANTICIPATED	NONE REQUIRED

3.7 HAZARDS POSED BY CHEMICALS BROUGHT ON THE SITE

This section discusses hazards posed by chemicals commonly used during RI/FS and SSA field activities. Additional chemicals may be needed for future tasks.

REFER T O THE SITE-SPECIFIC ADDENDUM FOR INFORMATION ON HAZARDS POSED BY OTHER CHEMICALS BROUGHT ON SITE

3.7.1 HAZARD COMMUNICATION

(Reference Section 10 of *CDM Federal Programs Corporation, Corporate Health and Safety Program*)

CDM Federal's Hazard Communication Program is described in Section 10 of *CDM Federal Programs Corporation, Corporate Health and Safety Program* which is available from area or regional offices and from the Corporate Human Resources Department in Fairfax, Virginia. The project manager is to request Material Safety Data Sheets (MSDSs) from the client or from the contractors and the subcontractors for chemicals to which CDM Federal employees potentially are exposed. The SSC is to do the following:

- Give employees required site-specific HAZCO training.
- Confirm that the inventory of chemicals brought on the site by subcontractors is available.
- Before or as the chemicals arrive on the site, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, if any.

The chemical products listed below may be used on site. Refer to Attachment 2 for MSDSs.

Chemical	Quantity	Location
Methane (calibration gas)	1 liter, compressed gas	Support Zone
Isobutylene (calibration gas)	1 liter, compressed gas	Support Zone
Pentane (calibration gas)	1 liter, compressed gas	Support Zone
Hydrochloric Acid (sample preservative)	< 500 ml	Support/Exclusion Zone
Nitric Acid (sample preservative)	< 500 ml	Support/Exclusion Zone
Sulfuric Acid (sample preservative)	< 500 ml	Support/Exclusion Zone
Sodium Hydroxide (sample preservative)	< 500 ml	Support/Exclusion Zone
Methanol (decontamination solvent)	< 1 gallon	Support/Decontamination Zone
Hexane (decontamination solvent)	< 1 gallon	Support/Decontamination Zone
Isopropanol (decontamination solvent)	< 1 gallon	Support/Decontamination Zone
pH Buffers (calibration standard)	< 500 ml	Support Zone
MSA Sanitizer (respirator cleaner)	< 1 liter, powder	Support/Decontamination Zone
Alconox/Liquinox (detergent)	< 1 liter, powder/liquid	Support/Decontamination Zone

3.7.2 SHIPPING AND TRANSPORTATION OF CHEMICAL PRODUCTS

(Reference CDM Federal's *Guidance for Shipment of Hazardous Materials*)

Nearly all chemicals brought to the site are considered hazardous materials by the U.S. Department of Transportation (DOT). All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the Corporate HSM or the Equipment Coordinator for additional information.

3.8 POTENTIAL CONTAMINANTS (REFER TO PROJECT FILES FOR MORE-DETAILED CONTAMINANT INFORMATION)

Contaminant	Location and Highest[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[4] (eV)
Acetone	GW: SB: SS:	250 ppm	20,000 ppm	Irritation of eyes, nose, throat, headache, dizziness.	9.69
Arsenic	GW: SB: SS:	0.01 mg/m^3	5 Ca	Ulceration of nasal septum, respiratory irritation; dermatitis; gastrointestinal disturbances; peripheral neuropathy, hyperpigmentation	NA
Beryllium	GW: SB: SS:	0.025 mg/m^3	10 mg/m^3 Ca	Respiratory Symptoms, weakness fatigue	9.24
BHC (Lindane)	GW: SB: SS:	0.5 mg/m^3 (skin)	1000 mg/m^3	Irritation of eyes, nose, throat, skin; headache, nausea, resp. difficulty, cyan.; muscle spasm.	NA
Cadmium	GW: SB: SS:	0.005 mg/m^3	9 Ca	Pulmonary edema, coughing, chest tightness/pain, headache; chills, muscle aches, nausea, vomiting, diarrhea; difficulty breathing; loss of sense of smell; emphysema; mild anemia	NA
Carbon Tetrachloride	GW: SB: SS:	2 ppm	200 Ca	Central nervous system (CNS) depression; nausea; vomiting; eye and skin irritation, liver and kidney injury, drowsiness; dizziness.	11.47
Chlordane	GW: SB: SS:	0.5 mg/m^3	100 Ca	Blurred vision, confusion, ataxia, delirium, coughing, abdominal pain, nausea, vomiting, diarrhea, irritability, tremors, anuria	UK

3.8 POTENTIAL CONTAMINANTS (REFER TO PROJECT FILES FOR MORE-DETAILED CONTAMINANT INFORMATION)

Contaminant	Location and Highest[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[4] (eV)
Chloroform	GW: SB: SS:	2 ppm	500 Ca	Dizziness, mental dullness, nausea, confusion, disorientation, headache, fatigue, eye and skin irritation, anesthesia, enlarged liver	11.42
Chromium (as Cr(II) & Cr (III))	GW: SB: SS:	0.5 mg/m^3	25	Irritated eyes, sensitization dermatitis, histologic fibrosis of lungs	NA
Chromium (hexavalent)	GW: SB: SS:	0.05 mg/m^3	15 Ca	Irritated respiratory system; nasal septum perforation; liver and kidney damage; leucytosis; leupen; monocytosis; eosinophilla; eye injury, conjuctivitis; skin ulcer; sensitization dermatitis	NA
Cobalt (Metal, Dusts, and Fumes)	GW: SB: SS:	0.05 mg/m^3	20	Coughing; difficulty breathing; wheezing; decreased pulmonary function; diffuse nodule fibrosous; dermatitis; respiratory hypersensitivity; asthma	NA
Copper (dust)	SB: SS:	1 mg/m^3	NL	Nasal perforation, metal taste.	NA
DDT	GW: SB: SS:	0.5 mg/m^3	500 Ca	Paresthesia of tongue, lips, hand, and face; tremors; dizziness; confusion; headache; fatigue; convulsions; eye and skin irritation; vomiting	UK
Dieldrin	GW: SB: SS:	0.25 mg/m^3	450 mg/m^3	Headache, dizziness, vomiting, nausea, convulsions.	NA
Dinitrotoluene	GW: SB: SS:	1.5 mg/m^3 (skin)	250 Ca	Anoxia, cyan., anemia, jaundice.	NA
1,1-Dichloroethane	GW: SB: SS:	100 ppm	3,000	CNS depression, skin irritation; liver, kidney, and lung damage	11.06

3.8 POTENTIAL CONTAMINANTS (REFER TO PROJECT FILES FOR MORE-DETAILED CONTAMINANT INFORMATION)

Contaminant	Location and Highest[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[4] (eV)
Endosulfan	GW: SB: SS:	0.1 mg/m^3	NL	Irritated skin, nausea, confusion, agitation, flushing, dry mouth, tremor, convulsion, headache	UK
Lead	GW: SB: SS:	0.05 mg/m^3	100	Weakness, lassitude; facial pallor; pal eye; weight loss, malnutrition; abdominal pain, constipation; anemia; gingival lead line; tremors; paralysis of wrist and ankles; encephalopathy; kidney disease; irritated eyes; hypotension.	NA
Methylene Chloride	GW: SB: SS:	500 ppm	5000 ppm Ca	Fatigue, weakness, sleepiness, numbness, nausea, irritation of eyes and skin.	11.35
Mercury	GW: SB: SS:	0.05 mg/m^3	10	Skin and eye irritation, cough, chest pain, difficult breathing, bronchitis, pneumonitis, tremors, insomnia, irritability, indecision, headache, fatigue, weakness, GI disturbance	NA
Naphthalene	GW: SB: SS:	10 ppm	250	Eye irritation, headache, confusion, excitement, nausea, vomiting, abdominal pain, bladder irritation, profuse sweating, dermatitis, corneal damage, optical neuritis	8.12
PCBs	GW: SB: SS:	0.5 mg/m^3	5 Ca	Eye and skin irritation, acne-form dermatitis, liver damage, reproductive effects	UK
Phenol	GW: SB: SS:	5 ppm	250 ppm	Irritation of eyes, nose, throat; weakness; muscle ache; dark urine; cyan.; liver and kidney damage; skin burns.	8.5
PNAs (Limits as Coal Tar Pitch)	GW: SB: SS:	0.2 mg/m^3	80 Ca	Dermatitis, bronchitis	UK

3.8 POTENTIAL CONTAMINANTS (REFER TO PROJECT FILES FOR MORE-DETAILED CONTAMINANT INFORMATION)

Contaminant	Location and Highest[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Trichloroethylene	GW: SB: SS:	25 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	9.45
Vinylidene Chloride (1,1-dichloroethylene)	GW: SB: SS:	1 ppm	NL Ca	Eye, skin, and throat irritation; dizziness; headache; nausea; difficult breathing; liver and kidney dysfunction; pneumonitis	UK

Footnotes:

a: Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), SS (Surface Soil), SL (Sludge), SW (Surface Water),

b: Appropriate value of PEL, REL, or TLV listed

c: IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen

d: PIP = photoionization potential; NA = Not applicable; UK = Unknown

3.9 POTENTIAL ROUTES OF EXPOSURE		
DERMAL: Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 5.	**INHALATION:** Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in sections 5 and 6, respectively.	**OTHER:** Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before eating, drinking, or smoking).

4 PERSONNEL

REFER TO SITE-SPECIFIC PLANS FOR ADDITIONAL FIELD PERSONNEL

4.1 CDM FEDERAL EMPLOYEE MEDICAL SURVEILLANCE AND TRAINING

(Reference Section 4.0, Medical Surveillance Program, *CDM Federal Programs Corporation, Corporate Health and Safety Program*)

CDM Federal's medical surveillance program is described in Section 4.0 of *CDM Federal Programs Corporation, Corporate Health and Safety Program*. All CDM Federal employees working at the site will participate in the medial surveillance program. The program consists of a combination of: (1) baseline, annual, interim, exit and return-to-work examinations; (2) services for the evaluation and follow-up of occupationally related injuries and illnesses; and (3) emergency medical services required to stabilize severely injured or ill patients prior to their transport to an offsite medical care facility. The Medical Surveillance Program is designed and administered by a board-certified occupational physician.

All CDM Field personnel will be provided with a thorough, initial baseline medical examination to assess fitness for the job and to provide baseline health data for subsequent reference. During the medical examination, employees will be evaluated for their ability to wear respiratory protection and other protective equipment.

Annual/interim medical examinations will be given every 12 months or more frequently if indicated by substandard performance; evidence of particular stress, or difficulty in using personal respiratory protection; signs/symptoms of illness commonly associated with chemicals present at the site; or if employees are exposed wile unprotected. Site-specific contaminants may warrant specific biological monitoring. When these types of contaminants are identified, the contaminants and the work to be performed will be discussed with the Occupational Physician.

4.2 CONTACTS

4.2.1 CLIENT

Client Contact Name:	Mr.Tim Reisch, NTR
Phone Number:	(757) 322-4758
Facility Contact Names and Phone Numbers:	Mr. Leroy Eaves, Civil Engineering (757) 485-6574

4.2.2 CDM FEDERAL

REFER TO THE SITE-SPECIFIC HASP FOR THE FOLLOWING INFORMATION:

Project Manager/Phone:	Dave Schroeder (703) 968-0900
Health and Safety Manager (PHSO)/Phone:	Chuck Myers (703) 968-0900
Field Team Leader/Phone:	
Site Safety Coordinator/Phone:	

The SSC is responsible for contacting the field team leader and the project manager. In general, the project manager either will contact or will identify the client contact. The Health and Safety Manager (HSM) should be contacted as appropriate. The SSC or the project manager must notify the client and the HSM when a serious injury or a death occurs or when health and safety inspections by OSHA or other agencies are conducted. Refer to sections 10 through 12 for emergency procedures and phone numbers.

4.2.3 SUBCONTRACTORS

When specified in the project documents (e.g., contract), this plan may cover CH2M HILL subcontractors. However, this plan does not address hazards associated with tasks and equipment that the subcontractor has expertise in (e.g., operation of drill rig). Specialty subcontractors are responsible for health and safety procedures and plans specific to their work. Specialty subcontractors are to submit plans to CDM Federal for review and approval before the start of fieldwork. Subcontractors must comply with the established health and safety plan(s) and CDM Federal must monitor and enforce compliance with the established plan(s).

REFER TO THE SITE-SPECIFIC HASP FOR THE FOLLOWING INFORMATION:

Subcontractor: To be named later.
Subcontractor Contact:
Telephone:

General health and safety communication with subcontractors contracted with CH2M HILL and covered by this plan is to be conducted as follows:

- Request that the subcontractor, if a specialty subcontractor, submit a safety or health plan applicable to their expertise (e.g., drill-rig safety plan or nuclear density gauge [NDG] health plan); attach the reviewed plan.
- Supply subcontractors with a copy of this plan, and brief them on its provisions.
- Direct health and safety communications to the subcontractor-designed safety representative
- Notify the subcontractor-designated representative if a violation of the plan(s) is observed. Specialty subcontractors are responsible for mitigating hazards in which they have expertise.
- If a hazard condition persists, inform the subcontractor. If the hazard is not mitigated, stop affected work as a last resort and notify the project manager.
- When an apparent imminent danger exists, promptly remove all affected personnel. Notify the project manager.
- Make clear that consistent violations of the health and safety plan by a subcontractor may result in termination of the subcontract.

4.2.4 CONTRACTORS

This plan does not cover contractors that are contracted directly to the client or the owner. CDM Federal is not responsible for directing contractor personnel and is not to assume responsibility through their actions. When the contractor is in control of the site, ask the contractor to conduct a briefing of their health and safety practices and to describe how they apply to CDM Federal's activities. Request a copy of the contractor's health and safety plan.

REFER TO THE SITE-SPECIFIC HASP FOR THE FOLLOWING INFORMATION:

Contractor:
Contact Name:
Telephone:

General health and safety communication with contractors *not* contracted with CH2M HILL is listed below. These procedures can also be applied to other third party communications (e.g., client personnel).

- Ask the contractor to brief CDM Federal on the contractor's health and safety plan for how the plan affects CDM Federal employees on the site.
- If acceptable to the client, communicate about health and safety directly with the contractor PM or other onsite contractor-designated representative. CDM Federal employees are not to direct the details of the contractor's work or to advise on health and safety (e.g., how the contractor corrects unsafe conditions).
- If an observed hazard poses a risk to CDM Federal personnel, notify the party controlling the work activity as soon as possible. Notify the project manager; the project manager will notify the client. Document oral notification in project records (i.e., the field logbook).
- If a hazardous condition endangering a CDM Federal employee persists, inform the contractor and the project manager (the project manager will contact the client) that CDM Federal cannot execute the assigned work until the hazard is mitigated.
- When an apparent imminent danger exists, orally warn the person(s) in danger and orally notify the contractor promptly. When an imminent danger involves a CDM Federal employee, remove the employee and suspend CDM Federal work immediately until the hazard has been mitigated. Inform the project manager and the contractor promptly.
- The SSC or the project manager must notify the client and CDM Federal health and safety staff when (1) the contractor fails to remedy an unsafe condition affecting CDM Federal personnel, (2) the contractor does not remedy the hazardous condition within a reasonable period of time, or (3) the contractor repeatedly creates the hazardous condition.

5 PERSONAL PROTECTIVE EQUIPMENT (PPE) (Reference Section 7, Personal Protective Equipment, *CDM Federal Programs Corporation, Corporate Health and Safety Program*)

REFER TO THE SITE-SPECIFIC HASP FOR THE REQUIRED LEVEL OF PERSONAL PROTECTION TO USE DURING FIELD ACTIVITIES

5.1 PPE SPECIFICATIONS

Task	Level	Body	Head	Respirator[b]
General work uniform when no chemical exposure is anticipated	D	Work clothes; steel-toe, steel-shank leather work boots; work gloves	Hardhat[c] Safety glasses Ear protection[d]	None required
Low exposure tasks such as: Monitoring well installation and all sampling activities.	Modified D	**COVERALLS:** Uncoated Tyvek® **BOOTS:** Steel-toe, steel-shank chemical-resistant boots OR steel-toe, steel-shank leather work boots with outer rubber boot covers **GLOVES:** Inner surgical-style nitrile glove AND outer chemical-resistant nitrile glove.	Hardhat[c] Splash shield[c] Safety glasses Ear protection[d]	None required
Tasks requiring upgrade per sections 5.2 or 6.	C	**COVERALLS:** Polycoated Tyvek® **BOOTS:** Steel-toe, steel-shank chemical-resistant boots OR steel-toe, steel-shank leather work boots with outer rubber boot covers **GLOVES:** Inner surgical-style nitrile glove AND outer chemical-resistant nitrile glove.	Hardhat[c] Splash shield[c] Ear protection[d] Spectacle inserts	APR, full face, MSA Ultratwin or equivalent; with GME-H[e] cartridges or equivalent
None anticipated	B	**COVERALLS:** Polycoated Tyvek® **BOOTS:** Steel toe, steel-shank chemical-resistant boots OR steel-toe, steel-shank leather work boots with outer rubber boot covers **GLOVES:** Inner surgical-style nitrile glove AND outer chemical-resistant nitrile glove.	Hardhat[c] Splash shield[c] Ear protection[d] Spectacle inserts	Positive-pressure demand self-contained breathing apparatus (SCBA): MSA Ultralite, or equivalent

[a] Modifications are as indicated. CDM Federal will provide PPE to only CDM Federal employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to determined by the SSC.
[d] Ear protection should be worn while working around equipment with noise warning labels (such as drill rigs or other noise-producing equipment). Equipment producing noise in excess of 85 dBa shall be labeled.
Refer to Section 6 for other requirements.
[e] The GME-H cartridge is the new standard-issue cartridge. Available stock of the previously standard GMC-H cartridges may be used for tasks covered by this plan.

5.2 REASONS FOR UPGRADING OR DOWNGRADING LEVEL OF PROTECTION

Upgrade*	Downgrade
• Request from individual performing task. • Change in work task that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels (Section 6) exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decreases the hazard. • Change in work task that will reduce contact with hazardous materials.

*Performing a task that requires an upgrade to a higher level of protection (e.g., level D to level C) is permitted only when the PPE requirements have been specified in Section 5 and an SSC who meets the requirements specified in subsection 4.1 is present.

