ARCS V

Remedial Activities at Uncontrolled Hazardous Waste Sites in Region V

United States Environmental Protection Agency

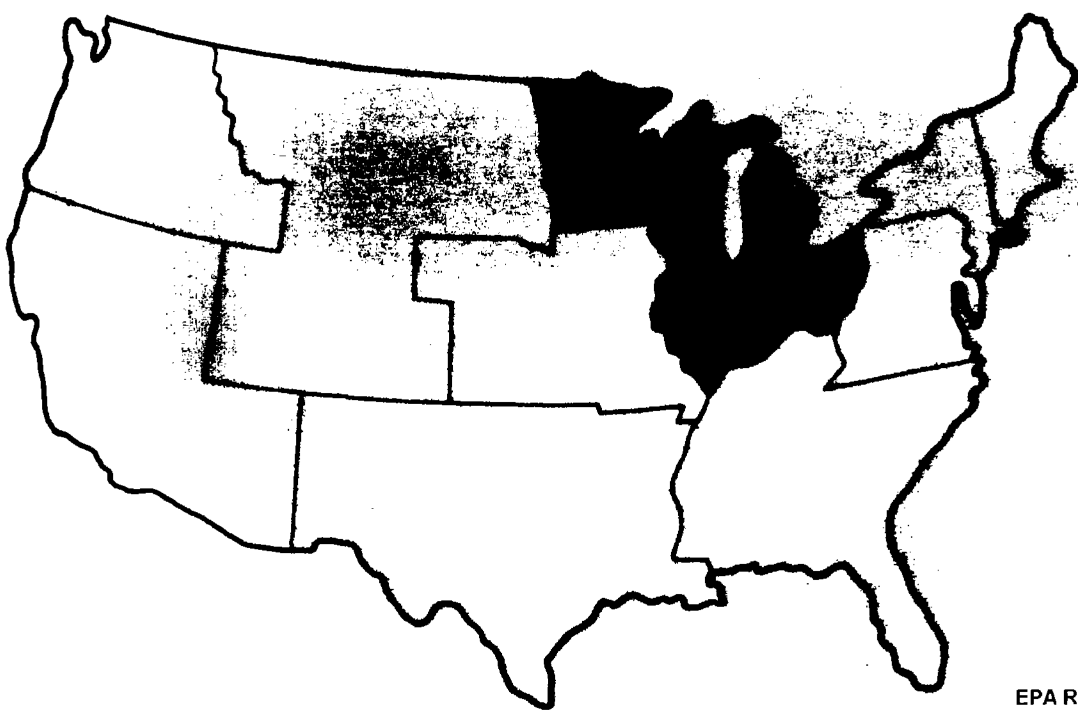
Quality Assurance Project Plan

CARTER-LEE LUMBER SITE
Indianapolis, Indiana

Groundwater Remedial Investigation/ Feasibility Study

WA No. 49-5LBD/Contract No. 68-W8-0040

June 1992



CH2M HILL

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June 1992

GLT272/030.51

Title Page

Quality Assurance Project Plan (QAPjP)

Project Title: Carter-Lee Lumber Site
Indianapolis, Indiana

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QUALITY ASSURANCE SECTION
ENVIRONMENTAL SCIENCES DIV.

Work Assignment No.: 49-5LBD

EPA Contract No.: 68-W8-0040

EPA Project Coordinator: Deborah Orr

Prepared by: CH2M HILL

Date: September 1992

Approved by: John T. Fleissner /for
Dale Cira
CH2M HILL Project Manager
Date: 9/3/92

Approved by: John T. Fleissner
John Fleissner
Acting CH2M HILL Quality Assurance Manager
Date: 9/3/92

Approved by: Deborah Orr
Deborah Orr
EPA Region 5
Project Manager
Date: 9/28/92

* Approved by: Dale C. Goode
Valerie Jones
EPA Region 5
Quality Assurance Manager
Date: 9/21/92

Approved by: Charles T. Elly
Charles Elly
EPA Region 5
Central Regional Laboratory Director
DATE: 9/21/92

* Conditional Approval is based on incorporating corrections listed in the attachment.

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Table I
List of Acronyms/Abbreviations

ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Standards for Testing Materials
BNA	Base-Neutral-Acid Extractables (Semivolatile Organics)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CLP	Contract Laboratory Program
CRDL	Contract Required Detection Limits
CRQL	Contract Required Quantitation Limits
CRL	Central Regional Laboratory
DQO	Data Quality Objective
EMSL	Environmental Monitoring and Support Laboratory
LSSS	Laboratory Scientific Support Section (Region V)
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NPL	National Priorities List
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAMP	Quality Assurance Management Plan
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RFI	RCRA Facility Investigation
RPM	Remedial Project Manager
RPC	RCRA Project Coordinator
RPW	RCRA Permit Writer
RQAM	Regional Quality Assurance Manager
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SAS	Special Analytical Services
SMC	Sample Management Coordinator
SMO	Sample Management Office
SOP	Standard Operating Procedure
SOW	Statement of Work
SW846	Test Methods for Evaluating Solid Waste 1986, 3rd Edition
TAL	Target Analyte List
TCL	Target Compound List
TIC	Tentatively Identified Compound
U.S. EPA	United States Environmental Protection Agency
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

DATE: June 28, 1993

SUBJECT: Addendum to Appendix A of the Quality Assurance Project Plan for the Fund-lead Remedial Investigation/Feasibility Study for the Carter-Lee Lumber Superfund Site in Indianapolis, Indiana.

FROM: Deborah Orr DO
Remedial Project Manager

TO: File

Attached is a copy of the referenced document for your records. This amendment documents a decrease in the analytical services required for the second phase at the site and adds a groundwater user survey. The QAPjP for this site was given conditional approval on September 28, 1992. This change in the QAPjP is approved.

If you have any questions, I can be reached at 6/7576.

cc: Kenneth Gunter, SQ-14J
Kaushal Khanna, HSRLT-5J

Dale Cira, CH2M Hill

File Copy

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

FAX TRANSMITTAL

REPLY TO THE ATTENTION OF:

DATE: September 28, 1992

SUBJECT: QAPP Approval for Carter Lee Lumber Co. Superfund Site

FROM: Deborah Orr DO
Remedial Project Manager

TO: Laura Peterson
CH2M Hill
(414)272-4408

As we discussed Friday, I've attached a copy of the contingent approval for the QAPP. I will be sending a hard copy out today along with copies of the SAS's requested via overnite mail.

If you have any questions, please call me at 312/886-7576. Thanks.

cc KStreet FYI
Overnited 29 Sept 92

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Introduction

The United States Environmental Protection Agency (EPA) requires that all environmental monitoring and measurement efforts mandated or supported by the U.S. EPA participate in a centrally managed quality assurance (QA) program.

Any party generating data under this program has the responsibility to implement minimum procedures to ensure that the precision, accuracy, completeness, and representativeness of its data are known and documented. To ensure the responsibility is met uniformly, each party must prepare a written QA Project Plan (QAPjP) covering each project it is to perform.

This QAPjP presents the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with the *Remedial Investigation/Feasibility Study (RI/FS) for the Carter-Lee Lumber site.* This QAPjP also describes the specific protocols which will be followed for sampling, sample handling and storage, chain of custody, and laboratory analysis.

All QA/QC procedures will be in accordance with applicable professional technical standards, U.S. EPA requirements, government regulations and guidelines, and specific project goals and requirements. This QAPjP is prepared by CH2M HILL in accordance with all U.S. EPA QAPjP guidance documents, in particular, the Contract Laboratory Program (CLP) guidelines, *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (QAMS-005/80), and the Region 5 Model QAPjP (1991).*

- benzo[a]anthracene—2,100 ppb
- chrysene—1,300 ppb
- benzo[b&k]fluoranthene—2,600 ppb
- benzo[a]pyrene—1,600 ppb
- arsenic—40 ppm
- cadmium—8.2 ppm
- chromium—319 ppm
- copper (93 ppm)
- lead (137 ppm)
- mercury (0.24 ppm)
- nickel (121 ppm)
- cyanide (1.2 ppm).