6 AIR MONITORING SPECIFICATIONS

REFER TO THE SITE-SPECIFIC HASP FOR THE REQUIRED MONITORING INSTRUMENTS TO USE DURING FIELD ACTIVITIES

Instrument	Tasks	Action Levels[a]		Frequency[b]	Calibration
PID: OVM with 10.6eV or 11.8 eV lamp or equivalent	Monitoring well installation, soil, and groundwater sampling activities.	0 - 5 ppm 5 - 10 ppm > 10 ppm	Level D Level C Level B (not anticipated)	Initially and periodically during task	Daily; before and after each period of use
CGI: MSA model 260 or 261 or equivalent	Drilling Excavation	0-10%[c] LEL: 10-25%[c] LEL: >25%[c] LEL:	No explosion hazard Potential explosion hazard Explosion hazard; evacuate or vent	Continuous during advancement of boring or trench	Daily; before and after each period of use
O_2 Meter: MSA model 260 or 261 or equivalent	Drilling Excavation	>25.0%[c] O_2: 20.9%[c] O_2: <19.5%[c] O_2:	Explosion hazard; evacuate or vent Normal O_2 O_2 deficient; vent or use SCBA	Continuous during advancement of boring or trench	Daily; before and after each period of use
Dust Monitor: Visual	All tasks	No visible dust Visible dust	Level D Level C Stop work; implement dust suppression measures	Initially and periodically during task	Zero twice daily; once before use and once at midday

Note a: Action levels apply to sustained breathing-zone measurements above background.

Note b: The exact frequency of monitoring depends on field conditions and is to be determined by the SSC; generally, every 5 to 15 minutes is acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time and measurement result, personnel monitored, and place/location where measurement is taken (e.g., "Breathing Zone/MW-3," "at surface/SB-2," etc.).

Note c: If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply to only ambient working atmospheres, and do not apply to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry; refer to Section 9.

6.1 CALIBRATION SPECIFICATIONS

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Instrument	Gas	Span	Reading	Method
PID: OVM, 10.0 or 10.6 eV bulb	100 ppm isobutylene	RF = 0.55	55 ppm	1.5 lpm reg T-tubing
OVM, 11.8 eV bulb		RF = 0.68	68 ppm	
PID: MiniRAE, 10.6 eV bulb	100 ppm isobutylene	CF=53	53 ppm ±5 ppm	1.5 lpm REG T-Tubing
PID: TVA 1000	100 ppm isobutylene	CF=0.55	55 ppm ± 5 ppm	1.5 lpm REG T-Tubing
FID: TVA 1000	100 ppm methane	CF=1.00	100 ppm ± 10	1.5 lpm reg T-tubing
Dust Monitor: Miniram-PDM3	Dust-free air	Not applicable	0.00 mg/m^3 in "Measure" mode	Dust-free area OR Z-bag with HEPA filter
CGI: MSA 260, 261, 360, or 361	0.75% pentane	N/A	50% LEL ± 5 % LEL	1.5 lpm reg direct tubing

6.2 AIR SAMPLING

Sampling may be required by other OSHA regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds. Contact the HSM immediately if these contaminants are encountered.

Method Description: REFER TO SITE-SPECIFIC HASP IF APPLICABLE

Personnel and Areas

Results must be sent immediately to the HSM. Regulations may require reporting to monitored personnel. Results reported to:

HSM: Chuck Myers
Other:

7 DECONTAMINATION (Reference: Standard Operating Procedure for Decontamination

REFER TO THE SITE-SPECIFIC HASP FOR DETAILS OF DECONTAMINATION

REFER TO THE MASTER INVESTIGATION-DERIVED WASTE MANAGEMENT PLAN FOR METHODS OF DISPOSAL

The SSC must monitor the effectiveness of the decontamination procedures. Decontamination procedures found to be ineffective will be modified by the SSC.

7.1 DECONTAMINATION SPECIFICATIONS

Personnel	Sample Equipment	Heavy Equipment
• Boot wash/rinse	• Wash/rinse equipment	• Power wash
• Glove wash/rinse	• Solvent-rinse equipment	• Steam clean
• Outer-glove removal	• **Solvent-disposal method:**	• **Water-disposal method:**
• Body-suit removal		
• Inner-glove removal		
• Respirator removal		
• Hand wash/rinse		
• Face wash/rinse		
• Shower ASAP		
• **PPE-disposal method:**		
• **Water-disposal method:**		

7.2 DIAGRAM OF PERSONNEL-DECONTAMINATION LINE

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SSC should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones.

Figure 7-1 illustrates a typical establishment of work zones, including the decontamination line. Work zones are to be modified by the SSC to accommodate task-specific requirements.

8 SPILL-CONTAINMENT PROCEDURES

Sorbent material will be maintained in the support zone. Incidental spills will be contained with sorbent and will be disposed of properly.

9 CONFINED-SPACE ENTRY

(Reference, Section 8, Confined Space Entry, *CDM Federal Programs Corporation, Corporate Health and Safety Program*),)

No confined-space entry will be permitted. Confined-space entry requires additional health and safety procedures, training, and a permit. If conditions change such that confined-space entry is necessary, contact the HSM to develop the required entry permit.

When planned activities will not include confined-space entry, permit-required confined spaces accessible to CDM Federal personnel are to be identified before the task begins. The SSC is to confirm that permit spaces are properly posted or that employees are informed of their locations and informed of their hazards.

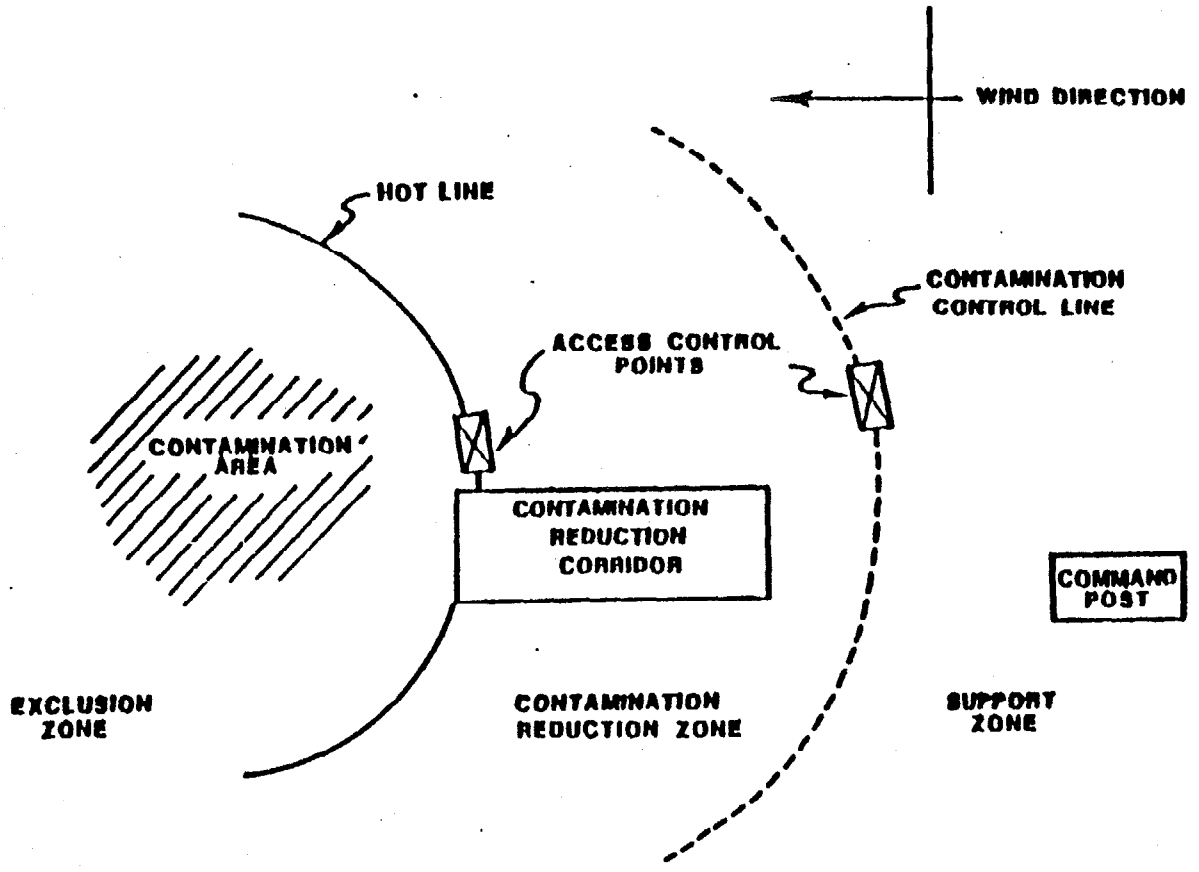


DIAGRAM OF SITE WORK ZONES

Figure 7-1

10.0 SITE HEALTH AND SAFETY ORGANIZATION

10.1 SITE-CONTROL PROCEDURES

- The site safety coordinator (SSC) will conduct a site safety briefing (see below) before starting field activities or as tasks and site conditions change.
- Topics for briefing on site safety: general discussion of health and safety plan, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, emergencies.
- The SSC or Field Manager records attendance at safety briefings in a logbook and documents the topics discussed.
- The SSC or delegate will ensure that a daily log-in and log-out book is maintained for all personnel entering the site.
- Post the OSHA job-site poster in a central and conspicuous location at sites where project field offices, trailers, or equipment storage boxes are established. Posters can be obtained by calling either 800/548-4776 or 800/999-9111.
- Field Trailers: Post "Exit" signs above exit doors, and post "Fire Extinguisher" signs above locations of extinguishers. Keep areas near exits and extinguishers clear.
- Determine wind direction.
- Establish work zones: support, decontamination, and exclusion zones. Delineate work zones with flags or cones as appropriate. Support zone should be upwind of the site.
- Establish decontamination procedures, including respirator-decontamination procedures, and test the procedures.
- Use access control at the entry and exit from each work zone.
- Store chemicals in appropriate containers.
- Make MSDSs available for onsite chemicals to which employees are exposed.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals
  - Air horn
  - Two-way radio or cellular telephone if available
- Establish offsite communication.
- Establish and maintain the "buddy system."
- Establish procedures for disposing of material generated on the site.
- Initial air monitoring is conducted by the SSC in appropriate level of protection.
- The SSC is to conduct periodic inspections of work practices to determine the effectiveness of this plan Deficiencies are to be noted, reported to the HSM, and corrected.

10.2 HAZWOPER COMPLIANCE PLAN

This section outlines procedures to be followed when certain activities do not require 24- or 40-hour training. ***Note, prior approval from the HSM is required before these tasks are conducted on regulated hazardous waste sites.***

- Certain parts of the site work may be covered by state or federal Hazwoper standards and therefore require training and medical monitoring. Anticipated tasks must be included in subsection 2.2.1.
- Air sampling must confirm that there is no exposure to gases or vapors before non-Hazwoper-trained personnel are allowed on the site. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data. Refer to subsections 3.8 and 6.2 for contaminant data and air sampling requirements, respectively.
- Non-Hazwoper-trained personnel must be informed of the nature of the existing contamination and its locations, the limits of their access, and the emergency action plan for the site. Non-Hazwoper-trained personnel also must be trained in accordance with all other state and federal OSHA requirements, including 29 CFR 1910.1200 (HAZCOM). Refer to subsection 3.7.1 for hazard communication requirements.
- Air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-Hazwoper-trained personnel (e.g., in an adjacent area) are not exposed to volatile contaminants. Non-Hazwoper-trained personnel should be monitored whenever the belief is that there may be a possibility of exposure (e.g., change in site conditions), or at some reasonable frequency to confirm that there is no exposure. Refer to Section 6.1 for air monitoring requirements.
- Treatment system start-ups: Once a treatment system begins to pump and treat contaminated media, the site is, for the purposes of applying the Hazwoper standard, considered a treatment, storage, and disposal facility (TSDF). Therefore, once the system begins operation, only Hazwoper-trained personnel (minimum of 24 hours of training) will be permitted to enter the site. All non-Hazwoper-trained personnel must leave the site.

If Hazwoper-regulated tasks are conducted concurrently with nonregulated tasks, non-Hazwoper-trained subcontractors must be removed from areas of exposure. If non-Hazwoper-trained personnel remain on the site while a Hazwoper-regulated task is conducted, the contaminant/exposure area (exclusion zone) must be posted, non-Hazwoper-trained personnel must be reminded of the locations of restricted areas and the limits of their access, and real-time monitoring must be conducted. Non-Hazwoper-trained personnel at risk of exposure must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.

11 EMERGENCY RESPONSE PLAN

11.1 PRE-EMERGENCY PLANNING

The SSC performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with the facility and local emergency-service providers as appropriate.

- Review the facility emergency and contingency plans where applicable.
- Locate the nearest telephone; determine what onsite communication equipment is available (e.g., two-way radio, air horn).
- Identify and communicate chemical, safety, radiological, and biological hazards.
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel.
- Post site map marked with locations of emergency equipment and supplies, and post OSHA job-site poster. The OSHA job-site poster is required at sites where project field offices, trailers, or equipment-storage boxes are established. Posters can be obtained by calling either 800/548-4776 or 800/999-9111.
- Field Trailers: Post "Exit" signs above exit doors, and post "Fire Extinguisher" signs above locations of extinguishers. Keep areas near exits and extinguishers clear.
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures.
- Evaluate capabilities of local response teams where applicable.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, chemical and vapor releases.
- Review notification procedures for contacting CDM Federal's medical consultant and team member's occupational physician.
- Rehearse the emergency response plan once before site activities begin, including driving the route to the hospital.
- The emergency response plan will be periodically exercised and critiqued.
- Brief new workers on the emergency response plan.
- The SSC will evaluate emergency response actions and initiate appropriate follow-up actions.

11.2 EMERGENCY EQUIPMENT AND SUPPLIES

REFER TO SITE-SPECIFIC HASP FOR A LIST OF ADDITIONAL EMERGENCY EQUIPMENT

The SSC should mark the locations of emergency equipment on the site map and should post the map.

Emergency Equipment and Supplies	Location
20 lb. (or two 10-lb.) fire extinguisher (A, B, and C classes)	Field Vehicle/Site Office
First aid kit	Field Vehicle/Site Office
Eye wash*	Field Vehicle/Site Office
Potable water	Field Vehicle/Site Office
Bloodborne-pathogen kit	Field Vehicle/Site Office

*The emergency eye wash unit must meet the American National Standards Institute (ANSI) criteria and be capable of delivering 1.5 liters (0.4 gallons) per minute of potable water to the eyes for fifteen minutes.

11.3 EMERGENCY MEDICAL TREATMENT

- Notify appropriate emergency response authorities listed in sections 12 and 13 (e.g., 911).
- During a time of no emergency, contact CDM Federal's medical consultant for advice and guidance on medical treatment.
- The SSC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR where feasible by persons trained in first aid, CPR, and bloodborne pathogens.
- Get medical attention immediately.
- Perform decontamination where feasible, and to the extent possible; lifesaving and first aid or medical treatment take priority. Decontamination procedures may need to be postponed, but should be implemented as soon as possible after the victim is stabilized.
- Notify the field team leader and the project manager of the injury.
- Make certain that the injured person is accompanied to the emergency room.
- Notify the health and safety manager.
- Notify the injured person's human resources department within 24 hours.
- Prepare an incident report. Submit the report to the corporate director of health and safety and the corporate human resources department (COR) within 48 hours.
- When contacting the medical consultant, state that you are calling about a CDM Federal matter, and give your name, your telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.

11. 4 NON-EMERGENCY PROCEDURES

The procedures listed above may be applied to non-emergency incidents. Injuries and illnesses (including overexposure to contaminants) must be reported to Human Resources. If there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the CDM Federal medical consultant.

- When contacting the medical consultant, state that the situation is a CDM Federal matter, and give your name, your telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- Follow these procedures as appropriate.

11.5 INCIDENT RESPONSE

In fires, explosions, or chemical releases, actions to be taken include the following:

- Shut down CDM Federal operations and evacuate the immediate work area.
- Account for personnel at the designated assembly area(s).
- Notify appropriate response personnel.
- Assess the need for site evacuation, and evacuate the site as warranted.

Instead of implementing a work-area evacuation, note that small fires or spills posing minimal safety or health hazards may be controlled.

11.6 EVACUATION

- Evacuation routes will be designated by the SSC before work begins.
- Onsite and offsite assembly points will be designated before work begins.
- Personnel will leave the exclusion zone and assemble at the onsite assembly point upon hearing the emergency signal for evacuation.
- Personnel will assemble at the offsite point upon hearing the emergency signal for a site evacuation.
- The SSC and a "buddy" will remain on the site after the site has been evacuated (if possible) to assist local responders and advise them of the nature and location of the incident.
- The SSC accounts for all personnel in the onsite assembly zone.
- A person designated by the SSC before work begins will account for personnel at the offsite assembly area.
- The SSC will write up the incident as soon as possible after it occurs and will submit a report to the corporate director of health and safety.

11.7 EVACUATION ROUTES AND ASSEMBLY POINTS

Refer to the site map in Section 1. Evacuation routes and assembly areas (and alternative routes and assembly areas) are specified on the site map in the site-specific HASPs.

11.8 EVACUATION SIGNALS

Signal	Meaning
Grasping throat with hand	Emergency–help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

12 EMERGENCY RESPONSE

12.1 EMERGENCY RESPONSE TELEPHONE NUMBERS

REFER TO SITE-SPECIFIC HASP FOR ADDITIONAL PHONE NUMBERS

SITE ADDRESS: St. Juliens Creek Annex Portsmouth, Virginia	**Phone:** Section 4. **Cellular Phone:** See Site-specific plans
Security (NAVBASE): Chief Bailey	**Phone:** 757-396-0241
Fire: Security: Mr. Frank King	**Phone:** 757-396-3335
Ambulance: Shipyard Emergency	**Phone:** 757-398-2200 or 911
Public Works Department (Utility Clearances):	**Phone:** 757-367-8308 (pager)
Mr. Paul Christopher	
Emergency: (one call)	**Phone:** 911
Hazardous Waste Dispatcher:	**Phone:** (757) 444-7528
Mr. William Whitmire	
COMNAVBASE Duty Desk**	**Phone:** (757) 322-2866/67
Local Emergency Planning Committee (LEPC)	**Phone:** (757) 441-2171

*When using a cellular phone outside the telephone's normal calling area, exercise caution in relying on the cellular phone to activate 911. When the caller is outside the normal calling area, the cellular service carrier should connect the caller with emergency services in the area where the call originated, but this may not occur. Telephone numbers of backup emergency services should be provided if a cellular phone is relied on to activate 911.

** All spills must be reported to the COMNAVBASE Duty Desk

Hospital: Maryview Medical Center **Address:** 3636 High St, Portsmouth, Virginia 23707-3236	**Phone:** (757) 398-2200

Route to Hospital: (Refer to Figure 12-1) – Leave main gate of Annex and take left onto Victory Blvd. At Route 17 (George Washington Hwy) take a right and go north. Make left onto Frederick Blvd, and continue on Frederick until it dead ends. Make a left onto High Street, the Maryview Medical Center in on the right at the first light. (Total Distance = 4.5 miles)

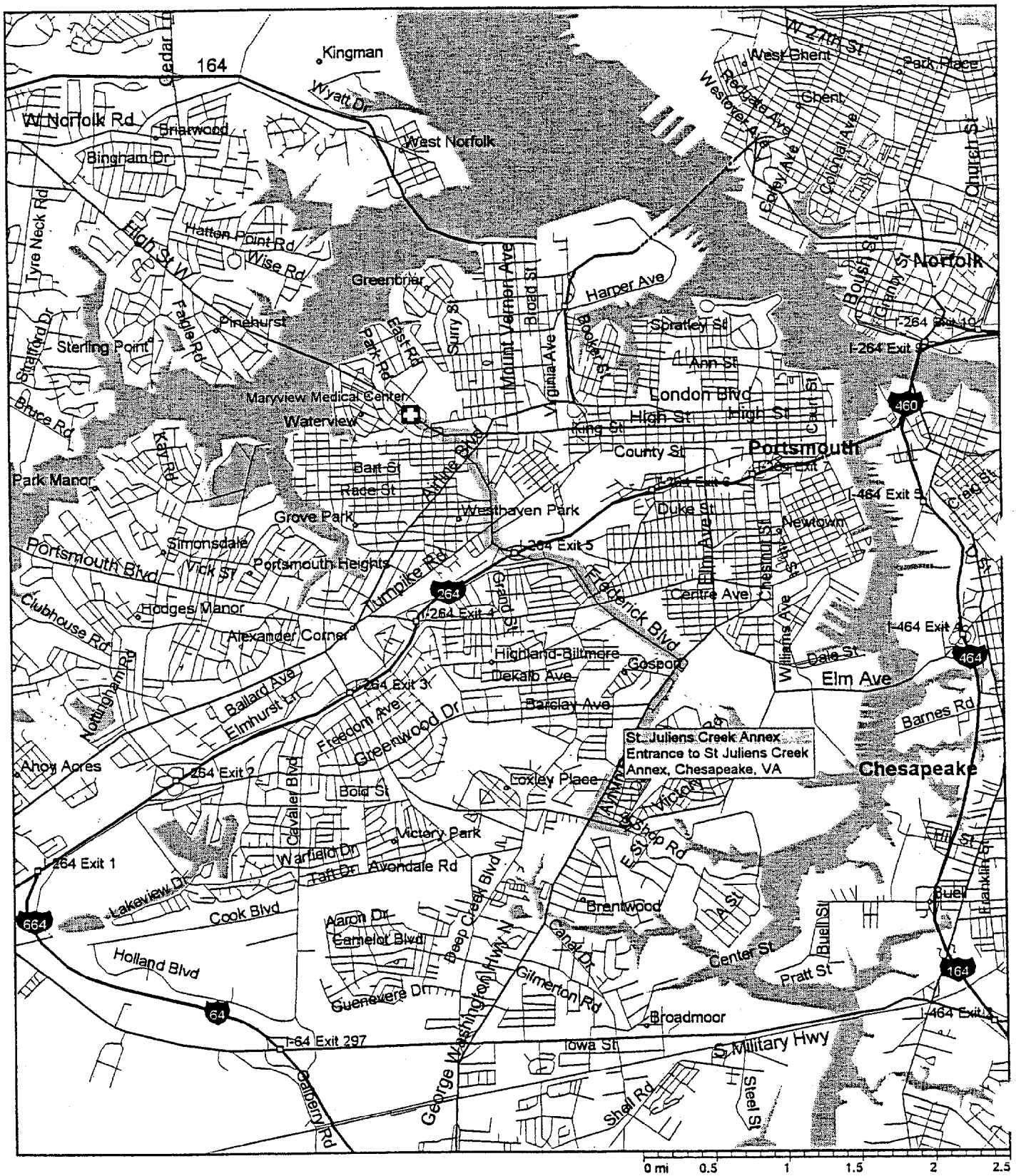
12.2 GOVERNMENT AGENCIES INVOLVED IN PROJECT

Federal Agency and Contact Name: **Phone:**	Department of the Navy, Atlantic Division Mr. Tim Reisch, NTR (757) 322-4783
State Agency and Contact Name: **Phone:**	Ms. Sharon Wilcox 804-698-4143
Local Agency and contact Name: **Phone:**	Not assigned

Contact the project manager. Generally, the project manager will contact relevant government agencies.

Health and Safety Plan - CDM Federal Health and Safety Program

Route to Maryview Medical Center from St. Juliens Creek Annex



Streets98

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13 EMERGENCY CONTACTS

REFER TO SITE-SPECIFIC HASP FOR ADDITIONAL NAMES AND PHONE NUMBERS

If an injury occurs, notify the injured person's personnel office as soon as possible after obtaining medical attention for the injured person. Notification MUST be made within 24 hours of the injury.

CDM Federal Medical Consultant

Name: Dr. Thomas Winters,
Health Resources

Address: 600 West Cummings Park
Woburn, MA
800/350-4511

Occupational Physician (Regional or Local)

Name:

Address:

Corporate Director Health and Safety

Name: Mr. Chuck Myers
Phone: 703/968-0900 Ext. 299

Site Safety Coordinator (SSC)

Name: Refer to site-specific addendum
Phone:

Health and Safety Manager (HSM)

Name:
Phone:

Project Manager

Name: Refer to site-specific addendum
Phone:

Radiation Health Manager (RHM)

Name: Mike Stafford
Phone: 423/482-1065

Regional Human Resources Department

Name: Kim Updegrove
Phone: 703/968-0900 Ext. 307

Client
Name: Tim Reisch, NTR
Phone: (757) 322-4758

Corporate Human Resources Department

Name: Kim Updegrove
Phone: 703/968-0900 Ext. 307

Federal Express Dangerous Goods Shipping
Phone: 800/238-5355

CDM Federal Emergency Number for Shipping Dangerous Goods
Phone: 800/535-5053

Worker's Compensation and Auto Claims

Phone:
After hours

Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars.

14 APPROVAL

This site-specific health and safety plan has been written for use by CDM Federal only. CDM Federal claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

14.1 ORIGINAL PLAN

WRITTEN BY: Lynne J. France **DATE:** 10-7-98

APPROVED BY: Chuck Myers **DATE:** 10-26-98

14.2 REVISIONS

REVISIONS MADE BY: **DATE:**

REVISIONS TO PLAN:

REVISIONS APPROVED BY: **DATE:**

15 DISTRIBUTION

REFER TO SITE-SPECIFIC HASP FOR ADDITIONAL NAMES

Name	Responsibility	Number of Copies
Chuck Myers	Corporate Health and Safety Manager/Approver	1
	Project Manager	
	Field Team Leader/Member	
	Site Safety Coordinator	
	Client Project Manager	

16 ATTACHMENTS

Attachment 1: Employee Signoff
Attachment 2: Applicable Material Safety Data Sheets

Attachment 1
Employee Signoff

EMPLOYEE SIGNOFF

The employees listed below have been given a copy of this health and safety plan, have read and understood it, and agree to abide by its provisions.

EMPLOYEE NAME	EMPLOYEE SIGNATURE AND DATE

Attachment 2

Material Safety Data Sheets

BACHARACH -- CALIBRATION GAS, METHANE 2% IN AIR - CALIBRATING GAS MIXTURE
MATERIAL SAFETY DATA SHEET
NSN: 6830013601866
Manufacturer's CAGE: 05083
Part No. Indicator: B
Part Number/Trade Name: CALIBRATION GAS, METHANE 2% IN AIR

General Information

Item Name: CALIBRATING GAS MIXTURE
Company's Name: BACHARACH INC
Company's Street: 625 ALPHA DR
Company's City: PITTSBURGH
Company's State: PA
Company's Country: US
Company's Zip Code: 15238
Company's Emerg Ph #: 800-424-9300
Company's Info Ph #: 412-963-2223 OR FAX 412-963-2091
Safety Data Action Code: A
Record No. For Safety Entry: 002
Tot Safety Entries This Stk#: 002
Status: SE
Date MSDS Prepared: 02MAY94
Safety Data Review Date: 09SEP96
Supply Item Manager: CX
Preparer's Company: BACHARACH INC
Preparer's St Or P. O. Box: 625 ALPHA DR
Preparer's City: PITTSBURGH
Preparer's State: PA
Preparer's Zip Code: 15238
MSDS Serial Number: CBSMM
Hazard Characteristic Code: G3
Unit Of Issue: CY
Unit Of Issue Container Qty: 37 LITERS
Type Of Container: CYLINDERS
Net Unit Weight: UNKNOWN

Ingredients/Identity Information

Proprietary: NO
Ingredient: METHANE
Ingredient Sequence Number: 01
Percent: 2
Ingredient Action Code: A
NIOSH (RTECS) Number: PA1490000
CAS Number: 74-82-8
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: ASPHYXIANT; 9596
Other Recommended Limit: NONE RECOMMENDED

Proprietary: NO
Ingredient: AIR
Ingredient Sequence Number: 02
Percent: 98
Ingredient Action Code: A
NIOSH (RTECS) Number: AX5275000
CAS Number: UNKNOWN
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: NOT ESTABLISHED
Other Recommended Limit: NONE RECOMMENDED

Physical/Chemical Characteristics

Appearance And Odor: COLORLESS, ODORLESS, TASTELESS COMPRESSED GAS IN CYLINDERS.
Boiling Point: -260F,-162C
Melting Point: -296F,-182C
Vapor Pressure (MM Hg/70 F): N/A (GAS)
Vapor Density (Air=1): 0.991
Specific Gravity: 0.673 KG/CUM
Solubility In Water: NEGLIGIBLE
Autoignition Temperature: 580C

Fire and Explosion Hazard Data

Flash Point: -306F,-188C(MET)
Flash Point Method: CC
Lower Explosive Limit: 5%

Upper Explosive Limit: 15%
Extinguishing Media: THIS GAS IS NOT FLAMMABLE. COOL EXPOSED CONTAINERS W/ WATER.
Special Fire Fighting Proc: FIREFIGHTERS SHOULD WEAR NIOSH APPROVED POSITIVE PRESSURE SCBA & FULL PROTECTIVE CLOTHING. USE SHIELDING TO PROTECT FROM CYLINDER EXPLOSION.
Unusual Fire And Expl Hazrds: THIS MIXTURE IS BELOW THE LEL OF METHANE & NON-FLAMMABLE. COMPRESSED AIR/METHANE MIXTURES AT HIGH PRESSURE WILL ACCELERATE BURNING OF OTHER MATERIAL.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): AVOID HEAT OR FLAMES.
Materials To Avoid: NONE KNOWN.
Hazardous Decomp Products: NONE KNOWN.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): N/A

Health Hazard Data

LD50-LC50 Mixture: ORAL LD50 (RAT) IS UNKNOWN
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: NO
Health Haz Acute And Chronic: ACUTE: INHALATION-NONE. METHANE IS A NON-TOXIC SIMPLE ASPHYXIANT. THE CONCENTRATION OF METHANE IN THIS GAS IS TOO LOW TO DEPRESS OXYGEN CONCENTRATION. CHRONIC: NONE KNOWN OR EXPECTED.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE OF THE COMPONENTS IS LISTED AS A CARCINOGEN OR SUSPECTED CARCINOGEN BY IRAC, NTP OR OSHA.
Signs/Symptoms Of Overexp: NONE SPECIFIED BY MANUFACTURER.
Med Cond Aggravated By Exp: NONE KNOWN OR EXPECTED.
Emergency/First Aid Proc: EYE CONTACT-NONE NEEDED. SKIN CONTACT-NONE NEEDED. INHALATION-NONE NEEDED. INGESTION-NONE NEEDED.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: NONE NEEDED. THIS MATERIAL IS NON TOXIC AND NON FLAMMABLE.
Waste Disposal Method: DISPOSE OF IN ACCORDANCE W/LOCAL, STATE, & FEDERAL REGULATIONS. DO NOT INCINERATE CYLINDER.
Precautions-Handling/Storing: DON'T STORE CYLINDERS NEAR HEAT/OPEN FLAME. EXPOSURE TO TEMPERATURES ABOVE 130F MAY CAUSE RUPTURE. SECURE CYLINDERS-DON'T DROP.
Other Precautions: WHEN REMOVABLE CAP IS PROVIDED, STORE AND HANDLE WITH CAP IN PLACE. CONTENTS UNDER HIGH PRESSURE. KEEP CYLINDERS AWAY FROM HEAT & FLAMES. FOR ADDITIONAL HANDLING RECOMMENDATIONS ON COMPRESSED GAS CYLINDERS, CONSULT PAMPHLET P-1.

Control Measures

Respiratory Protection: NONE NEEDED.
Ventilation: NO SPECIAL VENTILATION REQUIRED.
Protective Gloves: LEATHER GLOVES RECOMMENDED FOR HANDLING.
Eye Protection: SAFETY GLASSES RECOMMENDED.
Other Protective Equipment: NONE NEEDED.
Work Hygienic Practices: DO NOT PUNCTURE. NEVER THROW CONTAINER INTO FIRE OR INCINERATE. DO NOT DROP OR DAMAGE. USE ONLY WITH PROPER EQUIPMENT.
Suppl. Safety & Health Data: THE DATA FOR BOILING POINT, MELTING POINT AND FLASH POINT IS FOR METHANE. CLOSE CYLINDER VALVES WHEN CYLINDER IS NOT IN USE AND WHEN EMPTY.

Transportation Data

Transportation Action Code: A
Trans Data Review Date: 96253
DOT PSN Code: DQQ
DOT Proper Shipping Name: COMPRESSED GASES, N.O.S.
DOT Class: 2.2
DOT ID Number: UN1956
DOT Label: NONFLAMMABLE GAS
IMO PSN Code: EQH
IMO Proper Shipping Name: COMPRESSED GAS, N.O.S.
IMO Regulations Page Number: 2125
IMO UN Number: 1956
IMO UN Class: 2(2.2)
IMO Subsidiary Risk Label: -

IATA PSN Code: HDO
IATA UN ID Number: 1956
IATA Proper Shipping Name: COMPRESSED GAS, N.O.S. *
IATA UN Class: 2.2
IATA Label: NON-FLAMMABLE GAS
AFI PSN Code: HDO
AFI Prop. Shipping Name: COMPRESSED GAS, N.O.S.
AFI Class: 2.2
AFI ID Number: UN1956
AFI Label: NON-FLAMMABLE GAS
AFI Basic Pac Ref: A6.3,A6.5,A6.7
MMAC Code: NR
N.O.S. Shipping Name: COMPRESSED GAS N.O.S., (METHANE 2% IN AIR), 2.2, UN 1956.

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Disposal Data

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Label Data

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Label Required: YES
Technical Review Date: 09SEP96
Label Date: UNDATED
Label Status: D
Common Name: CALIBRATION GAS, METHANE 2% IN AIR
Chronic Hazard: YES
Signal Word: WARNING!
Acute Health Hazard-Moderate: X
Contact Hazard-None: X
Fire Hazard-None: X
Reactivity Hazard-None: X
Special Hazard Precautions: ACUTE: INHALATION-NONE. METHANE IS A NON-TOXIC SIMPLE ASPHYXIANT. THE CONCENTRATION OF METHANE IN THIS GAS IS TOO LOW TO DEPRESS OXYGEN CONCENTRATION. CHRONIC: NONE KNOWN OR EXPECTED. DON'T STORE CYLINDERS NEAR HEAT/OPEN FLAME. EXPOSURE TO TEMPERATURES ABOVE 130F MAY CAUSE RUPTURE. SECURE CYLINDERS- DON'T DROP. THIS MIXTURE IS BELOW THE LEL OF METHANE & NON-FLAMMABLE. COMPRESSED AIR/METHANE MIXTURES AT HIGH PRESSURE WILL ACCELERATE BURNING OF OTHER MATERIAL. IN CASE OF SPILL: NONE NEEDED. THIS MATERIAL IS NON TOXIC AND NON FLAMMABLE. FIRST AID: EYE CONTACT-NONE NEEDED. SKIN CONTACT-NONE NEEDED. INHALATION-NONE NEEDED. INGESTION-NONE NEEDED.
Protect Eye: X
Protect Skin: X
Label Name: BACHARACH INC
Label Street: 625 ALPHA DR
Label City: PITTSBURGH
Label State: PA
Label Zip Code: 15238
Label Country: US
Label Emergency Number: 800-424-9300

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URL for this msds http://siri.org. If you wish to change, add to, or delete information in this archive please send updates to dan@siri.org.

SCOTT SPECIALTY GASES -- ISOBUTYLENE IN AIR - CALIBRATION GAS CYL
MATERIAL SAFETY DATA SHEET
NSN: 6665012148247
Manufacturer's CAGE: 51847
Part No. Indicator: A
Part Number/Trade Name: ISOBUTYLENE IN AIR

General Information

Item Name: CALIBRATION GAS CYL
Company's Name: SCOTT SPECIALTY GASES
Company's Street: ROUTE 611 NORTH
Company's City: PLUMSTEADVILLE
Company's State: PA
Company's Country: US
Company's Zip Code: 18949
Company's Emerg Ph #: 215-766-8861; 908-754-7700
Company's Info Ph #: 215-766-8861
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 002
Status: SMJ
Date MSDS Prepared: 23APR92
Safety Data Review Date: 27SEP94
MSDS Serial Number: BVRGC
Hazard Characteristic Code: G3

Ingredients/Identity Information

Proprietary: NO
Ingredient: PROPENE, 2-METHYL-; (ISOBUTYLENE)
Ingredient Sequence Number: 01
NIOSH (RTECS) Number: UD0890000
CAS Number: 115-11-7
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Proprietary: NO
Ingredient: AIR, REFRIGERATED LIQUID; AIR COMPRESSED (UN1002, DOT); AIR REFRIGERATED LIQUID (CRYOGENIC LIQUID) (UN1003) (DOT)
Ingredient Sequence Number: 02
NIOSH (RTECS) Number: AX5271000
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Physical/Chemical Characteristics

Appearance And Odor: COLORLESS GAS W/POSSIBLE SLIGHT OLEFINIC ODOR.
Boiling Point: -318F,-194C
Vapor Pressure (MM Hg/70 F): N/A
Vapor Density (Air=1): 1.2
Specific Gravity: 0.88 (H^2O=1)
Evaporation Rate And Ref: NOT APPLICABLE
Solubility In Water: INSOLUBLE
Percent Volatiles By Volume: 100

Fire and Explosion Hazard Data

Flash Point: NONFLAMMABLE
Lower Explosive Limit: N/A
Upper Explosive Limit: N/A
Extinguishing Media: USE WHAT IS APPROPRIATE FOR SURROUNDING FIRE.
Special Fire Fighting Proc: USE NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N). USE WATER SPRAY TO KEEP FIRE EXPOSED CYLINDERS COOL.
Unusual Fire And Expl Hazrds: COMPRESSED AIR AT HIGH PRESSURES WILL ACCELERATE THE BURNING OF FLAMMABLE MATERIALS.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NONE SPECIFIED BY MANUFACTURER.
Materials To Avoid: NONE.
Hazardous Decomp Products: NONE.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT

Health Hazard Data

LD50-LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.

Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: NO
Health Haz Acute And Chronic: ACUTE:CONCENTRATION OF ISOBUTYLENE IS THIS MIXTURE SHOULD NOT PRESENT ANY SYMPTOMS OF TOXICITY. CHRONIC:NONE.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NOT RELEVANT
Signs/Symptoms Of Overexp: NONE SPECIFIED BY MANUFACTURER.
Med Cond Aggravated By Exp: NONE.
IMMEDIATELY FLUSH W/POTABLE WATER FOR A MINIMUM OF 15 MINUTES. SEEK ASSISTANCE FROM MD (FP N). SKIN:FLUSH W/COPIOUS AMOUNTS OF WATER. CALL MD (FP N). INHAL:IMMEDIATELY REMOVE VICTIM TO FRESH AIR. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: EVACUATE & VENTILATE AREA. REMOVE LEAKING CYLINDER TO EXHAUST HOOD OR SAFE OUTDOORS AREA IF THIS CAN BE DONE SAFELY.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Method: DISPOSAL MUST BE I/A/W FEDERAL, STATE & LOCAL REGULATIONS (FP N). RETURN CYLS TO SUPPLIER FOR PROPER DISP W/ANY VALVE OUTLET PLUGS/CAPS SECURED & VALVE PROT CAP IN PLACE. ALLOW GAS TO DISCHARGE AT SLOW RATE TO ATM IN UNCONFINED AREA/EXHST HOOD.
Precautions-Handling/Storing: STORE IN WELL VENTILATED AREAS ONLY. KEEP VALVE PROT CAP ON CYLS WHEN NOT IN USE & SECURE CYL WHEN USING TO PROT FROM FALLING.
Other Precautions: USE SUITABLE HAND TRUCK TO MOVE CYLS. PROT CYLS FROM PHYSICAL DMG. DO NOT DEFACE CYLS/LBLS. MOVE CYL W/ADEQ HAND TRUCK. CYL SHOULD BE REFILLED BY QUALIFIED PRODUCERS OF COMPRESSED GAS. SHIPMENT OF COMPRESSED GAS CYL WHICH HAS NOT (SUPDAT)

Control Measures

Respiratory Protection: USE NIOSH/MSHA APPROVED SCBA IN CASE OF EMERGENCY OR NON-ROUTINE USE.
Ventilation: PROVIDE ADEQUATE GENERAL & LOCAL EXHAUST VENTILATION.
Protective Gloves: RUBBER GLOVES.
Eye Protection: ANSI APPROVED CHEM WORKERS GOGGS (FP N).
Other Protective Equipment: WEAR SAFETY SHOES. A SAFETY SHOWER & EYEWASH STATION SHOULD BE READILY AVAILABLE.
Work Hygienic Practices: NONE SPECIFIED BY MANUFACTURER.
Suppl. Safety & Health Data: OTHER PREC:BEEN FILLED BY OWNER OR WITH HIS WRITTEN CONSENT IS A VIOLATION OF FEDERAL LAW (49 CFR).

Transportation Data

Trans Data Review Date: 94269

Disposal Data

Label Data

Label Required: YES
Technical Review Date: 27SEP94
Label Date: 26SEP94
Label Status: G
Common Name: ISOBUTYLENE IN AIR
Chronic Hazard: NO
Signal Word: NONE
Acute Health Hazard-None: X
Contact Hazard-None: X
Fire Hazard-None: X
Reactivity Hazard-None: X
Special Hazard Precautions: ACUTE:CONCENTRATION OF ISOBUTYLENE IS THIS MIXTURE SHOULD NOT PRESENT ANY SYMPTOMS OF TOXICITY. CHRONIC:NONE LISTED BY MANUFACTURER.
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: SCOTT SPECIALTY GASES
Label Street: ROUTE 611 NORTH
Label City: PLUMSTEADVILLE
Label State: PA
Label Zip Code: 18949
Label Country: US
Label Emergency Number: 215-766-8861; 908-754-7700

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delete information in this archive please send updates to dan@siri.org.

MINE SAFETY APPLIANCES -- 466193 CALIBRATION CHECK GAS 0.75% PENTANE IN AIR - CALIBRATION KIT, GAS
MATERIAL SAFETY DATA SHEET
NSN: 6665012971039
Manufacturer's CAGE: 40912
Part No. Indicator: A
Part Number/Trade Name: 466193 CALIBRATION CHECK GAS 0.75% PENTANE IN AIR

General Information

Item Name: CALIBRATION KIT, GAS
Company's Name: MINE SAFETY APPLIANCES CO
Company's P. O. Box: 426
Company's City: PITTSBURGH
Company's State: PA
Company's Country: US
Company's Zip Code: 15230
Company's Emerg Ph #: 412-967-3000
Company's Info Ph #: 412-967-3000
Distributor/Vendor # 1: MINE SAFETY APPLIANCES
Distributor/Vendor # 1 Cage: 3J685
Distributor/Vendor # 2: MINE SAFETY APPLIANCES CO DBA MSA
Distributor/Vendor # 2 Cage: 55799
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 002
Status: SE
Date MSDS Prepared: 01FEB88
Safety Data Review Date: 01NOV95
Supply Item Manager: CX
MSDS Preparer's Name: UNKNOWN
MSDS Serial Number: BHXQY
Specification Number: NONE
Spec Type, Grade, Class: NONE
Hazard Characteristic Code: G3
Unit Of Issue: EA
Unit Of Issue Container Qty: 17 LITERS GAS
Type Of Container: CYLINDER
Net Unit Weight: UNKNOWN

Ingredients/Identity Information

Proprietary: NO
Ingredient: PENTANE
Ingredient Sequence Number: 01
Percent: 0.75
NIOSH (RTECS) Number: RZ9450000
CAS Number: 109-66-0
OSHA PEL: 1000 PPM
ACGIH TLV: 600 PPM/750STEL;9495
Other Recommended Limit: NOT ESTABLISHED

Proprietary: NO
Ingredient: AIR
Ingredient Sequence Number: 02
Percent: 99.25
NIOSH (RTECS) Number: AX5275000
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE
Other Recommended Limit: NOT APPLICABLE

Physical/Chemical Characteristics

Appearance And Odor: COLORLESS GAS. FAINT HYDROCARBON ODOR.
Vapor Density (Air=1): >1
Decomposition Temperature: UNKNOWN
Solubility In Water: NEGLIGIBLE
Viscosity: UNKNOWN

Fire and Explosion Hazard Data

Flash Point: NONE
Lower Explosive Limit: 1.4 PENTANE
Upper Explosive Limit: 8.0 PENTANE
Extinguishing Media: NONFLAMMABLE. DLA-HMIS: USE WATER FOG, CARBON DIOXIDE, FOAM, OR DRY CHEMICAL.
Special Fire Fighting Proc: DLA-HMIS: FIRE FIGHTERS SHOULD USE NIOSH APPROVED SCBA & FULL PROTECTIVE EQUIPMENT. USE WATER SPRAY TO COOL NEARBY CONTAINERS EXPOSED TO FIRE.
Unusual Fire And Expl Hazrds: GAS UNDER PRESSURE. 250 PSIG AT 70F. DO NOT

EXCEED 120F.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): HIGH TEMPERATURES, OPEN FLAMES.
Materials To Avoid: NONE SPECIFIED BY MANUFACTURER.
Hazardous Decomp Products: NONE SPECIFIED BY MANUFACTURER.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NONE SPECIFIED BY MANUFACTURER.

Health Hazard Data

LD50-LC50 Mixture: LD50 (ORAL RAT) IS UNKNOWN
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: NO
Health Haz Acute And Chronic: PENTANE MAY BE IRRITATING TO MUCOUS MEMBRANES.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE OF THE COMPOUNDS IN THIS PRODUCT IS LISTED BY IARC, NTP, OR OSHA AS A CARCINOGEN.
Signs/Symptoms Of Overexp: MAY CAUSE RESPIRATORY TRACT IRRITATION.
Med Cond Aggravated By Exp: NO INFORMATION.
Emergency/First Aid Proc: REMOVE FROM EXPOSURE.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: VENTILATE AREA. AVOID BREATHING GAS.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Method: DO NOT PUNCTURE OR INCINERATE CYLINDER. BEFORE DISCARDING CYLINDER, SLOWLY RELEASE CONTENTS TO A SAFE EXHAUST.
Precautions-Handling/Storing: STORE IN A COOL, DRY, WELL-VENTILATED AREA. DO NOT EXCEED 120F. DLA-HMIS: PROTECT FROM PHYSICAL DAMAGE.
Other Precautions: AVOID BREATHING GAS. USE ONLY IN WELL-VENTILATED AREAS. FOLLOW THE CALIBRATION PROCEDURE DETAILED IN THE MSA INSTRUCTION MAUNUAL PROVIDED WITH THE INSTRUMENT UNDER CALIBRATION.

Control Measures

Respiratory Protection: NONE NORMALLY REQUIRED. DLA-HMIS: IF ENGINEERING CONTROLS FAIL OR NON-ROUTINE USE OR AN EMERGENCY OCCURS; WEAR AN MSHA/NIOSH APPROVED AIR-SUPPLIED RESPIRATOR OR SCBA, AS REQUIRED. USE IN ACCORDANCE WITH 29 CFR 1910.134.
Ventilation: USE ADEQUATE MECHANICAL VENTILATION TO MAINTAIN EXPOSURE BELOW TLV(S).
Protective Gloves: WORK GLOVES FOR HANDLING CYLINDERS.
Eye Protection: APPROVED SAFETY GLASSES OR FACE SHIELD.
Other Protective Equipment: SAFETY SHOES AND HEARING PROTECTION.
Work Hygienic Practices: OBSERVE GOOD PERSONAL HYGIENE PRACTICES AND RECOMMENDED PROCEDURES. USE PROPER CARE WHEN HANDLING AND STORING CYLINDERS.
Suppl. Safety & Health Data: NONE.

Transportation Data

Trans Data Review Date: 95305
DOT PSN Code: DQQ
DOT Proper Shipping Name: COMPRESSED GASES, N.O.S.
DOT Class: 2.2
DOT ID Number: UN1956
DOT Label: NONFLAMMABLE GAS
IMO PSN Code: EQH
IMO Proper Shipping Name: COMPRESSED GAS, N.O.S.
IMO Regulations Page Number: 2125
IMO UN Number: 1956
IMO UN Class: 2(2.2)
IMO Subsidiary Risk Label: -
IATA PSN Code: HDO
IATA UN ID Number: 1956
IATA Proper Shipping Name: COMPRESSED GAS, N.O.S. *
IATA UN Class: 2.2
IATA Label: NON-FLAMMABLE GAS
AFI PSN Code: HDO
AFI Prop. Shipping Name: COMPRESSED GAS, N.O.S.
AFI Class: 2.2
AFI ID Number: UN1956
AFI Label: NON-FLAMMABLE GAS

AFI Basic Pac Ref: A6.3,A6.5,A6.7
N.O.S. Shipping Name: PENTANE, AIR.
Additional Trans Data: GAS UNDER PRESSURE, 250 PSIG AT 70F, APPROXIMATELY 17 LITERS GAS AT ATMOSPHERIC PRESSURE.

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Disposal Data

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Label Data

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Label Required: YES
Technical Review Date: 30AUG90
MFR Label Number: NONE
Label Status: F
Common Name: MSA 466193 CALIBRATION CHECK GAS
Chronic Hazard: NO
Signal Word: CAUTION!
Acute Health Hazard-Slight: X
Contact Hazard-None: X
Fire Hazard-Slight: X
Reactivity Hazard-None: X
Special Hazard Precautions: PENTANE MAY BE IRRITATING TO MUCOUS MEMBRANES. PROTECT CYLINDERS FROM PHYSICAL DAMAGE. STORE AWAY FROM EXTREME HEAT. KEEP CYLINDER VALVES CLOSED WHEN NOT IN USE AND WHEN EMPTY. DO NOT EXCEED 120F. IF INHALED, REMOVE VICTIM TO FRESH AIR.
Protect Eye: Y
Protect Skin: Y
Label Name: MINE SAFETY APPLIANCES CO
Label P.O. Box: 428
Label City: PITTSBURGH
Label State: PA
Label Zip Code: 15230
Label Country: US
Label Emergency Number: 412-967-3000
Year Procured: 1989

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J T BAKER CHEMICAL -- HYDROCHLORIC ACID - HYDROCHLORIC ACID, ACS
MATERIAL SAFETY DATA SHEET
NSN: 6810007534786
Manufacturer's CAGE: 70829
Part No. Indicator: A
Part Number/Trade Name: HYDROCHLORIC ACID

General Information

Item Name: HYDROCHLORIC ACID, ACS
Company's Name: J.T.BAKER CHEMICAL CO.
Company's Street: 222 RED SCHOOL LANE
Company's City: PHILLIPSBURG
Company's State: NJ
Company's Country: US
Company's Zip Code: 08865-2219
Company's Emerg Ph #: 201-859-2151
Company's Info Ph #: 201-859-2151
Distributor/Vendor # 1: SHAPE PRODUCTS (415-534-1186)
Distributor/Vendor # 1 Cage: 3D869
Distributor/Vendor # 2: CHEMICAL COMMODITIES AGENCY
Distributor/Vendor # 2 Cage: 60777
Record No. For Safety Entry: 005
Tot Safety Entries This Stk#: 007
Status: SE
Date MSDS Prepared: 07AUG91
Safety Data Review Date: 07MAR94
Supply Item Manager: CX
MSDS Serial Number: BFNCY
Specification Number: O-C-265
Hazard Characteristic Code: C1
Unit Of Issue: PT
Unit Of Issue Container Qty: 16 FL OUNCES
Type Of Container: BOTTLE
Net Unit Weight: 1.2 LBS

Ingredients/Identity Information

Proprietary: NO
Ingredient: HYDROGEN CHLORIDE (HYDROCHLORIC ACID) (SARA III)
Ingredient Sequence Number: 01
Percent: 33-40
NIOSH (RTECS) Number: MW4025000
CAS Number: 7647-01-0
OSHA PEL: C 5 PPM
ACGIH TLV: C 5 PPM; 9192

Proprietary: NO
Ingredient: WATER
Ingredient Sequence Number: 02
Percent: 60-67
NIOSH (RTECS) Number: ZC0110000
CAS Number: 7732-18-5
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: NOT ESTABLISHED
Other Recommended Limit: NONE RECOMMENDED

Physical/Chemical Characteristics

Appearance And Odor: CLEAR, COLORLESS OR SLIGHTLY YELLOW, PUNGENT, FUMING LIQUID.
Boiling Point: 230F,110C
Melting Point: -13F,-25C
Vapor Pressure (MM Hg/70 F): NOT GIVEN
Vapor Density (Air=1): 1.3
Specific Gravity: 1.19
Decomposition Temperature: UNKNOWN
Evaporation Rate And Ref: NOT GIVEN
Solubility In Water: COMPLETE
Percent Volatiles By Volume: 100 %
pH: 1.0
Corrosion Rate (IPY): UNKNOWN

Fire and Explosion Hazard Data

Flash Point: NONFLAMMABLE
Lower Explosive Limit: NOT GIVEN
Upper Explosive Limit: NOT GIVEN

Extinguishing Media: USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.
Special Fire Fighting Proc: FIRE FIGHTERS SHOULD USE NIOSH APPROVED SCBA & FULL PROTECTIVE EQUIPMENT WHEN FIGHTING CHEMICAL FIRE. USE WATER SPRAY TO COOL NEARBY CONTAINERS EXPOSED TO FIRE.
Unusual Fire And Expl Hazrds: DO NOT GET WATER INSIDE OF CONTAINERS. MAY EMIT HYDROGEN GAS UPON CONTACT WITH METAL.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): HEAT, MOISTURE
Materials To Avoid: MOST COMMON METALS, WATER, AMINES, METAL OXIDES, ACETIC ANHYDRIDE, PROPIOLACETONE, VINYL ACETATE, MERCURIC SULFATE
Hazardous Decomp Products: HYDROGEN CHLORIDE, HYDROGEN, CHLORINE
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NONE, WILL NOT OCCUR.

Health Hazard Data

LD50-LC50 Mixture: LD50 ORAL = 900 MG/KG (RABBIT)
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: INHALATION OF VAPORS MAY CAUSE PULMONARY EDEMA, CIRCULATORY SYSTEM COLLAPSE, DAMAGE TO UPPER RESPIRATORY SYSTEM, COLLASPE, MAY CAUSE COUGHING AND DIFFICULT BREATHING. LIQUID MAY CAUSE SEVERE BURNS TO SKIN AND EYES. INGESTION MAY CAUSE SEVERE BURNING TO STOMACH AND MOUTH. MAY CAUSE NAUSEA AND VOMITING.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: PRODUCT CONTAINS NO INGREDIENTS CURRENTLY CLASSIFIED AS CARCINOGENIC BY NTP, IARC OR OSHA.
Signs/Symptoms Of Overexp: PULMONARY EDEMA, CIRCULATORY SYSTEM COLLAPSE, UPPER RESPIRATORY TRACT DAMAGE, COLLAPSE, COUGHING, DIFFICULTY IN BREATHING, EYE BURNS, SKIN BURNS, BURNS TO STOMACH AND/OR MOUTH, NAUSEA AND VOMITING.
Med Cond Aggravated By Exp: NONE SPECIFIED BY MANUFACTURER.
Emergency/First Aid Proc: CALL A PHYSICIAN AT ONCE. INGESTION: DO NOT INDUCE VOMITING. IF CONSCIOUS, GIVE WATER, MILK OR MILK OF MAGNESIA. INHALATION: REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN. EYES/SKIN: IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. STOP LEAK IF CAN DO SO WITHOUT RISK. VENTILATE AREA. NEUTRALIZE SPILL. WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER. REMOVE FROM AREA. FLUSH AREA
Neutralizing Agent: SODA ASH OR LIME.
Waste Disposal Method: PREVENT WASTE FROM CONTAMINATING SURROUNDING ENVIRONMENT. DISCARD ANY PRODUCT, RESIDUE, DISPOSAL CONTAINER OR LINER IN ACCORDANCE WITH ALL FEDERAL, STATE AND LOCAL REGULATIONS.
Precautions-Handling/Storing: KEEP CONTAINER TIGHTLY CLOSED. STORE IN CORROSION-PROOF AREA. ISOLATE FROM INCOMPATIBLE MATERIALS. DO NOT STORE NEAR OXIDIZING MATERIALS.
Other Precautions: EPA HAZARDOUS WASTE NUMBER: D002 (CORROSIVE WASTE).