A work plan detailing the project organization and responsibility, technical approach, RI/FS task descriptions, project schedule, and project budget was submitted to U.S. EPA Region 5 on May 11, 1992.

1.3 Project Objectives and Scope

The overall objectives of the Remedial Investigation at the Carter-Lee Lumber site are to:

- Determine the presence or absence of hazardous substances in environmental media within and adjacent to the site

- Define the nature, extent, degree, and rate of movement of hazardous substances

- Estimate the risks to public health and the environment related to site contamination

- Support the development and evaluation of remedial action alternatives

Because only limited data are available from a previous field investigation, the actual level of risk associated with the site has not been clearly established, and a phased investigative approach will be used. The object of the first phase will be to determine if potential exposure to contaminants at the site presents potential risk to public health or the environment and whether that potential risk exceeds the U.S. EPA's point of departure for acceptability. If past disposal activities at the site contribute to potential exposures and result in unacceptable risks caused by soil or groundwater contaminants, a second phase of field work will be performed. The objects of

Phase 2 will be to determine the extent of contamination identified in Phase 1 and to quantify risks attributable to the site.

The scope of the Phase 1 field investigation is directed toward identifying whether hazardous substances are present in soil and groundwater at concentrations above background and whether they could cause unacceptable risk. Because the site is located in an urban industrial area, determination of background concentrations will be an important aspect of the Phase 1 investigation. The Phase 1 investigation will consist of the following:

- Surface soil sampling to evaluate background contaminant concentrations and contaminant concentrations in the drainage ways
- Subsurface soil sampling within the following areas of reported disposal:
  - Area of suspected waste pickle liquor disposal;
  - Area of red soil stockpile;
  - Trench where site debris and potentially hazardous substances were disposed of;
  - Area where the stockpiled red soil was spread and covered; and
  - Area of likely eroded site soil accumulation;
  - Area where railroad car dumping most likely would have occurred
- Installation and sampling of shallow monitoring wells
- Measurement of groundwater elevations

Soil samples will be analyzed for full Target Compound List (TCL) organic compounds and Target Analyte List (TAL) inorganic chemicals. A limited number of samples will be analyzed for total organic carbon (TOC) and cation exchange capacity (CEC). These samples will be held for possible analysis of additional soil physical characteristics to be performed if a Phase 2 investigation is deemed necessary. Groundwater samples will be analyzed for the full TAL and TCL. Groundwater samples for metal analysis will be field filtered.

Soil and groundwater analytical data from the Phase 1 investigation will be qualitatively and statistically evaluated to determine whether a Phase 2 investigation is necessary. During the evaluation, outliers in the Phase 1 data set will be eliminated. Outliers will be identified through the use of a box plot, a non-parametric statistical method. A box plot is a graphical tool that identifies the median (50th percentile), the lower and upper quartiles (25th and 75th percentiles), and the range of the data. The edges of the box demarcate the 25th and 75th percentiles, and so represent the middle 50 percent range (interquartile range) of the parameter values for the data. Outliers are defined as outside values which lie 1½ or more interquartile ranges away from the nearest box edge. A 95 percent upper tolerance limit (UTL) of the mean will be calculated using the background data which is assumed to be lognormally distributed. The parametric method to calculate the UTL will require the log transformation of the data. The tolerance limit defines a value that bounds a specified fraction of the distribution of observations. Therefore, the 95 percent UTL is a value below which you can expect 95 percent of the distribution of sample values to lie. The onsite data will then be compared to the 95 percent UTL. If the concentration of an onsite constituent falls below the 95 percent UTL, it will be concluded that the constituent does not exceed its background concentration. The following factors will be considered during the preliminary evaluation of the need for a Phase 2 investigation:

- Background contaminant concentrations versus site contaminant concentrations using the 95-percent UTL

- Soil ingestion criteria based on target numbers for 10^{-6} risk and a Hazard Index of 1

- Leachability of soil contaminants and potential effect on groundwater

- Drinking water MCLs and water ingestion criteria (again based on target numbers for 10^{-6} risk and a Hazard Index of 1)

Findings of the Phase 1 investigation will be reviewed with the EPA. The EPA will decide either to proceed with a Phase 2 field investigation or to prepare the RI Report, including a quantitative risk assessment, based solely on Phase 1 data. Potential Phase 2 work may include:

- Site mapping
- Additional surface and subsurface soil sampling
- Installation of shallow, intermediate, and deep monitoring wells
- Groundwater sampling

- Measurement of groundwater elevations

1.4 Sample Network Design and Rationale

The sample network design and rationale for sample locations are described in detail in the Field Sampling Plan (FSP) in Appendix A.

1.5 Parameters to be Tested and Frequency

Sample matrixes, analytical parameters, and frequencies of sample collection can be found in Table 1-1.

1.6 Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements which specify the quality of the data required to support decisions made during RI/FS activities and are based on the end uses of the data to be collected. As such, different data may require different levels of data quality. There are five analytical levels which address various data uses and the QA/QC effort and methods required to achieve the desired level of quality. These levels are:

- Screening (DQO Level 1): This 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 screening of engineering alternatives (bench-scale tests). These types of data include those generated onsite through the use of HNu, pH, conductivity, and other real-time monitoring equipment at the site.

- Field Analysis (DQO Level 2): This provides rapid results and better quality than Level 1. This level will include quick turnaround method (QTM) analyses. This level may also include mobile lab generated data depending on the level of quality control exercised.

- Engineering (DQO Level 3): This provides an intermediate level of data quality and is used for site characterization. Engineering analyses may include mobile lab generated data and some analytical lab methods (e.g., laboratory data with quick turnaround used for screening but without full quality control documentation).

Table 1-1
SOIL AND GROUNDWATER ANALYSIS NUMBERS

Parameter	Number Samples	Sample Duplicates	Field Blanks	Trip Blanks	MS or MS/MSD Samples	Total Analyses
PHASE 1						
Soil - CLP Organic	34	4	0	0	(2)	38
Soil - CLP Inorganic	34	4	0	0	(2)	38
Soil - QTM (Organic only)	34	4	0	0	(2)	38
Soil - SAS a	6	1	0	0	(1)	7
Water - CLP Organic	9	1	2	0	(1)	11
Water - CLP Inorganic	9	1	2	0	(1)	11
Water - QTM (Organic only)	9	1	2	0	(1)	11
Water - VOC Only	0	0	0	5	(0)	5
PHASE 2						
Soil - CLP Organic	37	4	0	0	(2)	41
Soil - CLP Inorganic	37	4	0	0	(2)	41
Soil - SAS b	9	1	0	0	(1)	10
Water - CLP Organic	28	3	3	0	(2)	32
Water - CLP Inorganic	28	3	3	0	(2)	32
Water - QTM (Organic only)	23	3	3	0	(2)	29
Water - SAS c	23	3	3	0	(2)	29
Water - VOC only	0	0	0	10	(0)	10

SAS:
a) TOC, Cation Exchange
b) TCLP, Grain Size, Atterberg Limits, Porosity, % Moisture, Density
c) TOC, COD, TSS, TDS, Chloride, Alkalinity, Hardness

- Confirmational (DQO Level 4): This provides the highest level of data quality and is used for the purposes of risk assessment, evaluation of remedial alternatives, and PRP determination. These analyses require full Contract Laboratory Program (CLP) analytical and data validation procedures in accordance with U.S. EPA recognized protocol.

- Non-Standard (DQO Level 5): This refers to analyses by non-standard protocols, for example, when exacting detection limits or analysis of an unusual chemical compound is required. These analyses often require method development or adaptation. The level of quality control is usually similar to that of DQO Level 4 data.

The DQO levels and intended data uses are provided in Table 1-2.