Control Measures

Respiratory Protection: IF VENTILATION DOES NOT MAINTAIN INHALATION EXOSURES BELOW PEL (TLV), USE NIOSH/MSHA APPROVED RESPIRATOR AS PER CURRENT 29 CFR 1910.134, INSTRUCTIONS/WARNINGS AND NIOSH RESPIRATOR SELECTION.
Ventilation: LOCAL EXHAUST AND MECHANICAL (GENERAL) VENTILATION TO MAINTAIN EXPOSURE LEVELS.
Protective Gloves: ACID RESISTANT
Eye Protection: SAFETY GOGGLES AND FACE SHEILD
Other Protective Equipment: UNIFORM, PROTECTIVE SUIT
Work Hygienic Practices: WASH WITH SOAP AND WATER AFTER HANDLING PRODUCT AND BEFORE EATING DRINKING OR SMOKING.
Suppl. Safety & Health Data: NONE SPECIFIED BY MANUFACTURER.

Transportation Data

Trans Data Review Date: 93264
DOT PSN Code: HJG
DOT Proper Shipping Name: HYDROCHLORIC ACID, SOLUTION

DOT Class: 8
DOT ID Number: UN1789
DOT Pack Group: II
DOT Label: CORROSIVE
IMO PSN Code: IEX
IMO Proper Shipping Name: HYDROCHLORIC ACID.SOLUTION
IMO Regulations Page Number: 8183
IMO UN Number: 1789
IMO UN Class: 8
IMO Subsidiary Risk Label: -
IATA PSN Code: NPG
IATA UN ID Number: 1789
IATA Proper Shipping Name: HYDROCHLORIC ACID SOLUTION
IATA UN Class: 8
IATA Label: CORROSIVE
AFI PSN Code: NPG
AFI Symbols: T
AFI Prop. Shipping Name: HYDROCHLORIC ACID, SOLUTION
AFI Class: 8
AFI ID Number: UN1789
AFI Pack Group: II
AFI Label: CORROSIVE
AFI Special Prov: A3,A6,N41
AFI Basic Pac Ref: 12-S

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Disposal Data

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Disposal Data Review Date: 88085
Rec # For This Disp Entry: 02
Tot Disp Entries Per NSN: 004
Landfill Ban Item: YES
Disposal Supplemental Data: IN CASE OF ACCIDENTAL EXPOSURE OR DISCHARGE, cONSULT HEALTH AND SAFETY FILE FOR PRECAUTIONS.
1st EPA Haz Wst Code New: D002
1st EPA Haz Wst Name New: CORROSIVE
1st EPA Haz Wst Char New: CORROSIVITY
1st EPA Acute Hazard New: NO

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Label Data

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Label Required: YES
Technical Review Date: 07MAR94
MFR Label Number: NONE
Label Status: G
Common Name: HYDROCHLORIC ACID
Chronic Hazard: NO
Signal Word: DANGER!
Acute Health Hazard-Moderate: X
Contact Hazard-Severe: X
Fire Hazard-Slight: X
Reactivity Hazard-Slight: X
Special Hazard Precautions: INHALATION OF VAPORS MAY CAUSE PULMONARY EDEMA, CIRCULATORY SYSTEM COLLAPSE, DAMAGE TO UPPER RESPIRATORY SYSTEM, COLLASPE. MAY CAUSE COUGHING AND DIFFICULT BREATHING. LIQUID MAY CAUSE SEVERE BURNS TO SKIN AND EYES. INGESTION MAY CAUSE SEVERE BURNING TO STOMACH AND MOUTH. MAY CAUSE NAUSEA AND VOMITING. KEEP CONTAINER TIGHTLY CLOSED. STORE IN CORROSION-PROOF AREA. ISOLATE FROM INCOMPATIBLE MATERIALS. DO NOT STORE NEAR OXIDIZING MATERIALS. FIRST AID: CALL A PHYSICIAN AT ONCE. INGESTION: DO NOT INDUCE VOMITING. IF CONSCIOUS, GIVE WATER, MILK OR MILK OF MAGNESIA. INHALATION: REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BR
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: J.T.BAKER CHEMICAL CO.
Label Street: 222 RED SCHOOL LANE
Label City: PHILLIPSBURG
Label State: NJ
Label Zip Code: 08865-2219
Label Country: US
Label Emergency Number: 201-859-2151

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J T BAKER CHEMICAL -- NITRIC ACID - NITRIC ACID.ACS
MATERIAL SAFETY DATA SHEET
NSN: 6810002372954
Manufacturer's CAGE: 70829
Part No. Indicator: A
Part Number/Trade Name: NITRIC ACID

General Information

Item Name: NITRIC ACID.ACS
Company's Name: J.T.BAKER CHEMICAL CO.
Company's Street: 222 RED SCHOOL LANE
Company's City: PHILLIPSBURG
Company's State: NJ
Company's Country: US
Company's Zip Code: 08865-2219
Company's Emerg Ph #: 201-859-2151
Company's Info Ph #: 201-859-2151
Record No. For Safety Entry: 017
Tot Safety Entries This Stk#: 019
Status: SE
Date MSDS Prepared: 01MAY89
Safety Data Review Date: 19MAY92
Supply Item Manager: CX
MSDS Serial Number: BMTWQ
Hazard Characteristic Code: D4
Unit Of Issue: BT
Unit Of Issue Container Qty: 7.0 LBS
Type Of Container: BOTTLE
Net Unit Weight: 7.0 LBS

Ingredients/Identity Information

Proprietary: NO
Ingredient: NITRIC ACID (SARA III) *
Ingredient Sequence Number: 01
Percent: 65-71
NIOSH (RTECS) Number: QU5775000
CAS Number: 7697-37-2 *
OSHA PEL: 2 PPM/4 STEL *
ACGIH TLV: 2 PPM/4 STEL; 9192 *
Other Recommended Limit: NONE SPECIFIED

Proprietary: NO
Ingredient: WATER
Ingredient Sequence Number: 02
Percent: 29 - 35
NIOSH (RTECS) Number: ZC0110000
CAS Number: 7732-18-5
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: NOT ESTABLISHED
Other Recommended Limit: NONE SPECIFIED

Physical/Chemical Characteristics

Appearance And Odor: CLEAR, COLORLESS LIQUID, SUFFOCATING (CHOKING) ODOR
Boiling Point: 249F,121C
Melting Point: -43F,-42C
Vapor Pressure (MM Hg/70 F): 9
Specific Gravity: 1.4
Evaporation Rate And Ref: UNKNOWN
Solubility In Water: COMPLETE
Percent Volatiles By Volume: 100
pH: 1(.1M)
Corrosion Rate (IPY): UNKNOWN

Fire and Explosion Hazard Data

Flash Point: NONE
Extinguishing Media: WATER SPRAY. USE WATER SPRAY TO KEEP FIRE EXPOSED CONTAINERS COOL & FLUSH SPILLS AWAY.
Special Fire Fighting Proc: USE SELF-CONTAINED BREATHING APPARATUS IN POSITIVE PRESSURE MODE AND FULL BODY PROTECTION. REMOVE FIRE-EXPOSED CONTAINERS . DO NOT GET WATER INSIDE CONTAINERS.
Unusual Fire And Expl Hazrds: STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. WITH METALS PRODUCES H2 WHICH WITH AIR CAN FORM EXPLOSIVE MIXTURE. EXOTHERMIC REACTION WITH WATER.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): HEAT, LIGHT, MOISTURE
Materials To Avoid: STRONG BASES, COMBUSTIBLES, STRONG REDUCING AGENTS, MOST COMMON METALS, ORGANIC MATERIALS, ALCOHOLS, CARBIDES, CARBONATE
Hazardous Decomp Products: NITROGEN OXIDES , HYDROGEN GAS
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT APPLICABLE

Health Hazard Data

LD50-LC50 Mixture: TLV IS 2 PPM
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: ACUTE-SEVERE IRRITATION/BURNS OF EYE,SKIN, RESPIRATORY SYSTEM.INHALING CAUSES COUGHING,DIFFICULTY IN BREATHING,CHEST PAIN,PULMONARY EDEMA,LUNG INFLAMMATION,UNCONSCIOUSNESS & MAY BE FATAL. ORALLY CAUSES NAUSEA,VOMITING,SEVERE BURNS & ULCERATION OF MOUTH,THROAT, STOMACH.MAY BE FATAL.CHRONIC-DAMAGE TO LUNG & TEETH.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Signs/Symptoms Of Overexp: SEVERE IRRITATION/BURNS OF EYE, SKIN, RESPIRATORY SYSTEM. INHALING CAUSES COUGHING, DIFFICULTY IN BREATHING, CHEST PAIN, PULMONARY EDEMA, LUNG INFLAMMATION, UNCONSCIOUSNESS & MAY BE FATAL. ORALLY CAUSES NAUSEA, VOMITING, SEVERE BURNS & ULCERATION OF MOUTH, THROAT, STOMACH. MAY BE FATAL.
Med Cond Aggravated By Exp: PERSONS WITH PRE-EXISTING SKIN DISORDERS OR EYE PROBLEMS OR IMPAIRED RESPIRATORY FUNCTION OR CARDIOPULMONARY DISEASE MAY BE MORE SUSCEPTIBLE TO THE EFFECTS OF THE SUBSTANCE.
IMMEDIATELY FLUSH WITH WATER FOR AT LEAST 15 MINUTES.HOLD EYELIDS OPEN. INHALED:REMOVE TO FRESH AIR & PROVIDE OXYGEN/CPR IF NEEDED.ORAL:DO NOT INDUCE VOMITING.IF CONSCIOUS,DRINK LARGE AMOUNT OF WATER/MILK/MILK OF MAGNESIA.CALL A PHYSICIAN IMMEDIATELY.NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: WEAR PROPER PROTECTIVE EQUIPMENT. VENTILATE AREA. DO NOT RELEASE INTO SOIL, SEWER, STREAM. STOP LEAK IF POSSIBLE. NEUTRALIZE WITH SODA ASH OR LIME. WITH CLEAN SHOVEL, PLACE MATERIAL INTO CLEAN CONTAINER FOR DISPOSAL. FLUSH SPILL AREA WITH WATER.
Neutralizing Agent: J.T. BAKER NEUTRASORB
Waste Disposal Method: DISPOSE OF IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS. EPA HAZARDOUS WASTE NUMBER: D001, D002 (IGNITABLE,CORROSIVE WASTE). KEEP COMBUSTIBLES (WOOD, PAPER, OIL, ETC. .) AWAY FROM SPILLED MATERIAL.
Precautions-Handling/Storing: STORAGE-STORE IN COOL,DRY,WELL VENTILATED AREA AWAY FROM INCOMPATIBLES & LIGHT.KEEP CONTAINER TIGHTLY CLOSED.PROTECT CONTAINERS FROM PHYSICAL DAMAGE.
Other Precautions: AVOID BREATHING VAPORS OR MISTS. DO NOT GET IN EYES, ON SKIN OR ON CLOTHING. WASH THOROUGHLY AFTER HANDLING AND BEFORE EATING OR DRINKING. REMOVE CONTAMINATED CLOTHING PROMPTLY. KEEP OUT OF REACH OF CHILDREN.

Control Measures

Respiratory Protection: USE CHEMICAL CARTRIDGE RESPIRATOR UP TO 100 PPM. USE SELF CONTAINED BREATHING APPARATUS AT AND ABOVE 100 PPM.
Ventilation: USE GENERAL OR LOCAL EXHAUST.
Protective Gloves: ACID RESISTANT GLOVES.
Eye Protection: SAFETY GLASSES/CHEMICAL SPLASH GOGGLES
Other Protective Equipment: SAFETY SHOWER AND EYE BATH. INDUSTRIAL TYPE WORK CLOTHING AND APRON AS REQUIRED TO AVOID PROLONGED OR REPEATED CONTACT.
Work Hygienic Practices: OBSERVE GOOD PERSONAL HYGIENE PRACTICES AND RECOMMENDED PROCEDURES. DO NOT WEAR CONTAMINATED CLOTHING OR FOOTWEAR.

Transportation Data

Trans Data Review Date: 92140
DOT PSN Code: KFD
DOT Proper Shipping Name: NITRIC ACID
DOT Class: 8
DOT ID Number: UN2031
DOT Pack Group: II
DOT Label: CORROSIVE
IMO PSN Code: KPF
IMO Proper Shipping Name: NITRIC ACID

IMO Regulations Page Number: 8195
IMO UN Number: 2031
IMO UN Class: 8
IMO Subsidiary Risk Label: -
IATA PSN Code: RWF
IATA UN ID Number: 2031
IATA Proper Shipping Name: NITRIC ACID
IATA UN Class: 8
IATA Label: CORROSIVE
AFI PSN Code: RWF
AFI Symbols: C
AFI Prop. Shipping Name: NITRIC ACID
AFI Class: 8
AFI ID Number: UN2031
AFI Pack Group: II
AFI Label: CORROSIVE
AFI Basic Pac Ref: 12-14
Additional Trans Data: CONTAINS 65 - 71 % NITRIC ACID.

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Disposal Data

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Label Data

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Label Required: YES
Technical Review Date: 19MAY92
MFR Label Number: UNKNOWN
Label Status: F
Common Name: NITRIC ACID
Signal Word: DANGER!
Acute Health Hazard-Severe: X
Contact Hazard-Severe: X
Fire Hazard-None: X
Reactivity Hazard-Slight: X
Special Hazard Precautions: ACUTE-SEVERE IRRITATION/BURNS OF EYE,SKIN, RESPIRATORY SYSTEM.INHALING CAUSES COUGHING,DIFFICULTY IN BREATHING,CHEST PAIN,PULMONARY EDEMA,LUNG INFLAMMATION,UNCONSCIOUSNESS & MAY BE FATAL. ORALLY CAUSES NAUSEA,VOMITING,SEVERE BURNS & ULCERATION OF MOUTH,THROAT, STOMACH.MAY BE FATAL.CHRONIC-DAMAGE TO LUNG & TEETH.STORAGE-STORE IN COOL, DRY,WELL VENTILATED AREA.FIRST AID-GET MEDICAL ATTENTION IMMEDIATELY.EYE/ SKIN:IMMEDIATELY FLUSH WITH WATER FOR AT LEAST 15 MINUTES.HOLD EYELIDS OPEN.INHALED:REMOVE TO FRESH AIR & PROVIDE OXYGEN/CPR IF NEEDED.ORAL:DO NOT INDUCE VOMITING.IF CONSCIOUS,DRINK LARGE AMOUNT OF WATER/MILK/MILK OF MAGNESIA.CALL PHYSICIAN.
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: J.T.BAKER CHEMICAL CO.
Label Street: 222 RED SCHOOL LANE
Label City: PHILLIPSBURG
Label State: NJ
Label Zip Code: 08865-2219
Label Country: US
Label Emergency Number: 201-859-2151

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J T BAKER -- 9680. SULFURIC ACID - SULFURIC ACID.ACS
MATERIAL SAFETY DATA SHEET
NSN: 6810001467515
Manufacturer's CAGE: 70829
Part No. Indicator: A
Part Number/Trade Name: 9680. SULFURIC ACID

General Information

Item Name: SULFURIC ACID.ACS
Company's Name: J T BAKER INC
Company's Street: 222 RED SCHOOL LANE
Company's City: PHILLIPSBURG
Company's State: NJ
Company's Country: US
Company's Zip Code: 08865-2219
Company's Emerg Ph #: 201-859-2151;800-424-9300(CHEMTREC)
Company's Info Ph #: 201-582-2537
Record No. For Safety Entry: 004
Tot Safety Entries This Stk#: 004
Status: SMJ
Date MSDS Prepared: 01MAY89
Safety Data Review Date: 06MAY92
MSDS Serial Number: BNPLN
Hazard Characteristic Code: C1
Unit Of Issue Container Qty: 1.000 POUND
Type Of Container: BOTTLE
Net Unit Weight: 1.000 LB

Ingredients/Identity Information

Proprietary: NO
Ingredient: SULFURIC ACID
Ingredient Sequence Number: 01
Percent: 90-98
NIOSH (RTECS) Number: WS5600000
CAS Number: 7664-93-9
OSHA PEL: 1 MG/M3
ACGIH TLV: 1 MG/M3;3 MG/M3 STEL

Proprietary: NO
Ingredient: WATER
Ingredient Sequence Number: 02
Percent: 2-10
NIOSH (RTECS) Number: ZC0110000
CAS Number: 7732-18-5
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Physical/Chemical Characteristics

Appearance And Odor: CLEAR, COLORLESS TO YELLOW VISCOUS LIQUID. ODORLESS.
Boiling Point: 620F,327C
Melting Point: 28.4F,-2.0C
Vapor Pressure (MM Hg/70 F): < 0.3 @20C
Vapor Density (Air=1): 3.4
Specific Gravity: 1.84
Decomposition Temperature: UNKNOWN
Evaporation Rate And Ref: < 1 (BUTYL ACETATE = 1)
Solubility In Water: COMPLETE
Viscosity: UNKNOWN
Corrosion Rate (IPY): UNKNOWN

Fire and Explosion Hazard Data

Flash Point: NOT APPLICABLE
Lower Explosive Limit: N/A
Upper Explosive Limit: N/A
Extinguishing Media: USE DRY CHEMICAL OR CARBON DIOXIDE. DO NOT USE WATER.
Special Fire Fighting Proc: WEAR NIOSH/MSHA APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT. DO NOT GET WATER INSIDE CONTAINERS.
Unusual Fire And Expl Hazrds: REACTS W/MOST METALS TO PRDCE HYDROGEN GAS, WHICH CAN FORM AN EXPLO MIX W/AIR. A VIOLENT EXOTHERMIC RXN OCCURS W/H2O. SUFFICIENT HEAT MAY BE PRDCD (SUPP DATA)

Reactivity Data

Stability: YES

Cond To Avoid (Stability): MOISTURE. HEAT.
Materials To Avoid: WATER. MOST METALS. ORGANIC MATERIALS. STRONG REDUCING AGENTS. COMBUSTIBLE MATLS. STRONG BASES. CARBONATES. (SUPP DATA)
Hazardous Decomp Products: OXIDES OF SULFUR. HYDROGEN.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT

Health Hazard Data

LD50-LC50 Mixture: LD50:(ORAL,RAT)2140 MG/KG
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: NO
Health Haz Acute And Chronic: ACUTE: INHALATION: SEVERE IRRITATION OR SEVERE BURNS. SKIN ABSORPTION: NONE IDENTIFIED. INGESTION: NAUSEA. VOMITING. SEVERE BURNS TO MOUTH. THROAT. AND STOMACH. KIDNEY DISFUNCTION. CHRONIC: LUNG DAMAGE.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NOT RELEVANT
Med Cond Aggravated By Exp: RESPIRATORY SYSTEM DISEASE.
Emergency/First Aid Proc: INGESTION: CALL A DOCTOR. DO NOT INDUCE VOMITING. IF CONSCIOUS. GIVE LARGE AMOUNTS OF WATER. INHALATION: REMOVE TO FRESH AIR. IF NOT BREATHING. GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT. GIVE OXYGEN. SKIN: IMMEDIATELY FLUSH WITH WATER FOR AT LEAST 15 IMMEDIATELY FLUSH WITH WATER FOR AT LEAST 15 MINUTES.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: WEAR NIOSH/MSHA APPRVD SCBA & FULL PROT CLTHG. STOP LEAK IF YOU CAN DO SO W/OUT RISK. DO NOT USE WATER. NEUTRALIZE SPILL &/OR WASHING WITH SODA ASH OR LIME. W/CLEAN SHOVEL. PLACE MATL INTO CLEAN. DRY CONTR & COVER. MOVE CONTR(S) FROM SPILL AREA.
Neutralizing Agent: J.T. BAKER NEUTRASORB (R) OR TEAM 'LOW NA+' ACID NEUTRALIZERS. SODA ASH/LIME.
Waste Disposal Method: DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL. D002. D003 (CORROSIVE. REACTIVE WASTE).
Precautions-Handling/Storing: KEEP CONTAINERS TIGHTLY CLOSED. LOOSEN CLOSURE CAUTIOUSLY. STORE IN CORROSION-PROOF AREA. KEEP CONTAINERS OUT OF SUN AND AWAY FROM HEAT.
Other Precautions: ISOLATE FROM INCOMPATIBLE MATERIALS. DO NOT GET IN EYES. ON SKIN. OR ON CLOTHING. DO NOT BREATHE VAPORS.

Control Measures

Respiratory Protection: NONE REQUIRED WHERE ADEQUATE VENTILATION CONDITIONS EXIST. IF AIRBORNE CONCENTRATION EXCEEDS TLV. NIOSH/MSHA APPROVED SCBA IS ADVISED.
Ventilation: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS. VENT HOOD.
Protective Gloves: RUBBER GLOVES.
Eye Protection: CHEMICAL WORK GOGGLES. FULL FACESHIELD
Other Protective Equipment: UNIFORM. PROTECTIVE SUIT. LAB COAT. APRON. DELUGE SHOWER AND EMERGENCY EYE WASH
Work Hygienic Practices: WASH THOROUGHLY AFTER HANDLING.
TO IGNITE COMBUSTIBLE MATERIALS. MATERIALS TO AVOID: SULFIDES. CYANIDES. STRONG OXIDIZING AGENTS. CARBIDES.

Transportation Data

Trans Data Review Date: 92241
DOT PSN Code: NUC
DOT Proper Shipping Name: SULFURIC ACID
DOT Class: 8
DOT ID Number: UN1830
DOT Pack Group: II
DOT Label: CORROSIVE
IMO PSN Code: OFJ
IMO Proper Shipping Name: SULPHURIC ACID
IMO Regulations Page Number: 8230
IMO UN Number: 1830
IMO UN Class: 8
IMO Subsidiary Risk Label: -
IATA PSN Code: XIX
IATA UN ID Number: 1830
IATA Proper Shipping Name: SULPHURIC ACID
IATA UN Class: 8
IATA Label: CORROSIVE
AFI PSN Code: XIX

AFI Prop. Shipping Name: SULPHURIC ACID
AFI Class: 8
AFI ID Number: UN1830
AFI Pack Group: II
AFI Label: CORROSIVE
AFI Special Prov: 2,A3,A7,N34
AFI Basic Pac Ref: 12-5

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Disposal Data

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Label Data

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Label Required: YES
Technical Review Date: 06MAY92
Label Date: 05MAY92
Label Status: G
Common Name: 9680, SULFURIC ACID
Chronic Hazard: YES
Signal Word: DANGER!
Acute Health Hazard-Slight: X
Contact Hazard-Severe: X
Fire Hazard-None: X
Reactivity Hazard-Slight: X
Special Hazard Precautions: CORROSIVE! POISON! REACTS WITH METALS TO PRODUCE FLAMMABLE H*2 GAS. REACTS VIOLENTLY WITH WATER. CONTACT WITH OTHER MATERIALS MAY CAUSE FIRE. ACUTE: EYE/SKIN CONTACT CAUSES SEVERE BURNS. INHALATION CAUSES SEVERE BURNS OR IRRITATION OF THE RESPIRATORY SYSTEM. PULMONARY EDEMA, LUNG INFLAMMATION. INGESTION CAUSES NAUSEA, VOMITING, SEVERE BURNS TO MOUTH, THROAT, & STOMACH. CHRONIC: MAY CAUSE LUNG DAMAGE.
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: J T BAKER INC
Label Street: 222 RED SCHOOL LANE
Label City: PHILLIPSBURG
Label State: NJ
Label Zip Code: 08865-2219
Label Country: US
Label Emergency Number: 201-859-2151;800-424-9300(CHEMTREC)

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URL for this msds http://siri.org. If you wish to change, add to, or delete information in this archive please send updates to dan@siri.org.

J T BAKER -- SODIUM HYDROXIDE - SODIUM HYDROXIDE.ACS
MATERIAL SAFETY DATA SHEET
NSN: 6810001746585
Manufacturer's CAGE: 70829
Part No. Indicator: A
Part Number/Trade Name: SODIUM HYDROXIDE

General Information

Item Name: SODIUM HYDROXIDE.ACS
Company's Name: J.T.BAKER INC.
Company's Street: 222 RED SCHOOL LANE
Company's City: PHILLIPSBURG
Company's State: NJ
Company's Country: US
Company's Zip Code: 08865-2219
Company's Emerg Ph #: 201-859-2151
Company's Info Ph #: 201-859-2151
Record No. For Safety Entry: 010
Tot Safety Entries This Stk#: 010
Status: SE
Date MSDS Prepared: 01MAY89
Safety Data Review Date: 02MAY91
Supply Item Manager: CX
MSDS Serial Number: BDFQQ
Specification Number: O-C-265
Hazard Characteristic Code: C2
Unit Of Issue: LB
Unit Of Issue Container Qty: 1.0LB
Type Of Container: BOTTLE
Net Unit Weight: 500.0 GM

Ingredients/Identity Information

Proprietary: NO
Ingredient: SODIUM HYDROXIDE (SARA III)
Ingredient Sequence Number: 01
Percent: 98-100%
NIOSH (RTECS) Number: WB4900000
CAS Number: 1310-73-2
OSHA PEL: 2 MG/M3
ACGIH TLV: C 2 MG/M3; 9293
Other Recommended Limit: NONE SPECIFIED

Physical/Chemical Characteristics

Appearance And Odor: WHITE PELLETS OR FLAKES, ODORLESS.
Boiling Point: 2534F,1390C
Melting Point: 604F,318C
Vapor Pressure (MM Hg/70 F): < 1
Specific Gravity: 2.130
Decomposition Temperature: UNKNOWN
Solubility In Water: APPRECIABLE
Percent Volatiles By Volume: 0
Corrosion Rate (IPY): UNKNOWN

Fire and Explosion Hazard Data

Extinguishing Media: USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.
Special Fire Fighting Proc: WEAR FIRE FIGHTING PROTECTIVE EQUIPMENT AND A FULL FACED SELF CONTAINED BREATHING APPARATUS. FLOOD WITH WATER, DO NOT SPLATTER OR SPLASH THIS MATERIAL.
Unusual Fire And Expl Hazrds: CONTACT WITH MOISTURE OR WATER MAY GENERATE SUFFICIENT HEAT TO IGNITE COMBUSTIBLE MATERIALS. REACTS WITH MOST METALS TO PRODUCE HYDROGEN GAS.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): MOISTURE
Materials To Avoid: WATER, STRONG ACIDS, MOST COMMON METALS, COMBUSTIBLE MATERIALS, ORGANIC MATERIALS, ZINC, ALUMINUM, PEROXIDES.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT APPLICABLE

Health Hazard Data

LD50-LC50 Mixture: LD50 (ORAL RAT) IS UNKNOWN
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: ACUTE: CORROSIVE TO ALL BODY TISSUES W/ WHICH IT COMES IN CONTACT. CHRONIC: SUPERFICIAL DESTRUCTION OF THE SKIN AND OF PRIMARY IRRITANT DERMATITIS. IHALATION OF DUST, SPRAY OR MIST MAY RESULT IN VARYING DEGREES OF IRRITATION OR DAMAGE TO THE RESPIRATORY TRACT TISSUES AND AN INCREASED POSSIBILITY OF RESPIRATORY ILLNESS.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE OF THE CHEMICALS IN THIS PRODUCT IS LISTED BY IARC, NTP OR OSHA AS A CARCINOGEN.
Signs/Symptoms Of Overexp: INHALE: DAMAGE TO THE UPPER RESPIRATORY TRACT AND EVEN TO THE LUNG TISSUE. SKIN: SEVERE BURNS. EYE: SEVERE BURNS WITH DAMAGE TO THE EYE AND EVEN BLINDNESS. INGEST: SEVERE BURNS AND COMPLETE TISSUE PERFORATION OF MUCOUS MEMBRANES OF THE MOUTH, THROAT, ESOPHAGUS, AND STOMACH.
Med Cond Aggravated By Exp: PERSONS WITH A HISTORY OF SKIN AND RESPIRATORY DISORDERS MAY BE AT INCREASED RISK FROM EXPOSURE.
Emergency/First Aid Proc: SKIN:WASH W.SOAP & H*2O. EYES:FLUSH W. H*2O. INGESTED:DON'T INDUCE VOMITING. INHALED:REMOVE TO FRESH AIR. GIVE CPR/ OXYGEN IF NEED. KEEP WARM & QUIET. REMOVE CONTAMINATED CLOTHING. NEVER GIVE ANYTHING BY MOUTH TO UNCONSCIOUS PERSON.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: WEAR SCBA AND FULL PROTECTIVE CLOTHING. WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER.
Neutralizing Agent: NONE APPLICABLE FOR THIS MATERIAL
Waste Disposal Method: DISPOSE OF IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL LAWS AND REGULATIONS. KEEP OUT OF SEWERS, STORM DRAINS, SURFACE WATERS, AND SOIL.
Precautions-Handling/Storing: STORE IN COOL, DRY, WELL VENTILATED AREA AWAY FROM MOISTURE, SOLVENTS, ACIDS, AND ORGANIC MATTER. KEEP CONTAINERS CLOSED.
Other Precautions: THIS MATERIAL GENERATES CONSIDERABLE HEAT WHEN DISSOLVED IN WATER. WHEN MIXING WITH WATER ALWAYS ADD CAUSTIC SODA SLOWLY TO WATER AND STIR CONTINUOUSLY. NEVER ADD WATER TO CAUSTIC SODA.

Control Measures

Respiratory Protection: RESPIRATION PROTECTION IS NOT REQUIRED UNDER NORMAL USE. USE NIOSH/MSHA APPROVED RESPIRATORS WHERE DUST, MIST OR SPRAY MAY BE GENERATED.
Ventilation: USE ADEQUATE LOCAL EXHAUST VENTILATION WHERE DUST, MIST, OR SPRAY MAY BE GENERATED.
Protective Gloves: NATURAL OR BUTYL RUBBER
Eye Protection: CHEMICAL SAFETY GOGGLES/FACE SHIELD
Other Protective Equipment: SAFETY SHOWER AND EYE BATH. OTHER EQUIPMENT AS REQUIRED TO MINIMIZE EXPOSURE FROM PROLONGED OR REPEATED CONTACT.
Work Hygienic Practices: WASH THROUGHLY AFTER HANDLING AND BEFORE EATING. LAUNDER CONTAMINATED CLOTHING BEFORE REUSE.

Transportation Data

Trans Data Review Date: 91122
DOT PSN Code: NGU
DOT Proper Shipping Name: SODIUM HYDROXIDE, SOLID
DOT Class: 8
DOT ID Number: UN1823
DOT Pack Group: II
DOT Label: CORROSIVE
IMO PSN Code: NSX
IMO Proper Shipping Name: SODIUM HYDROXIDE, SOLID
IMO Regulations Page Number: 8225
IMO UN Number: 1823
IMO UN Class: 8
IMO Subsidiary Risk Label: -
IATA PSN Code: WSO
IATA UN ID Number: 1823
IATA Proper Shipping Name: SODIUM HYDROXIDE, SOLID
IATA UN Class: 8
IATA Label: CORROSIVE
AFI PSN Code: WSO
AFI Prop. Shipping Name: SODIUM HYDROXIDE, SOLID
AFI Class: 8
AFI ID Number: UN1823

AFI Pack Group: II
AFI Label: CORROSIVE
AFI Basic Pac Ref: 12-7

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Disposal Data

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Disposal Data Review Date: 88036
Rec # For This Disp Entry: 04
Tot Disp Entries Per NSN: 004
Landfill Ban Item: YES
Disposal Supplemental Data: MSDS EFFECTIVE:10/8/85,ISSUED ON 12/17/85; SPEC REFERENCE:O-C-265B REGULATED PER DLA/DoD REQUIREMENTS: CHECK 40 CFR 261 FOR EPA REGULATORY POLICY.
1st EPA Haz Wst Code New: D002
1st EPA Haz Wst Name New: CORROSIVE
1st EPA Haz Wst Char New: CORROSIVITY
1st EPA Acute Hazard New: NO

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Label Data

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Label Required: YES
Technical Review Date: 02MAY91
Label Status: F
Common Name: SODIUM HYDROXIDE
Signal Word: DANGER!
Acute Health Hazard-Moderate: X
Contact Hazard-Severe: X
Fire Hazard-None: X
Reactivity Hazard-Slight: X
Special Hazard Precautions: CONTACT CAUSES BURNS TO SKIN AND EYES. IF INHALED, MAY BE HARMFUL. FIRE MAY PRODUCE IRRITATING OR POISONOUS GASES. SUPERFICIAL DESTRUCTION OF THE SKIN AND OF PRIMARY IRRITANT DERMATITIS. INHALATION OF DUST, SPRAY OR MIST MAY RESULT IN VARYING DEGREES OF IRRITATION OR DAMAGE TO THE RESPIRATORY TRACT TISSUES AND AN INCREASED POSSIBILITY OF RESPIRATORY ILLNESS. STORE IN COOL, DRY, WELL VENTILATED AREA AWAY FROM MOISTURE, SOLVENTS, ACIDS, AND ORGANIC MATTER. KEEP CONTAINERS CLOSED.
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: J.T.BAKER INC.
Label Street: 222 RED SCHOOL LANE
Label City: PHILLIPSBURG
Label State: NJ
Label Zip Code: 08865-2219
Label Country: US
Label Emergency Number: 201-859-2151

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J T BAKER -- 9091 METHANOL - METHANOL
MATERIAL SAFETY DATA SHEET
NSN: 681000F016997
Manufacturer's CAGE: 70829
Part No. Indicator: A
Part Number/Trade Name: 9091 METHANOL

General Information

Item Name: METHANOL
Company's Name: J T BAKER INC
Company's Street: 222 RED SCHOOL LANE
Company's City: PHILLIPSBURG
Company's State: NJ
Company's Zip Code: 08865
Company's Emerg Ph #: (908) 859-2151
Company's Info Ph #: 1-800-582-2537
Distributor/Vendor # 1: LABCO SCIENTIFIC DIV OK 73104
Distributor/Vendor # 1 Cage: 1A109
Distributor/Vendor # 2: LABCO SCIENTIFIC DIV OK 73104
Distributor/Vendor # 2 Cage: 1A109
Distributor/Vendor # 3: LABCO SCIENTIFIC DIV OK 73104
Distributor/Vendor # 3 Cage: 1A109
Distributor/Vendor # 4: LABCO SCIENTIFIC DIV OK 73104
Distributor/Vendor # 4 Cage: 1A109
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Date MSDS Prepared: 01MAY89
Safety Data Review Date: 24JUL91
Preparer's Company: J T BAKER INC
Preparer's St Or P. O. Box: 222 RED SCHOOL LANE
Preparer's City: PHILLIPSBURG
Preparer's State: NJ
Preparer's Zip Code: 08865
Other MSDS Number: LABCO SCIENTIFIC DIV OK 73104
MSDS Serial Number: BKTVV

Ingredients/Identity Information

Proprietary: NO
Ingredient: METHYL ALCOHOL (METHANOL) (SARA III)
Ingredient Sequence Number: 01
Percent: 90-100%
NIOSH (RTECS) Number: PC1400000
CAS Number: 67-56-1
OSHA PEL: S,200PPM/250STEL
ACGIH TLV: S,200PPM/250STEL; 93
Other Recommended Limit: 200 PPM

Physical/Chemical Characteristics

Appearance And Odor: CLEAR, COLORLESS LIQUID W/PUNGENT ODOR.
Boiling Point: 149F
Melting Point: -144F
Vapor Pressure (MM Hg/70 F): 96
Vapor Density (Air=1): 1.11
Specific Gravity: 0.79
Evaporation Rate And Ref: (BU AC = 1): 4.6
Solubility In Water: COMPLETE
Percent Volatiles By Volume: 100%