1.7 Project Schedule

The project schedule, including key project milestones, is presented in Figure 1-3.

1.0 Project Description

1.1 Facility History/Background Information

The Carter-Lee Lumber site is located in Indianapolis, Indiana (Marion County, Center Township). The site is located at the south end of the Carter-Lee Lumber Company's property at 1621 West Washington Street (Figure 1-1).

The area's population and land use and the site's physical features, such as geology and soil, hydrogeology, and drainage, are described in the Preliminary Site Evaluation Report for the Carter-Lee Lumber Site. The report was submitted to U.S. EPA Region 5 by CH2M HILL on May 29, 1992.

The site was owned from 1889 until 1930 by the Cleveland, Cincinnati, Chicago, and St. Louis (CCC&StL) Railroad. The CCC&StL Railroad was acquired by New York Central Railroad in 1930, but retained its corporate identity through a series of railroad mergers and acquisitions, summarized below.

- 1889—Cleveland, Cincinnati, Chicago & St. Louis Railroad
- 1930—New York Central Railroad (NYCR) acquires CCC&STL
- 1968—NYCR merges with Pennsylvania Railway Company to form Pennsylvania New York Central Transportation Company (PNYCTC)
- 1968—PNYCTC renamed Penn Central Company
- 1969—Penn Central Company renamed Penn Central Transportation Company (CCC&StL retained corporate identity)
- 1970—Penn Central, including CCC&StL, filed for reorganization under Section 77 of the Bankruptcy Act
- 1979—Penn Central and CCC&StL sell 4-acre parcel to Carter-Lee Lumber Company

Before the site was sold to Carter-Lee Lumber Company, it was reportedly used for the disposal of neutralized metal plating sludge and neutralized calcium ferrosulfate (spent sulfuric acid pickling liquor) by land application. The property was leased for that purpose from Penn Central from 1969 to 1973 by Unversaw Trucking Company,

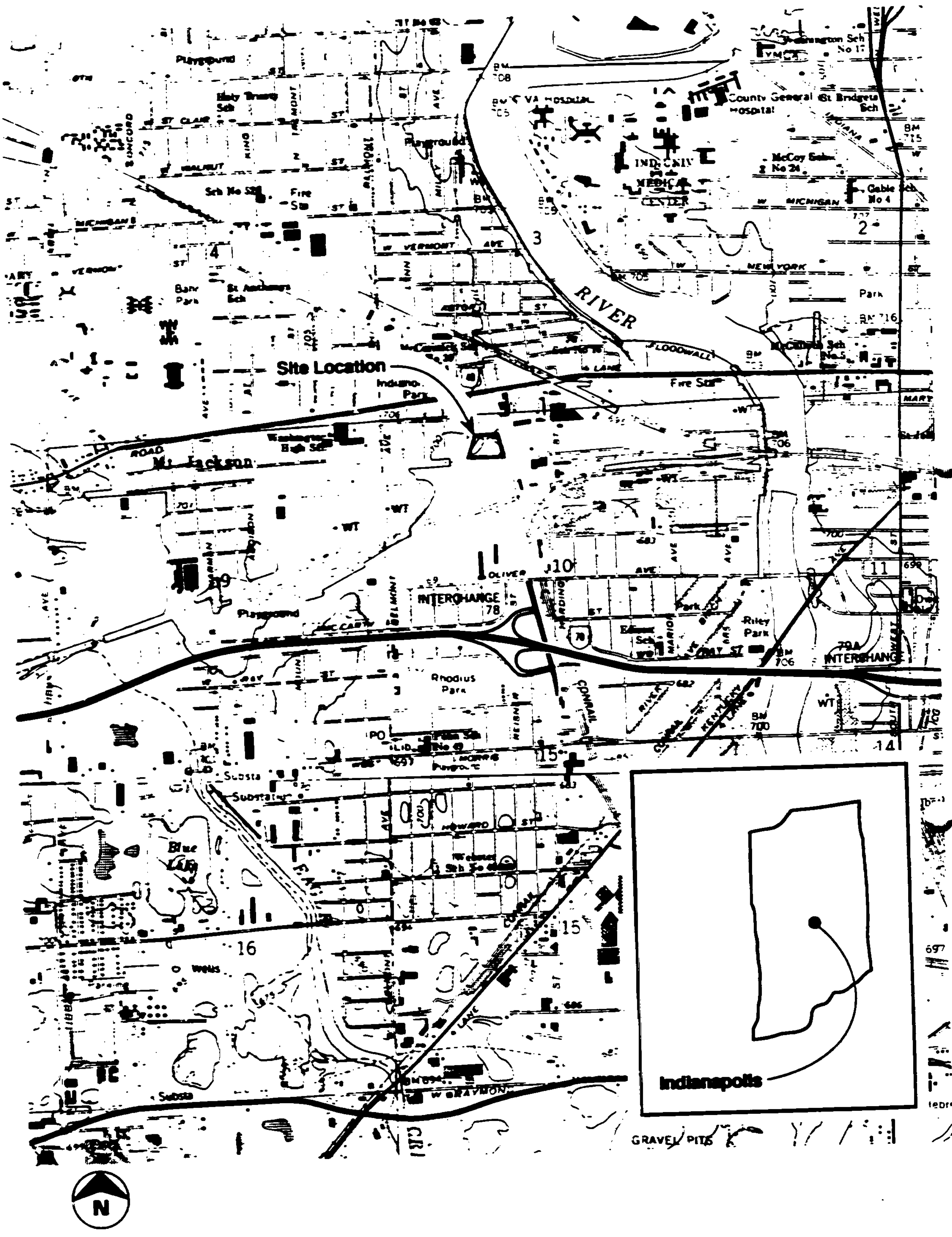

FIGURE 1-1
Site Vicinity Map
Carter-Lee Lumber QAPP

Map Source: USGS Indianapolis West, Ind. 7.5 Min. Quadrangle, 1967 with the lease later transferred to Central Lime Company (later operating as V&R Services, Universal Trucking, and R&V Services. The neutralized metal plating sludge and pickling liquor were reportedly sprayed on the site from 1971 to 1972. This material was observed by several witnesses in the area and reported as a "red liquid."

There were reports of the collection of oily filter cakes from Ford Motor Company, but it is unknown if these filter cakes were disposed of at the Carter-Lee site. In addition, there are unsubstantiated reports of railroad cars draining liquid into ditches immediately adjacent to the tracks on the south side of the site.

In 1981, Carter-Lee began developing the site to expand its lumber storage capacity. The site was cleared and a trench was excavated at the southeast corner for debris and brush disposal to enable paving and construction at the site. The excavation contractor reported the dimensions of the trench to be 10 feet deep by 30 feet wide by 70 feet long.

In 1983, a 1- to 6-inch thick layer of "red soil" was uncovered during clearing for the construction of Building No. 3 (Figure 1-2). In 1984, during construction of Building No. 4, more red soil was uncovered. The soil was collected and stockpiled near the trench dug in 1981.

In 1987, Carter-Lee personnel, following advice of an environmental engineering consultant, spread the red soil across an area about 220 by 250 feet in the southeast corner of the site. The material was covered with 6 inches of clean top soil followed by 6 inches of crushed gravel.

1.2 Past Data Collection Activity/Current Status

The uncovering of the red soil eventually lead to a review of site conditions and collection of soil samples in 1985 by a U.S. EPA Field Investigation Team (FIT). The FIT team estimated the volume of the red soil to be 80 cubic yards. The samples were collected by the FIT contractor from areas representative of the former trench, stockpiled red soils, and the reported red sludge application area (see Figure 1-2). The analytical results from those samples indicated the presence of heavy metals and organic polynuclear aromatic hydrocarbon (PAH) compounds. The following compounds and maximum concentrations were reported:

- phenanthrene—2,400 ppb
- di-n-butylphthalate—4,100 ppb
- fluoranthene—3,000 ppb
- pyrene—3,100 ppb

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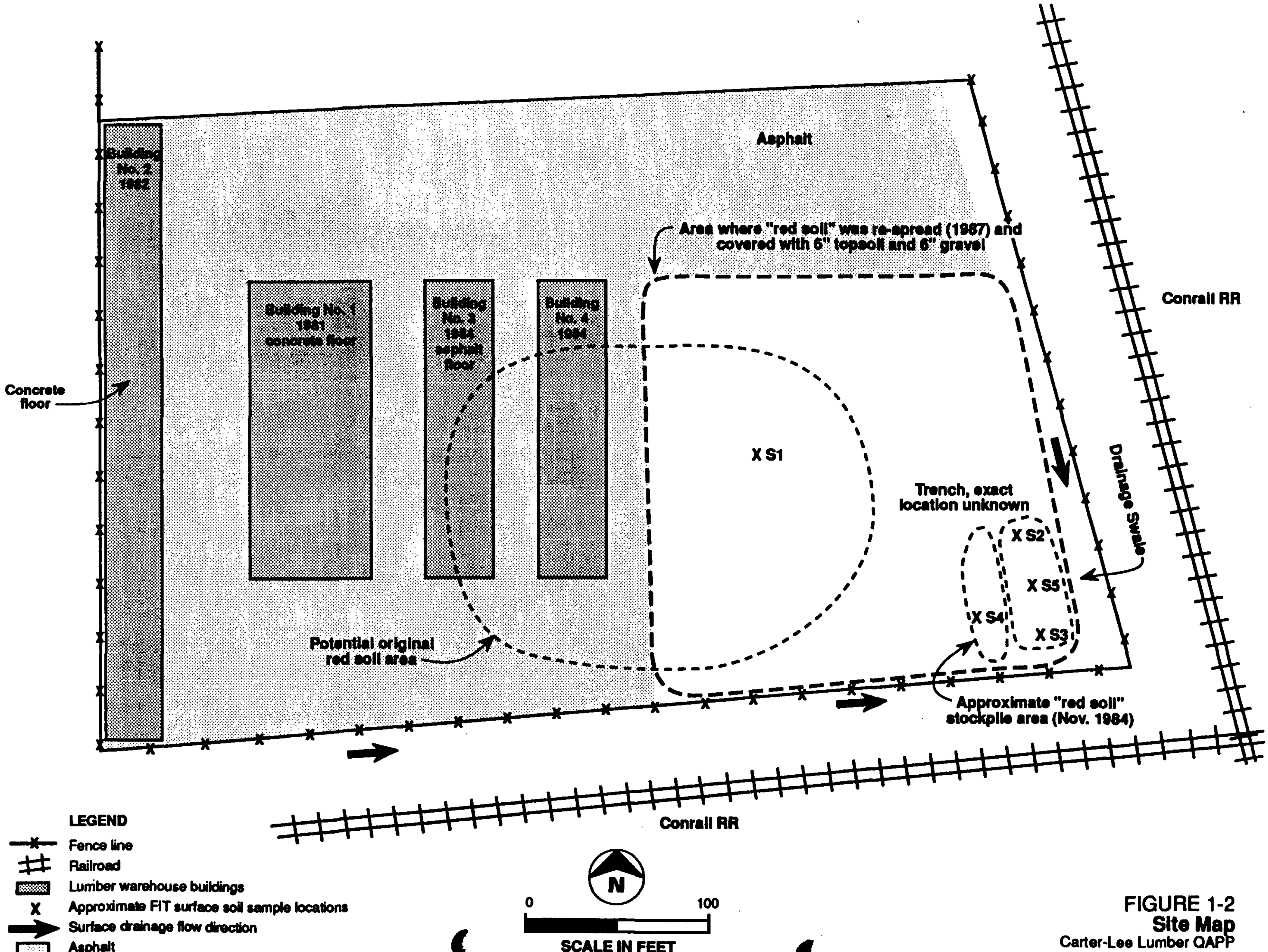


FIGURE 1-2
Site Map
Carter-Lee Lumber QAPP

2.0 Project Organization and Responsibility

The project organization chart is shown in Figure 2-1. CH2M HILL will oversee the field investigation and will have overall responsibility for all phases of the RI. CH2M HILL will report to the U.S. EPA Regional Project Manager (RPM) who, in turn, will coordinate activities with the U.S. EPA Quality Assurance Section (QAS), and the Central Regional Laboratory (CRL), and the Indiana Department of Environmental Management (IDEM) project manager.

Specific management responsibilities have been assigned for the project as follows:

- U.S. EPA Region 5 RPM, Deborah Orr
- IDEM, Project Manager, Bob Schaible
- CH2M HILL Project Manager, Dale Cira

The U.S. EPA Region 5 Quality Assurance Manager is responsible for the review and approval of all Quality Assurance Project Plans. The CH2M HILL Project Manager is responsible for implementing the project and has the authority to commit the resources necessary to meet project objectives and requirements. The CH2M HILL Project Manager will provide the major point of contact and control for matters concerning the project. CH2M HILL's Project Manager will:

- Define project objectives.
- Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task.
- Acquire and apply technical and corporate resources as needed to see that the project remains within budget and schedule constraints.
- Orient the Field Team Leader and all support staff concerning the project's special considerations.
- Monitor and direct the field leader.
- Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.

- Review the work performed on each task to check its quality, responsiveness, and timeliness.
- Review and analyze overall task performance with respect to planned requirements and authorizations.
- Approve all external reports (deliverables) before submittal to Region 5, EPA.
- Oversee the preparation and quality of final reports.

Other CH2M HILL staff members and their specific responsibilities are:

- Philip Smith, Review Team Leader (RTL), will be responsible for project QC and will coordinate with individual QC reviewers.
- Either Laura Peterson or Tom Miller, both Project Hydrogeologists, will serve as the Field Team Leader.
- Kirk Brandt, Project Engineer.
- Joe Sandrin, Senior Chemist, is responsible for the review and QA/QC of laboratory data.
- Dan MacGregor, Project Chemist, will coordinate with the QAS through the RPM. Internal laboratory auditing is the responsibility of the Project Chemist.
- Dave Shekoski, Sample Manager, will coordinate the sample management through the CRL and the Contract Laboratory Program (CLP) Sample Management Office (SMO).

The Field Team Leader is responsible for leading and coordinating the day-to-day activities of the various resource specialists under the leader's supervision. The Field Team Leader is an experienced environmental professional and will report directly to CH2M HILL's Project Manager. Specific field team leader responsibilities include:

- Day-to-day coordination with the Project Manager on technical issues.
- Coordination and management of field staff.

- Coordination of field sampling, drilling, and analyses.
- Implementation of QC for technical data provided by the field staff including field measurement data.
- Adherence to work schedules provided by the Project Manager.
- Authorship, review, and approval of text and graphics required for field team efforts.
- Coordination and oversight of technical efforts of subcontractors assisting the field team.
- Identification of problems at the field team level, discussion of resolutions with the Project Manager, and communicating between team and upper management.
- Participation in the preparation of the final report.