Fire and Explosion Hazard Data

Flash Point: 54F
Flash Point Method: CC
Lower Explosive Limit: 6%
Upper Explosive Limit: 36%
Extinguishing Media: ALCOHOL FOAM, DRY CHEMICAL, OR CO2. WATER MAY BE INEFFECTIVE. USE WATER SPRAY TO REDUCE VAPORS.
Special Fire Fighting Proc: WEAR PROTECTIVE EQUIP & SCBA W/FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. SAFELY, MOVE CONTAINERS. USE WATER TO KEEP FIRE EXPOSED CONTAINERS COOL.
Unusual Fire And Expl Hazrds: VAPORS MAY FLOW TO IGNITION SOURCES/ FLASHBACK. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. BURNS W/CLEAR, ALMOST INVISIBLE FLAME. AUTO-IGNITION TEMP: 867F.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): HEAT, FLAME, FLARES, SMOKING OR OTHER SOURCES OF IGNITION.
aterials To Avoid: STRONG OXIDIZING AGENTS, ACIDS, ZINC, ALUMINUM, & MAGNESIUM.
Hazardous Decomp Products: CO, CO2, & FORMALDEHYDE.
Hazardous Poly Occur: NO

Health Hazard Data

LD50-LC50 Mixture: ORAL LD50 (RAT): 5628 MG/KG
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: INHALATION: HARMFUL/HEADACHE/NAUSEA/VOMITING/DIZZINESS/NARCOSIS/RESPIRATORY FAILURE/LOW BLOOD PRESSURE/CNS DEPRESSION/FATAL. SKIN: IRRITATION/DERMATITIS. EYE: IRRITATION/CORNEAL DAMAGE. INGESTION: HARMFUL/BLINDNESS/HEADACHE/NAUSEA/VOMITING/DIZZINESS/GASTROINTESTINAL IRRITATION/CNS DEPRESSION/HEARING LOSS/FATAL.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE
HARMFUL, BLINDNESS, HEADACHE, NAUSEA, VOMITING, DIZZINESS, GASTROINTESTINAL IRRITATION, CNS DEPRESSION, HEARING LOSS, & FATAL. POISON, CANNOT BE MADE NON-POISONOUS.
Med Cond Aggravated By Exp: EYE, SKIN, LIVER OR KIDNEY DISORDERS.
Emergency/First Aid Proc: INGESTION: IF CONSCIOUS, DRINK PLENTY OF WATER. INDUCE VOMITING. INHALATION: REMOVE TO FRESH AIR. GIVE CPR OR OXYGEN IF NEEDED. SKIN/EYES: FLUSH W/PLENTY OF WATER FOR AT LEAST 15 MINS. OBTAIN MEDICAL ATTENTION IN ALL CASES. POISON. CANNOT BE MADE NON-POISONOUS.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: WEAR PROTECTIVE EQUIP. SHUT OFF IGNITION SOURCES. SAFELY, STOP LEAK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP W/ SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL & PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH AREA W/WATER.
Waste Disposal Method: DISPOSE OF IN ACCORDANCE W/LOCAL, STATE, & FEDERAL REGULATIONS. EPA HAZARDOUS WASTE NUMBER: U154. FLAMMABLE LIQUID. UN1230.
Precautions-Handling/Storing: KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED, FLAMMABLE LIQUID STORAGE AREA. BOND/GROUND CONTAINERS WHEN TRANSFERRING LIQUID.
Other Precautions: AVOID CONTACT W/EYES, SKIN, CLOTHING, & BREATHING VAPORS. KEEP OUT OF REACH OF CHILDREN. DON'T SMOKE. CONTACT W/STRONG OXIDIZERS MAY CAUSE FIRE.

Control Measures

Respiratory Protection: AT CONCENTRATIONS >200 PPM, USE A SELF-CONTAINED BREATHING APPARATUS.
Ventilation: PROVIDE GENERAL/LOCAL EXHAUST VENTILATION TO KEEP <TLV.
Protective Gloves: RUBBER
Eye Protection: SAFETY GOGGLES, FACE SHIELD
Other Protective Equipment: UNIFORM, PROTECTIVE SUIT
Work Hygienic Practices: REMOVE/LAUNDER CONTAMINATED CLOTHING BEFORE REUSE.

Transportation Data

Disposal Data

Label Data

Label Required: YES
Label Status: G
Common Name: 9091 METHANOL
Special Hazard Precautions: INHALATION: HARMFUL/HEADACHE/NAUSEA/VOMITING/DIZZINESS/NARCOSIS/RESPIRATORY FAILURE/LOW BLOOD PRESSURE/CNS DEPRESSION/FATAL. SKIN: IRRITATION/DERMATITIS. EYE: IRRITATION/CORNEAL DAMAGE. INGESTION: HARMFUL/BLINDNESS/HEADACHE/NAUSEA/VOMITING/DIZZINESS/KIDNEY/LIVER DAMAGE. SKIN: IRRITATION & DERMATITIS. EYES: IRRITATION & CORNEAL DAMAGE. INGESTION: HARMFUL, BLINDNESS, HEADACHE, NAUSEA, VOMITING, DIZZINESS, GASTROINTESTINAL IRRITATION, CNS DEPRESSION, HEARING LOSS, & FATAL. POISON, CANNOT BE MADE NON-POISONOUS.
Label Name: J T BAKER INC
Label Street: 222 RED SCHOOL LANE
Label City: PHILLIPSBURG

Label State: NJ
Label Zip Code: 08865
Label Emergency Number: (908) 859-2151
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URL for this msds http://siri.org. If you wish to change, add to, or delete information in this archive please send updates to dan@siri.org.

J T BAKER -- HEXANE, 9310 - N-HEXANE, ACS
MATERIAL SAFETY DATA SHEET
NSN: 6810003127109
Manufacturer's CAGE: 70829
Part No. Indicator: A
Part Number/Trade Name: HEXANE, 9310

General Information

Item Name: N-HEXANE, ACS
Company's Name: J T BAKER INC
Company's Street: 222 RED SCHOOL LANE
Company's City: PHILLIPSBURG
Company's State: NJ
Company's Country: US
Company's Zip Code: 08865
Company's Emerg Ph #: 201-859-2151;800-424-9300(CHEMTREC)
Company's Info Ph #: 201-859-2151
Record No. For Safety Entry: 003
Tot Safety Entries This Stk#: 003
Status: SMJ
Date MSDS Prepared: 01MAY89
Safety Data Review Date: 24FEB93
MSDS Serial Number: 3RRKC
Hazard Characteristic Code: NK

Ingredients/Identity Information

Proprietary: NO
Ingredient: HEXANE (N-HEXANE)
Ingredient Sequence Number: 01
Percent: >99
NIOSH (RTECS) Number: MN9275000
CAS Number: 110-54-3
OSHA PEL: 500 PPM
ACGIH TLV: 50 PPM; 9293

Proprietary: NO
Ingredient: CYCLOPENTANE, METHYL-;(METHYLCYCLOPENTANE)
Ingredient Sequence Number: 02
Percent: <2
NIOSH (RTECS) Number: GY4640000
CAS Number: 96-37-7
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Physical/Chemical Characteristics

Appearance And Odor: COLORLESS LIQUID. FAINT ODOR
Boiling Point: 156F,69C
Melting Point: -139F,-95C
Vapor Pressure (MM Hg/70 F): 130 @ 20C
Vapor Density (Air=1): 3
Specific Gravity: 0.66 (H*2O=1)
Evaporation Rate And Ref: 9 (BUTYL ACETATE=1)
Solubility In Water: NEGLIGIBLE (<0.1%)
Percent Volatiles By Volume: 100

Fire and Explosion Hazard Data

Flash Point: -9F,-23C
Flash Point Method: CC
Lower Explosive Limit: 1.2%
Upper Explosive Limit: 7.7%
Extinguishing Media: USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE).
Special Fire Fighting Proc: WEAR NIOSH/MSHA APPRVD SCBA & FULL PROT EQUIP(FP N). MOVE EXPOSED CNTNRS FROM FIRE AREA IF IT CAN BE DONE W/OUT RISK.USE WATER TO KEEP FIRE-EXPOSED CNTNRS COOL.
Unusual Fire And Expl Hazrds: VAPORS MAY FLOW ALONG SURFS TO DISTANT IGNIT SOURCES AND FLASH BACK. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CNTCT WITH STRONG OXIDIZERS MAY CAUSE FIRE.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): HEAT, FLAME, OTHER SOURCES OF IGNITION.
Materials To Avoid: STRONG OXIDIZING AGENTS, CHLORINE, FLUORINE, MAGNESIUM

PERCHLORATE.
Hazardous Decomp Products: CARBON MONOXIDE. CARBON DIOXIDE.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT.

Health Hazard Data

LD50-LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: BLOOD CHANGES HAVE BEEN REPORTED IN LABORATORY ANIMALS. IN TESTS WITH LABORATORY ANIMALS, FETAL DEATH HAS BEEN REPORTED IN ONE OUT OF THREE STUDIES. INHAL:HEADACHE, NAUSEA, VOMITING, DIZZINESS, DROWSINESS, IRRITATION OF UPPER RESPIRATORY TRACT, UNCONSCIOUSNESS, MAY CAUSE NARCOSIS. SKIN:IRRITATION, (EFTS OF OVEREXP)
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NOT RELEVANT.
HEADACHE, NAUSEA, VOMITING, DIZZINESS, GASTROINTESTINAL IRRITATION. CHRONIC:CENTRAL NERVOUS SYSTEM DEPRESSION. TARGET ORGANS:SKIN, EYES, RESPIRATORY SYSTEM, LUNGS.
Med Cond Aggravated By Exp: NONE IDENTIFIED.
Emergency/First Aid Proc: INGEST:CALL MD. DO NOT INDUCE VOMITING. INHAL:REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICAL RESPIRATION. IF BREATHING IS DIFFICULT GIVE OXYGEN. SKIN:IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. EYE:IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: WEAR SUITABLE PROT CLTHG. SHUT OFF IGNIT SOURCES; NO FLARES, SMOKING, OR FLAMES IN AREA. STOP LEAK IF YOU CAN DO SO W/OUT RISK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP W/SAND OR OTHER NON-COMBUST ABSORB MATL & PLACE INTO CNTNR FOR LATER (SUPP DATA)
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Method: DISPOSE OF IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.
Precautions-Handling/Storing: KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED, FLAMMABLE LIQUID STORAGE AREA.
Other Precautions: BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. KEEP AWAY FROM HEAT, SPARKS, FLAME. DO NOT BREATHE VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE VENTILATION.

Control Measures

Respiratory Protection: ALL RESPIRATORS MUST BE NIOSH/MSHA APPROVED. RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATION UP TO 1000 PPM, A CHEM CARTRIDGE RESP W/ORG VAP CARTRIDGE IS REC. ABOVE THIS LEVEL, A SCBA IS RECOMMENDED.
Ventilation: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.
Protective Gloves: NEOPRENE GLOVES.
Eye Protection: CHEMICAL WORKERS GOGGLES (FP N).
Other Protective Equipment: UNIFORMS AND APRONS.
Work Hygienic Practices: WASH THOROUGHLY AFTER HANDLING.
Suppl. Safety & Health Data: SPILL PROC:DISPOSAL. FLUSH AREA WITH WATER.

Transportation Data

Trans Data Review Date: 93288
DOT PSN Code: HEX
DOT Proper Shipping Name: HEXANES
DOT Class: 3
DOT ID Number: UN1208
DOT Pack Group: II
DOT Label: FLAMMABLE LIQUID
IMO PSN Code: IBN
IMO Proper Shipping Name: NORMAL HEXANE *
IMO Regulations Page Number: SEE 3129
IMO UN Number: 1208
IMO UN Class: 3.1
IMO Subsidiary Risk Label: -
IATA PSN Code: NKG
IATA UN ID Number: 1208
IATA Proper Shipping Name: HEXANES
IATA UN Class: 3
IATA Label: FLAMMABLE LIQUID
AFI PSN Code: NKG

AFI Prop. Shipping Name: HEXANES
AFI Class: 3
AFI ID Number: UN1208
AFI Pack Group: II
AFI Label: FLAMMABLE LIQUID
AFI Basic Pac Ref: 7-7

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Disposal Data

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Label Data

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Label Required: YES
Technical Review Date: 04MAR93
Label Date: 04MAR93
Label Status: G
Common Name: HEXANE, 9310
Chronic Hazard: YES
Signal Word: DANGER!
Acute Health Hazard-Slight: X
Contact Hazard-Slight: X
Fire Hazard-Severe: X
Reactivity Hazard-None: X
Special Hazard Precautions: FLAMMABLE. KEEP AWAY FROM HEAT, SPARKS AND FLAME. BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. USE WITH ADEQUATE VENTILATION. ACUTE:INHAL:HEADACHE, NAUSEA, VOMITING, DIZZINESS, DROWSINESS, IRRITATION OF UPPER RESPIRATORTY TRACT, UNCONSCIOUSNESS. MAY HEADACHE, NAUSEA, VOMITING, DIZZINESS, GASTROINTESTINAL IRRITATION. CHRONIC:CENTRAL NERVOUS SYSTEM DEPRESSION. TARGET ORGANS:SKIN, EYES, RESPIRATORY SYSTEM, LUNGS.
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: J T BAKER INC
Label Street: 222 RED SCHOOL LANE
Label City: PHILLIPSBURG
Label State: NJ
Label Zip Code: 08865
Label Country: US
Label Emergency Number: 201-859-2151;800-424-9300(CHEMTREC)

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CHEM SERVICE -- ISOPROPANOL, O-168
MATERIAL SAFETY DATA SHEET
NSN: 6810000N066279
Manufacturer's CAGE: 8Y898
Part No. Indicator: A
Part Number/Trade Name: ISOPROPANOL, O-168

General Information

Company's Name: CHEM SERVICE INC
Company's P. O. Box: 3108
Company's City: WEST CHESTER
Company's State: PA
Company's Country: US
Company's Zip Code: 19381
Company's Emerg Ph #: 215-692-3026
Company's Info Ph #: 215-692-3026
Safety Data Action Code: C
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SMJ
Date MSDS Prepared: 01SEP88
Safety Data Review Date: 07DEC95
MSDS Serial Number: CBDMH

Ingredients/Identity Information

Proprietary: NO
Ingredient: ISOPROPYL ALCOHOL; (ISOPROPANOL) (SARA 313)
Ingredient Sequence Number: 01
NIOSH (RTECS) Number: NT8050000
CAS Number: 67-63-0
OSHA PEL: 400 PPM
ACGIH TLV: 400 PPM; 500 STEL

Physical/Chemical Characteristics

Appearance And Odor: COLORLESS LIQUID.
Boiling Point: 181F,83C
Melting Point: -127F,-89C
Vapor Pressure (MM Hg/70 F): 33 @ 20C
Specific Gravity: 0.785
Solubility In Water: MISCIBLE

Fire and Explosion Hazard Data

Flash Point: 71.6F,22.0C
Lower Explosive Limit: 2%
Upper Explosive Limit: 12%
Extinguishing Media: CARBON DIOXIDE, DRY CHEMICAL POWDER OR WATER SPRAY.
Special Fire Fighting Proc: USE NIOSH/MSHA APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire And Expl Hazrds: THIS IS A FLAMMABLE CHEMICAL.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NONE SPECIFIED BY MANUFACTURER.
Materials To Avoid: FLAMMABLE. INCOMPATIBLE W/STRONG ACIDS, W/STRONG OXIDIZING AGENTS & W/HALOGENS. REACTS W/ACID HALIDES & ANHYDRIDES.
Hazardous Decomp Products: DECOMPOSITION LIBERATES TOXIC FUMES. *
Hazardous Poly Occur: NO *
Conditions To Avoid (Poly): NOT RELEVANT *

Health Hazard Data

LD50-LC50 Mixture: LD50: (ORAL, RAT) 5045 MG/KG *
Route Of Entry - Inhalation: YES *
Route Of Entry - Skin: YES *
Route Of Entry - Ingestion: YES *
Health Haz Acute And Chronic: CONTACT LENSES SHOULD NOT BE WORN IN LABORATORY. ALL CHEMICALS SHOULD BE CONSIDERED HAZARDOUS. AVOID DIRECT PHYSICAL CONTACT! CAN CAUSE EYE IRRITATION. CAN CAUSE SKIN IRRITATION. DUST AND/OR VAPORS CAN CAUSE IRRITATION TO RESPIRATORY TRACT. CAN BE IRRITATING TO MUCOUS MEMBRANES. CAN BE HARMFUL IF (EFTS OF OVEREXP) *
Carcinogenicity - NTP: NO *
Carcinogenicity - IARC: NO *
Carcinogenicity - OSHA: NO *

Explanation Carcinogenicity: NOT RELEVANT *
Signs/Symptoms Of Overexp: HLTH HAZ: SWALLOWED. NARCOTIC AT HIGH CONENTRATIONS. *
Med Cond Aggravated By Exp: NONE SPECIFIED BY MANUFACTURER. *
Emergency/First Aid Proc: INGEST: ANTIDOTE IS SUBSTANCE INTENDED TO COUNTERACT EFT OF POIS. IT SHOULD BE ADMIN ONLY BY MD OR TRAINED EMER PERS. MED ADVICE CAN BE OBTAINED FROM POIS CTL CTR. EYES: FLUSH CONTINUOUSLY W/ WATER FOR AT LEAST 15-20 MIN. SKIN: FLUSH W/WATER FOR 15-20 MIN. IF NO BURNS HAVE OCCURRED, USE SOAP & WATER TO CLEANSE SKIN. INHAL: REMOVE TO FRESH AIR. ADMIN OXYGEN IF HAVING DFCLTY BRTHG. IF BRTHG (SUPDAT) *

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: EVACUATE AREA. WEAR APPROPRIATE OSHA-REGULATED EQUIPMENT. VENTILATE AREA. ABSORB ON VERMICULITE OR SIMILAR MATERIAL. SWEEP UP AND PLACE IN AN APPROPRIATE CONTAINER. HOLD FOR DISPOSAL. WASH CONTAMINATED SURFACES TO REMOVE ANY RESIDUES. *
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER. *
Waste Disposal Method: DISPOSAL MUST BE IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS (FP N). BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER. *
Precautions-Handling/Storing: AVOID CONTACT WITH SKIN, EYES AND CLOTHING. KEEP TIGHTLY CLOSED AND STORE IN A COOL, DRY PLACE. STORE ONLY WITH COMPATIBLE CHEMICALS. *
Other Precautions: PERSONS NOT SPECIFICALLY & PROPERLY TRAINED SHOULD NOT HANDLE THIS CHEM/ITS CNTNR. PROD IS FURNISHED FOR LAB USE ONLY! PRODS MAY NOT BE USED AS DRUGS, COSMETICS, AGRICULTURAL OR PESTICIDAL PRODS, FOOD ADDITIVES OR AS HOUSEHOLD CHEMS. *