Table 1-2
DQOs AND INTENDED DATA USES
Carter-Lee Lumber

Task / Field Activity	Test / Measurement	Intended Data Use	Analysis	Intended Data Use
PHASE I				
Soil Boring and Sampling- Water Table Soil Borings	DQO Level 1- Field screening for volatile organic compounds	To select samples for submission to DQO level 4 lab.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated soil Quantify contaminants for determining risk to potential receptors and the environment
			DQO Level 3- TOC and CEC	Characterize site geologic and hydrogeologic properties
Soil Boring and Sampling- Shallow Soil Borings	DQO Level 1- Field screening for volatile organic compounds	To select samples for submission to DQO level 4 lab.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated soil Quantify contaminants for determining risk to potential receptors and the environment
Soil Boring and Sampling- Drainage-way Soil Borings	DQO Level 1- Field screening for volatile organic compounds	To determine whether sampling at greater depths is necessary.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated soil Quantify contaminants for determining risk to potential receptors and the environment
Soil Boring and Sampling- Background	DQO Level 1- Field screening for volatile organic compounds	To eliminate samples unrepresentative of background from submission to DQO level 4 lab.	DQO Level 4- CLP TAL and TCL	Determine background concentrations of the parameters to be analyzed for

Table 1-2
DQOs AND INTENDED DATA USES
Carter-Lee Lumber

Task / Field Activity	Test / Measurement	Intended Data Use	Analysis	Intended Data Use
Hydrogeologic Investigation Downgradient MWs	DQO Level 1- Field screening for volatile organic compounds	Health and safety of field personnel.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated groundwater Quantify contaminants for determining risk to potential receptors and the environment
Hydrogeologic Investigation Upgradient MWs	DQO Level 1- Field screening for volatile organic compounds	Health and safety of field personnel.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated groundwater Quantify contaminants for determining risk to potential receptors and the environment
PHASE II Soil Boring and Sampling- Shallow Soil Borings	DQO Level 1- Field screening for volatile organic compounds	To select samples for submission to DQO level 4 lab.	DQO Level 4- CLP TAL and TCL DQO Level 3- Additional Soil Parameters	Determine the nature and extent of contaminated soil Quantify contaminants for determining risk to potential receptors and the environment Characterize site geologic and hydrogeologic properties

Table 1-2
DQOs AND INTENDED DATA USES
Carter-Lee Lumber

Task / Field Activity	Test / Measurement	Intended Data Use	Analysis	Intended Data Use
Soil Boring and Sampling- Drainage-way Soil Borings	DQO Level 1- Field screening for volatile organic compounds	To determine whether sampling at greater depths is necessary.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated groundwater Quantify contaminants for determining risk to potential receptors and the environment
			DQO Level 3- Additional Soil Parameters	Characterize site geologic and hydrogeologic properties
Soil Boring and Sampling- Schaffer Garden, Composite	DQO Level 1- Field screening for volatile organic compounds	To determine whether sampling at greater depths is necessary.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated groundwater Quantify contaminants for determining risk to potential receptors and the environment

Table 1-2 DQOs AND INTENDED DATA USES Carter-Lee Lumber				
Task / Field Activity	**Test / Measurement**	**Intended Data Use**	**Analysis**	**Intended Data Use**
Hydrogeologic Investigation Deep MWs	DQO Level 1- Field screening for volatile organic compounds	Health and safety of field personnel.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated groundwater Quantify contaminants for determining risk to potential receptors and the environment
			DQO Level 3- Groundwater Transport and Treatment Parameters	Characterize site geologic and hydrogeologic properties
			DQO Level 2- CLP List for VOCs, SVOCs, Pesticides/PCBs	To select monitoring well locations
Hydrogeologic Investigation Intermediate MWs	DQO Level 1- Field screening for volatile organic compounds	Health and safety of field personnel.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated groundwater Quantify contaminants for determining risk to potential receptors and the environment
			DQO Level 3- Groundwater Transport and Treatment Parameters	Characterize site geologic and hydrogeologic properties
			DQO Level 2- CLP List for VOCs, SVOCs, Pesticides/PCBs	To select monitoring well locations

Table 1-2
DQOs AND INTENDED DATA USES
Carter-Lee Lumber

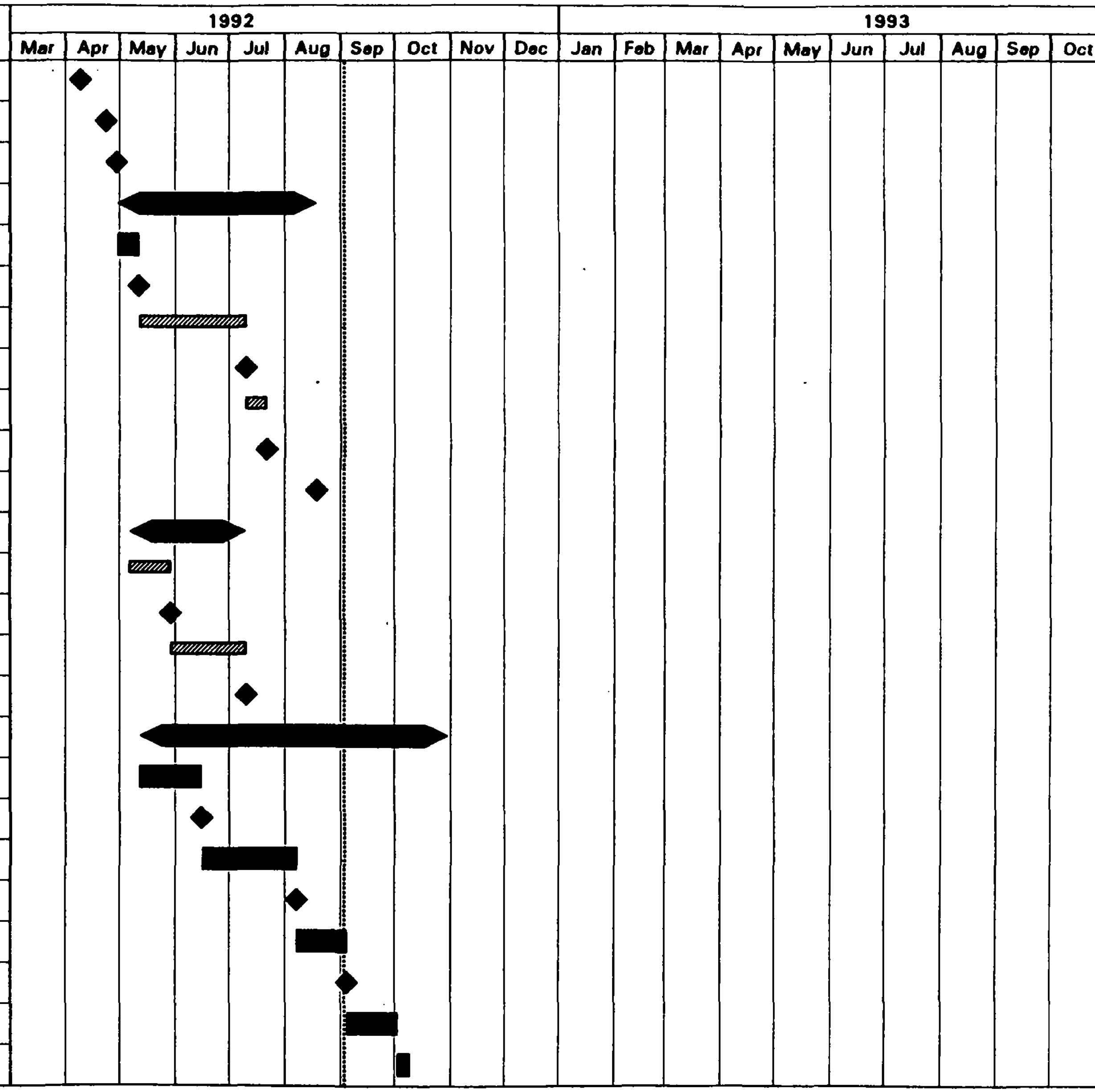
Task / Field Activity	Test / Measurement	Intended Data Use	Analysis	Intended Data Use
Hydrogeologic Investigation Shallow MWs	DQO Level 1- Field screening for volatile organic compounds	Health and safety of field personnel.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated groundwater Quantify contaminants for determining risk to potential receptors and the environment
			DQO Level 3- Groundwater Transport and Treatment Parameters	Characterize site geologic and hydrogeologic properties
			DQO Level 2- CLP List for VOCs, SVOCs, Pesticides/PCBs	To select monitoring well locations

Table 1-2 DQOs AND INTENDED DATA USES Carter-Lee Lumber				
Task / Field Activity	**Test / Measurement**	**Intended Data Use**	**Analysis**	**Intended Data Use**
Hydrogeologic Investigation Phase I MW Re-sampling	DQO Level 1- Field screening for volatile organic compounds	Health and safety of field personnel.	DQO Level 4- CLP TAL and TCL	Determine the nature and extent of contaminated groundwater Quantify contaminants for determining risk to potential receptors and the environment
			DQO Level 3- Groundwater Transport and Treatment Parameters	Characterize site geologic and hydrogeologic properties

Note: Soil Parameters: TCLP Metals, Grain Size, Atterburg Limits, Porosity, % Moisture, and Density.
Groundwater Transport and Treatment Parameters: TOC, CPD, TSS, TDS, Chloride, Alkalinity, and Hardness

Figure 1-3 Carter-Lee Lumber RI Project Schedule

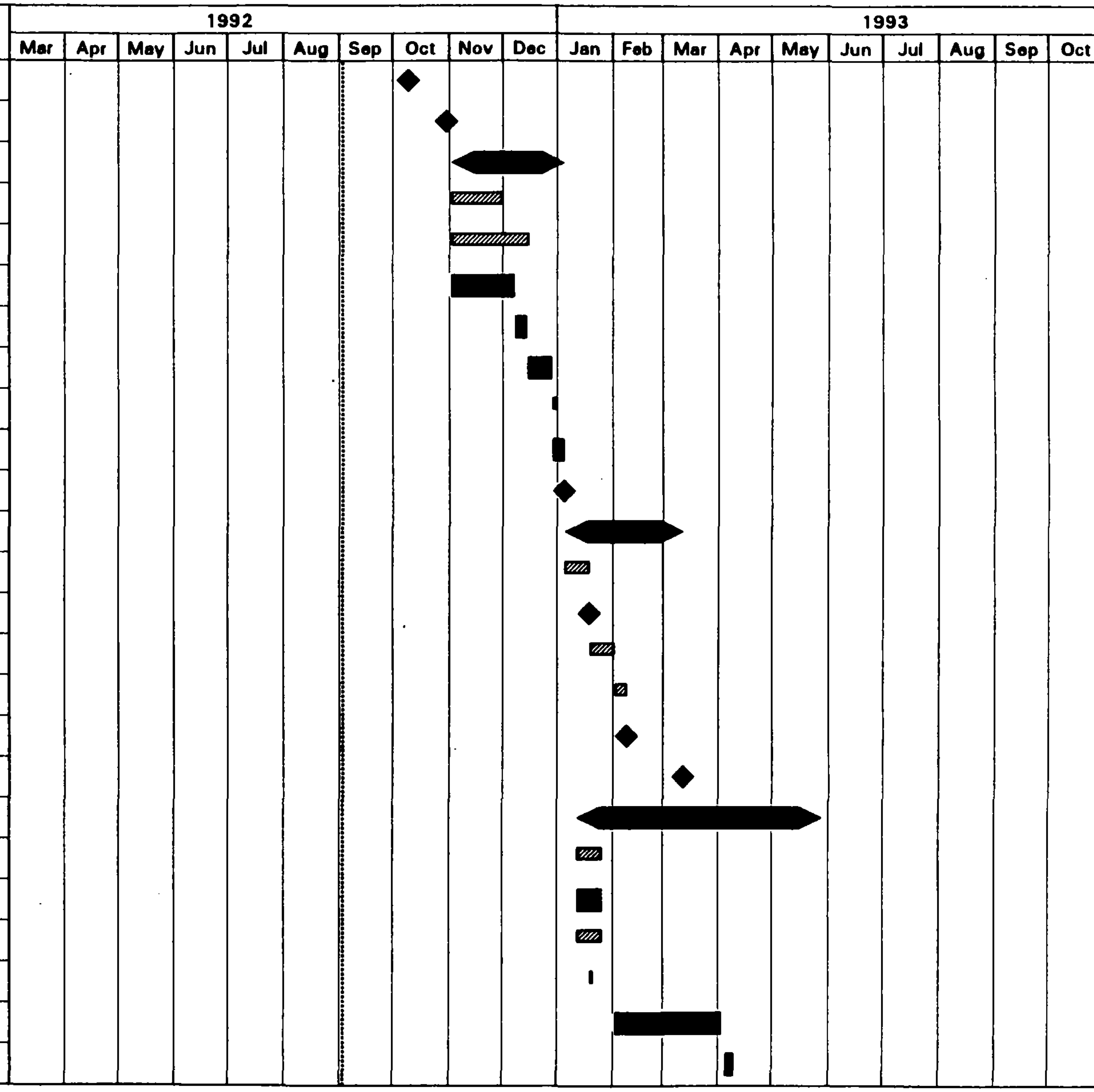
Proposed Project Tasks	Planned Start
Project Awarded	4/9/92
Kick-Off Meeting	4/23/92
Site Visit	4/29/92
RI/FS Work Plan	4/29/92
PP.WP RI/FS Work Plan Preparation	4/29/92
Submit Work Plan to EPA	5/11/92
Agency Review	5/12/92
Agency Comments Received	7/10/92
Revise Work Plan	7/10/92
Submit Revised Work Plan	7/21/92
Agency Work Plan Approval	8/18/92
PP.ED Preliminary Site Evaluation Letter	5/6/92
Prepare Preliminary Site Evaluation Letter	5/6/92
Submit Letter to EPA	5/29/92
Agency Review	5/29/92
Agency Comments Received	7/10/92
PP.QS Site Invest. Plans QAPP/SP/HSP/DMP/E	5/12/92
Prepare Plans	5/12/92
Submit Plans to EPA	6/15/92
Agency Review	6/16/92
Agency Comments Received	8/7/92
Revise Site Investigation Plans	8/7/92
Submit Revised Site Investigation Plans	9/4/92
Agency Comments Delivered	9/4/92
Revise Site Investigation Plans	10/2/92



Project: Carter-Lee Lumber RI
Date: 9/2/92

Figure 1-3 Carter-Lee Lumber RI Project Schedule

Proposed Project Tasks	Planned Start
Submit Revised Site Investigation Plans	10/9/92
Agency Approval of Plans	10/30/92
FO. Phase I Field Investigation	11/2/92
CLP Lab Procurement	11/2/92
FO.SM Sample Management	11/2/92
FO.FK Field Support/Mobilization	11/2/92
FO.FS Field Work	12/8/92
Laboratory Analysis (2 week turnaround)	12/15/92
FO.SM Data Validation	12/29/92
DE.DE Data Evaluation	12/29/92
Data Review Meeting with EPA	1/4/93
Phase II Work Plan Rev. Request (WPRR)	1/5/93
Prepare WPRR	1/5/93
Submit WPRR to EPA	1/18/93
Agency Comments Delivered	1/19/93
Revise WPRR	2/2/93
Submit Revised WPRR to EPA	2/8/93
Agency Approval of WPRR	3/12/93
F2. Phase II Field Investigation	1/12/93
F2.SM Sample Management	1/12/93
F2.FS Field Work-Source Characterization	1/12/93
F2.FQ Field Work-Hydrogeologic Investiga	1/12/93
F2.FB Field Work-Ecological Investigation	1/19/93
Laboratory Analysis	2/2/93
F2.SM Data Validation	4/5/93