Control Measures

Respiratory Protection: USE NIOSH/MSHA APPROVED RESPIRATOR APPROPRIATE FOR EXPOSURE OF CONCERN (FP N). *
Ventilation: THIS CHEMICAL SHOULD BE HANDLED ONLY IN A HOOD. *
Protective Gloves: IMPERVIOUS GLOVES (FP N). *
Eye Protection: ANSI APPRVD CHEM WORKERS GOGGLES (FP N). *
Other Protective Equipment: ANSI APPROVED EYE WASH & DELUGE SHOWER (FP N). USE APPROPRIATE OSHA/MSMA APPROVED SAFETY EQUIPMENT. *
Work Hygienic Practices: NONE SPECIFIED BY MANUFACTURER. *
Suppl. Safety & Health Data: FIRST AID PROC: HAS STOPPED ADMIN ARTF RESP. IF IN CARDIAC ARREST ADMIN CPR. CONTINUE LIFE SUPPORTING MEASURES UNTIL MEDICAL ASSISTANCE HAS ARRIVED. REMOVE & WASH CONTAMINATED CLOTHING. *

Transportation Data

Disposal Data

Label Data

Label Required: YES
Technical Review Date: 07DEC95
Label Date: 09NOV95
Label Status: B
Common Name: ISOPROPANOL, O-168
Chronic Hazard: NO
Signal Word: DANGER!
Acute Health Hazard-Moderate: X
Contact Hazard-Moderate: X
Fire Hazard-Severe: X
Reactivity Hazard-Slight: X
Special Hazard Precautions: FLAMMABLE. ACUTE: CAN CAUSE EYE AND SKIN IRRITATION. DUST AND/OR VAPORS CAN CAUSE IRRITATION TO RESPIRATORY TRACT. CAN BE IRRITATING TO MUCOUS MEMBRANES. CAN BE HARMFUL IF SWALLOWED. NARCOTIC AT HIGH CONCENTRATIONS. CHRONIC: NONE LISTED BY MANUFACTURER.
Protect Eye: X
Protect Skin: X
Protect Respiratory: X
Label Name: CHEM SERVICE INC
Label P.O. Box: 3108
Label City: WEST CHESTER
Label State: PA
Label Zip Code: 19381
Label Country: US
Label Emergency Number: 215-692-3026

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ARCHEM -- PH PLUS ALKALINE PH ADJUSTMENT
MATERIAL SAFETY DATA SHEET
NSN: 685000F045560
Manufacturer's CAGE: 0HL05
Part No. Indicator: A
Part Number/Trade Name: PH PLUS ALKALINE PH ADJUSTMENT

General Information

Company's Name: ARCHEM INC
Company's Street: 115 E ROBINS ST
Company's P. O. Box: 1490
Company's City: CONWAY
Company's State: AR
Company's Country: US
Company's Zip Code: 72032-5000
Company's Emerg Ph #: 501-327-7797
Company's Info Ph #: 501-327-7797
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SE
Date MSDS Prepared: 03FEB89
Safety Data Review Date: 14DEC95
Preparer's Company: ARCHEM INC
Preparer's St Or P. O. Box: 115 E ROBINS ST
Preparer's City: CONWAY
Preparer's State: AR
Preparer's Zip Code: 72032-5000
MSDS Serial Number: BYLTF

Ingredients/Identity Information

Proprietary: NO
Ingredient: SODIUM HYDROXIDE, CAUSTIC SODA, LYE
Ingredient Sequence Number: 01
Percent: 30-50
NIOSH (RTECS) Number: WB4900000
CAS Number: 1310-73-2
OSHA PEL: 2 MG/CUM
ACGIH TLV: 2 MG/CUM CEILING
Other Recommended Limit: 2MG/M3 CEILING NIOSH

Proprietary: NO
Ingredient: POTASSIUM HYDROXIDE
Ingredient Sequence Number: 02
Percent: 10-20
NIOSH (RTECS) Number: TT2100000
CAS Number: 1310-58-3
ACGIH TLV: 2 MG/CUM (CEILING)
Other Recommended Limit: 2 MG/CUM (CEILING)

Physical/Chemical Characteristics

Appearance And Odor: VISCOUS, WATER-WHITE LIQUID, CHARACTERISTIC ODOR
Boiling Point: 212F
Vapor Density (Air=1): <1
Specific Gravity: 1.5
Evaporation Rate And Ref: (WATER=1): <1
Solubility In Water: COMPLETE
Percent Volatiles By Volume: 50
pH: 14

Fire and Explosion Hazard Data

Flash Point: NONE
Extinguishing Media: WATER, FOAM, CO2, DRY CHEMICAL
Special Fire Fighting Proc: COOL DRUMS W/WATER FOG. EQUIP FIREFIGHTERS W/FULL PROTECTIVE GEAR INCLUDING SCBA.
Unusual Fire And Expl Hazrds: NONE

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NONE
Materials To Avoid: ACIDS & OTHER CLEANING CHEMICALS.
Hazardous Decomp Products: NONE
Hazardous Poly Occur: NO

Health Hazard Data

Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: EYES: SEVERE DESTRUCTION OF TISSUE, POSSIBLY RESULTING IN BLINDNESS. SKIN: SEVERE IRRITATION, BURNS & ULCERATIONS. INHALATION: BURNS TO RESPIRATORY TRACT. INGESTION: POISON CAUSES SEVERE BURNS & DESTRUCTION OF TISSUE.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE
Signs/Symptoms Of Overexp: IRRITATION, BURNS.
Emergency/First Aid Proc: EYES: FLUSH W/WATER FOR 15 MINS./FLUSH W/5% BORIC ACID SOLUTION. FLUSH UNTIL MEDICAL ATTENTION IS OBTAINED. SKIN: FLUSH W/VINEGAR & PLENTY OF WATER. INGESTION: GIVE SEVERAL GLASSES OF WATER, FOLLOWED BY CITRUS FRUIT JUICE. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON. OBTAIN MEDICAL ATTENTION IN ALL CASES.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: CONTAIN & NEUTRALIZE. FLUSH AREA W/LARGE AMOUNTS OF WATER.
Neutralizing Agent: DILUTE ACID SOLUTION
Waste Disposal Method: DISPOSE OF IAW/LOCAL, STATE & FEDERAL REGULATIONS.
Precautions-Handling/Storing: STORE IN COOL, DRY PLACE AWAY FROM ACIDS. DON'T MIX W/OTHER CLEANING CHEMICAL. DON'T ADD WATER TO PRODUCT, ADD PRODUCT TO WATER, STIRRING SLOWLY.
Other Precautions: RINSE CONTAINER THOROUGHLY BEFORE DISCARDING. KEEP CONTAINER TIGHTLY CLOSED WHEN NOT IN USE. KEEP OUT OF REACH OF CHILDREN. USE W/ADEQUATE VENTILATION.

Control Measures

Respiratory Protection: USE APPROVED RESPIRATOR TO PREVENT INHALATION OF MISTS/VAPORS.
Ventilation: LOCAL EXHAUST: RECOMMENDED. MECHANICAL: RECOMMENDED.
Protective Gloves: RUBBER
Eye Protection: CHEMICAL GOGGLES/FACE SHIELD
Other Protective Equipment: PROTECTIVE CLOTHING, EMERGENCY SHOWER & EYE WASH STATION.
Work Hygienic Practices: REMOVE/LAUNDER CONTAMINATED CLOTHING BEFORE REUSE.

Transportation Data

Disposal Data

Label Data

Label Required: YES
Label Status: G
Common Name: PH PLUS ALKALINE PH ADJUSTMENT
Special Hazard Precautions: EYES: SEVERE DESTRUCTION OF TISSUE, POSSIBLY RESULTING IN BLINDNESS. SKIN: SEVERE IRRITATION, BURNS & ULCERATIONS. INHALATION: BURNS TO RESPIRATORY TRACT. INGESTION: POISON CAUSES SEVERE BURNS & DESTRUCTION OF TISSUE. IRRITATION, BURNS.
Label Name: ARCHEM INC
Label Street: 115 E ROBINS ST
Label P.O. Box: 1490
Label City: CONWAY
Label State: AR
Label Zip Code: 72032-5000
Label Country: US
Label Emergency Number: 501-327-7797

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3M -- 3M BRAND SANITIZER CONCENTRATE - MULTI-SURFACE SANITIZER & CLEANER
MATERIAL SAFETY DATA SHEET
NSN: 7930014121036
Manufacturer's CAGE: 0WJ98
Part No. Indicator: A
Part Number/Trade Name: 3M BRAND SANITIZER CONCENTRATE

General Information

Item Name: MULTI-SURFACE SANITIZER & CLEANER
Company's Name: 3M
Company's Street: 3M CENTER
Company's City: ST. PAUL
Company's State: MN
Company's Country: US
Company's Zip Code: 55144-1000
Company's Emerg Ph #: 612-733-1110
Company's Info Ph #: 612-733-1110
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SE
Date MSDS Prepared: 16NOV94
Safety Data Review Date: 01DEC95
Supply Item Manager: CX
MSDS Serial Number: BXZKV
Specification Number: NK
Spec Type, Grade, Class: NK
Hazard Characteristic Code: NK
Unit Of Issue: BX
Unit Of Issue Container Qty: 6-2 L BT/BX
Type Of Container: NK
Net Unit Weight: NK
NRC/State License Number: NK
Net Explosive Weight: NK
Net Propellant Weight-Ammo: NK
Coast Guard Ammunition Code: NK

Ingredients/Identity Information

Proprietary: NO
Ingredient: WATER
Ingredient Sequence Number: 01
Percent: >90
NIOSH (RTECS) Number: ZC0110000
CAS Number: 7732-18-5
OSHA PEL: NONE
ACGIH TLV: NONE
Other Recommended Limit: NONE RECOMMENDED

Proprietary: NO
Ingredient: DIDECYLDIMETHYLAMMONIUM CHLORIDE
Ingredient Sequence Number: 02
Percent: 2.3
NIOSH (RTECS) Number: BP6560000
CAS Number: 7173-51-5
OSHA PEL: NONE
ACGIH TLV: NONE
Other Recommended Limit: NONE RECOMMENDED

Proprietary: NO
Ingredient: ALKYLDIMETHYLBENZYL AMMONIUM CHLORIDE.
Ingredient Sequence Number: 03
Percent: 1.5
NIOSH (RTECS) Number: BO3150000
CAS Number: 8001-54-5
OSHA PEL: NONE
ACGIH TLV: NONE
Other Recommended Limit: NONE RECOMMENDED

Physical/Chemical Characteristics

Appearance And Odor: LIQUID, CLEAR, COLORLESS TO LIGHT AMBER COLOR; MILD ODOR
Boiling Point: CA.212F
Melting Point: NA
Vapor Pressure (MM Hg/70 F): NK
Vapor Density (Air=1): NK
Specific Gravity: CA.1.0

Decomposition Temperature: NK
Evaporation Rate And Ref: CA.1 (WATER=1)
Solubility In Water: COMPLETE
Percent Volatiles By Volume: CA.95%
Viscosity: NK
pH: CA.7
Radioactivity: NK
Form (Radioactive Matl): NK
Magnetism (Milligauss): NK
Corrosion Rate (IPY): NK
Autoignition Temperature: NK

Fire and Explosion Hazard Data

Flash Point: NA
Lower Explosive Limit: NA
Upper Explosive Limit: NA
Extinguishing Media: NON-COMBUSTIBLE. CHOOSE MATERIAL SUITABLE FOR SURROUNDING FIRE.
Special Fire Fighting Proc: NA
Unusual Fire And Expl Hazrds: NA

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NA
Materials To Avoid: NA

Health Hazard Data

Precautions for Safe Handling and Use

Control Measures

Transportation Data

Trans Data Review Date: 95335
DOT PSN Code: ZZZ
DOT Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
DOT/DoD Exemption Number: NK
IMO PSN Code: ZZZ
IMO Proper Shipping Name: NOT REGULATED FOR THIS MODE OF TRANSPORTATION
IATA PSN Code: ZZZ
IATA Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
AFI PSN Code: ZZZ
AFI Prop. Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
MMAC Code: NK
N.O.S. Shipping Name: NK
Additional Trans Data: NK

Disposal Data

Label Data

Label Required: YES
Label Status: G
Common Name: 3M BRAND SANITIZER CONCENTRATE
Label Name: 3M
Label Street: 3M CENTER
Label City: ST. PAUL
Label State: MN
Label Zip Code: 55144-1000
Label Country: US
Label Emergency Number: 612-733-1110

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ALCONOX -- ALCONOX - DETERGENT, GENERAL PURPOSE
MATERIAL SAFETY DATA SHEET
NSN: 7930011986050
Manufacturer's CAGE: 17534
Part No. Indicator: A
Part Number/Trade Name: ALCONOX

General Information

Item Name: DETERGENT, GENERAL PURPOSE
Company's Name: ALCONOX INC.
Company's Street: 215 PARK AVE SOUTH
Company's City: NEW YORK
Company's State: NY
Company's Country: US
Company's Zip Code: 10003-1603
Company's Emerg Ph #: 212-473-1300
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SEU
Date MSDS Prepared: 01FEB91
Safety Data Review Date: 04DEC91
Supply Item Manager: CX
MSDS Serial Number: BLLFP
Hazard Characteristic Code: N1
Unit Of Issue: BX
Unit Of Issue Container Qty: 4.00 LBS
Type Of Container: BOX
Net Unit Weight: 4.00 LBS

Ingredients/Identity Information

Proprietary: NO
Ingredient: THE MANUFACTURER STATES THAT NO HAZARDOUS INGREDIENTS ARE PRESENT IN THIS PRODUCT.
Ingredient Sequence Number: 01
Percent: N/A
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE
Other Recommended Limit: NONE SPECIFIED

Physical/Chemical Characteristics

Appearance And Odor: WHITE POWDER INTERSPERSED WITH CREAM COLORED FLAKES, ODORLESS.
Boiling Point: N/A
Melting Point: N/A
Vapor Pressure (MM Hg/70 F): N/A
Vapor Density (Air=1): N/A
Specific Gravity: N/A
Evaporation Rate And Ref: N/A
Solubility In Water: APPRECIABLE (>10%)
Percent Volatiles By Volume: N/A
pH: N/A

Fire and Explosion Hazard Data

Flash Point: NONE
Lower Explosive Limit: N/A
Upper Explosive Limit: N/A
Extinguishing Media: WATER, CARBON DIOXIDE, FOAM, SAND/EARTH.
Special Fire Fighting Proc: FOR FIRES INVOLVING THIS MATERIAL DO NOT ENTER WITHOUT PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS.
Unusual Fire And Expl Hazrds: NONE

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NONE
Materials To Avoid: STRONG ACIDS.
Hazardous Decomp Products: MAY RELEASE CARBON DIOXIDE GAS ON BURNING.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT APPLICABLE

Health Hazard Data

LD50-LC50 Mixture: UNKNOWN

Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: INHALATION OF POWDER MAY PROVE LOCALLY IRRITATING TO MUCOUS MEMBRANES. INGESTION MAY CAUSE DISCOMFORT.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NOT APPLICABLE
Signs/Symptoms Of Overexp: INGESTION MAY CAUSE DIARRHEA.
Med Cond Aggravated By Exp: RESPIRATORY CONDITIONS.
Emergency/First Aid Proc: EYES: FLUSH WITH PLENTY OF WATER FOR 15 MIN. SKIN: FLUSH WITH PLENTY OF WATER. INGESTION: DRINK LARGE QUANTITIES OF WATER. GET MEDICAL ATTENTION FOR DISCOMFORT.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: MATERIAL FOAMS PROFUSELY. SHOVEL AND RECOVER AS MUCH AS POSSIBLE. RINSE REMAINDER TO SEWER. MATERIAL IS COMPLETELY BIODEGRADABLE.
Neutralizing Agent: NONE
Waste Disposal Method: SMALL QUANTITIES MAY BE DISPOSED OF IN SEWER. LARGE QUANTITIES SHOULD BE DISPOSED OF ACCORDING TO LOCAL REQUIREMENTS FOR NON-HAZARDOUS DETERGENTS.
Precautions-Handling/Storing: STORE IN A DRY AREA TO PREVENT CAKING.
Other Precautions: NO SPECIAL REQUIREMENTS OTHER THAN THE GOOD INDUSTRIAL HYGIENE AND SAFETY PRACTICES EMPOLYED WITH ANY INDUSTRIAL CHEMICAL.

Control Measures

Respiratory Protection: DUST MASK.
Ventilation: NORMAL LOCAL EXHAUST.
Protective Gloves: USEFUL BUT NOT REQUIRED.
Eye Protection: USEFUL BUT NOT REQUIRED.
Other Protective Equipment: NONE REQUIRED.
Work Hygienic Practices: NO SPECIAL PRACTICES REQUIRED.
Suppl. Safety & Health Data: NONE

Transportation Data

Trans Data Review Date: 91338
DOT PSN Code: ZZZ
DOT Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
IMO PSN Code: ZZZ
IMO Proper Shipping Name: NOT REGULATED FOR THIS MODE OF TRANSPORTATION
IATA PSN Code: ZZZ
IATA Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
AFI PSN Code: ZZZ
AFI Prop. Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
Additional Trans Data: NONE

Disposal Data

Label Data

Label Required: YES
Technical Review Date: 04DEC91
Label Date: 04DEC91
Label Status: F
Common Name: ALCONOX
Chronic Hazard: NO
Signal Word: CAUTION!
Acute Health Hazard-Slight: X
Contact Hazard-Slight: X
Fire Hazard-None: X
Reactivity Hazard-None: X
Special Hazard Precautions: INHALATION OF POWDER MAY PROVE LOCALLY IRRITATING TO MUCOUS MEMBRANES. INGESTION MAY CAUSE DISCOMFORT. STORE IN A DRY AREA TO PREVENT CAKING. FIRST AID: EYES: FLUSH WITH PLENTY OF WATER FOR 15 MIN. SKIN: FLUSH WITH PLENTY OF WATER. INGESTION: DRINK LARGE QUANTITIES OF WATER. GET MEDICAL ATTENTION FOR DISCOMFORT.
Protect Eye: Y
Protect Respiratory: Y
Label Name: ALCONOX INC.
Label Street: 215 PARK AVE SOUTH
Label City: NEW YORK
Label State: NY
Label Zip Code: 10003-1603
Label Country: US

Label Emergency Number: 212-473-1300

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