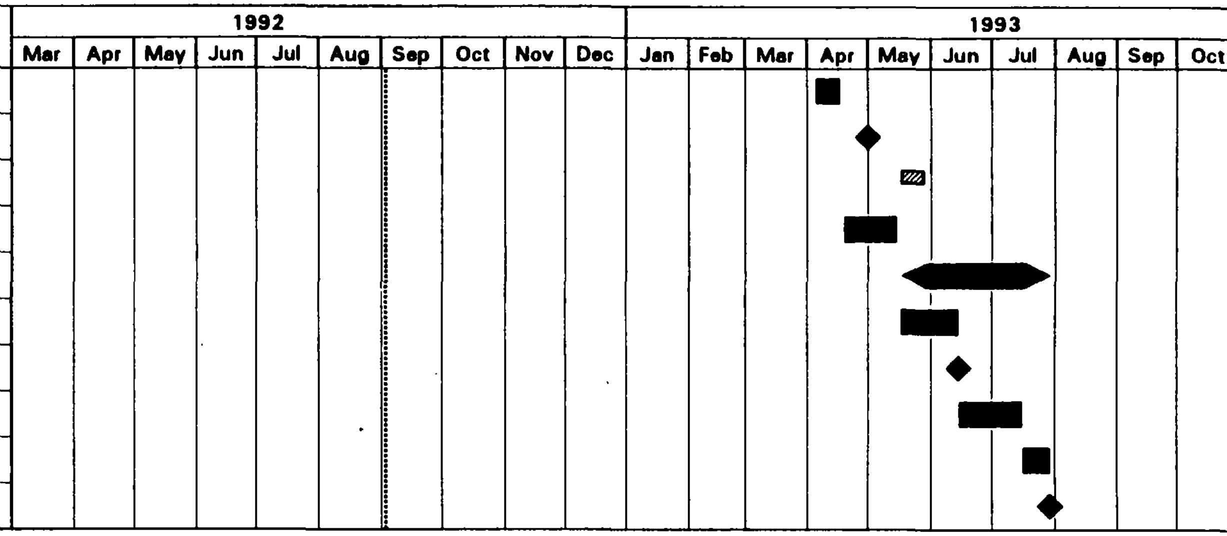


Project: Carter-Lee Lumber RI
Date: 9/2/92

Critical Noncritical Milestone Summary

Figure 1-3 Carter-Lee Lumber RI Project Schedule

Proposed Project Tasks	Planned Start
Data Evaluation	4/5/93
Data Review Meeting with EPA	4/30/93
F2.FM Site Mapping	5/17/93
Risk Assessment	4/19/93
RI Report	5/17/93
Prepare RI Report	5/17/93
Submit RI Report to EPA	6/14/93
Agency Comments Delivered	6/15/93
Revise RI Report	7/16/93
Submit Revised RI Report	7/29/93

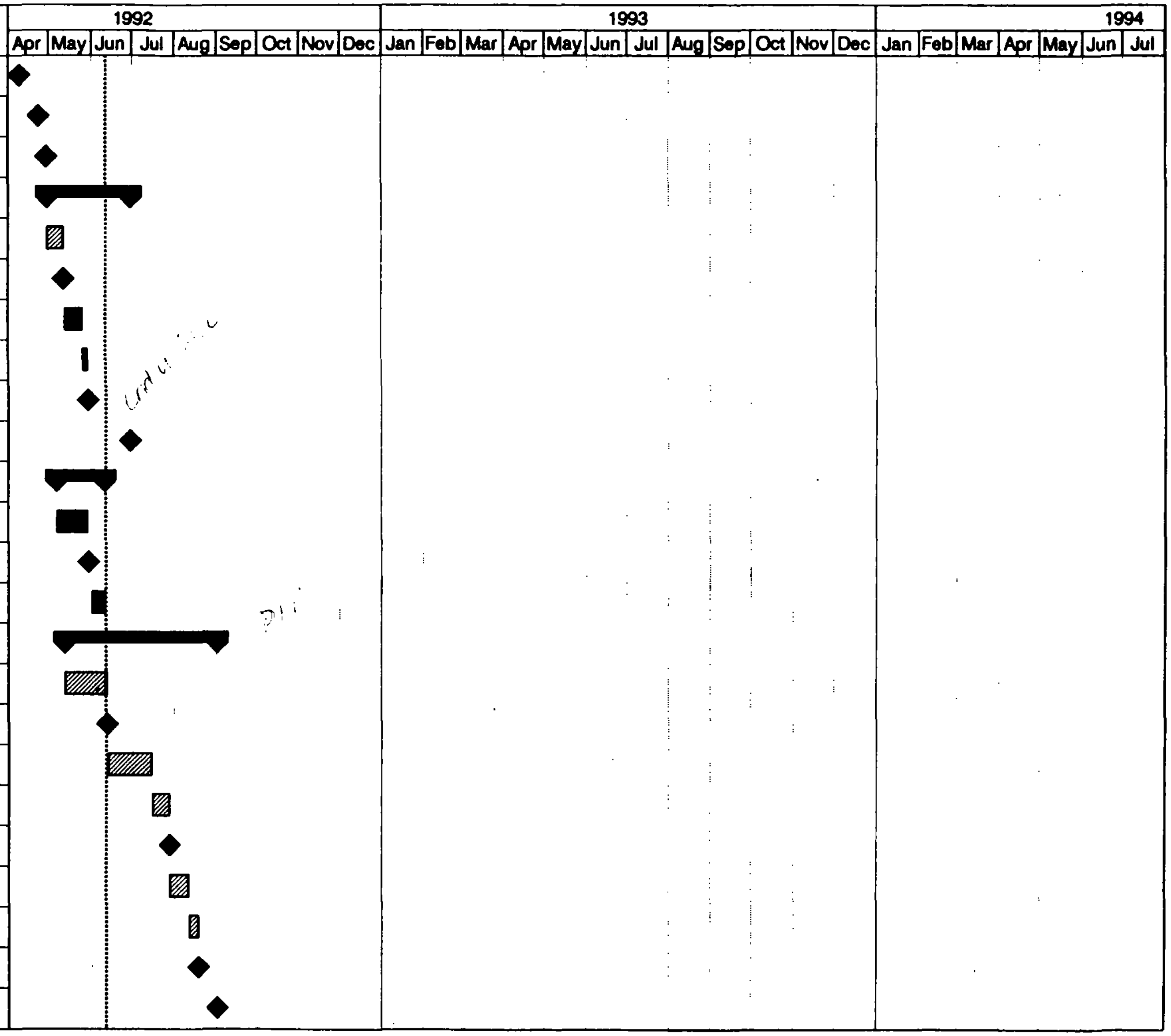


Project: Carter-Lee Lumber RI
Date: 9/2/92

Critical Noncritical Milestone Summary

Figure 1-3
Carter-Lee Lumber RI Project Schedule

ID	Name
1	Project Awarded
2	Kick-Off Meeting
3	Site Visit
4	RI/FS Work Plan
5	PP.WP RI/FS Work Plan Preparation
6	Submit Work Plan to EPA
7	Agency Comments Delivered
8	Revise Work Plan
9	Submit Revised Work Plan
10	Agency Work Plan Approval
11	PP.ED Preliminary Site Evaluation Letter
12	Prepare Preliminary Site Evaluation Letter
13	Submit Letter to EPA
14	Agency Comments Delivered
15	PP.QS Site Invest. Plans QAPP/SP/HSP/DMP/
16	Prepare Plans
17	Submit Plans to EPA
18	Agency Comments Delivered
19	Revise Site Investigation Plans
20	Submit Revised Site Investigation Plans
21	Agency Comments Delivered
22	Revise Site Investigation Plans
23	Submit Revised Site Investigation Plans
24	Agency Approval of Plans

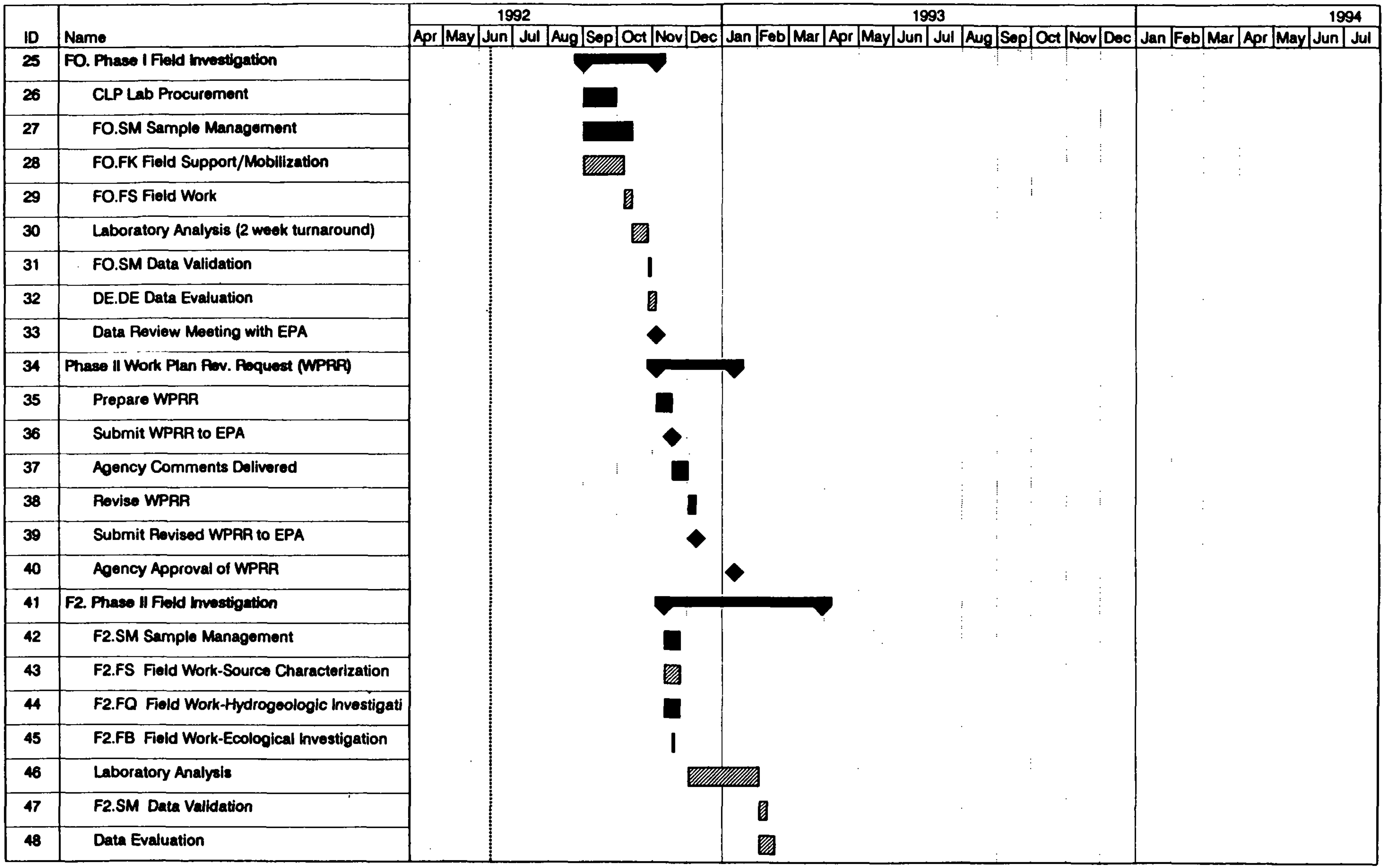


Project: Carter-Lee Lumber RI/FS
Company: CH2M HILL
Manager: Dale Cira

Critical
Noncritical
Milestone
Summary

File: CARTRI.MPP Date: 6/10/92 8:00am Page: 1 of 3

Figure 1-3
Carter-Lee Lumber RI Project Schedule



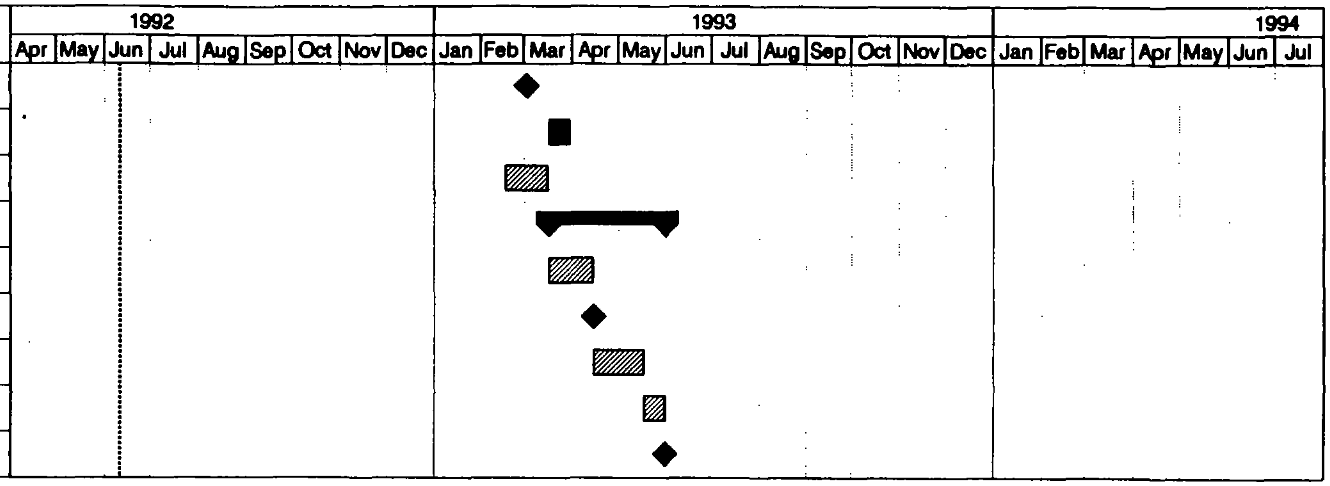
Project: Carter-Lee Lumber RI/FS
Company: CH2M HILL
Manager: Dale Cira

Critical | Milestone
Noncritical | Summary

File: CARTRI.MPP Date: 6/10/92 8:00am Page: 2 of 3

Figure 1-3
Carter-Lee Lumber RI Project Schedule

ID	Name
49	Data Review Meeting with EPA
50	F2.FM Site Mapping
51	Risk Assessment
52	RI Report
53	Prepare RI Report
54	Submit RI Report to EPA
55	Agency Comments Delivered
56	Revise RI Report
57	Submit Revised RI Report



Project: Carter-Lee Lumber RI/FS
Company: CH2M HILL
Manager: Dale Cira

Critical
Noncritical
Milestone
Summary

File: CARTRI.MPP Date: 6/10/92 8:00am Page: 3 of 3

3.0 Quality Assurance Objectives for Measurement Data

The overall QA objective is to develop and implement procedures for field sampling, chain of custody, laboratory analyses, and reporting that will provide results that are legally defensible in a court of law and meet project objectives. Specific procedures for QC sampling, chain of custody, instrument calibration, sample analyses, data reporting, internal and external audits, preventive maintenance, and corrective action are described in other sections of this QAPjP. The purpose of this section is to describe the extent of QC effort and to address the specific objectives for accuracy, precision, sensitivity, completeness, representativeness, and comparability.

3.1 Level of Quality Control Effort

Field blank, trip blank, field duplicate, and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling program. Field and trip blanks will be submitted to the analytical laboratories to assess the potential of contamination. Field blank samples are analyzed to check for procedural contamination at the site that may cause sample contamination. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage. Field duplicate samples are analyzed to check for sampling and analytical precision. Matrix spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. The organic matrix spike samples are performed in duplicate and are hereinafter referred to as MS/MSD samples. The inorganic matrix spike (MS) samples are collected in singular and require additional volume.

The general level of the QC effort will include the following:

- One field duplicate will be collected for every 10 or fewer investigative samples.
- One field blank will be collected for every 10 or fewer water investigative samples.
- One volatile organic analysis (VOA) trip blank, consisting of distilled deionized ultra pure water, will be included along with each shipment of VOA samples.
- One MS or one set of MS/MSD samples will be collected for every 20 or fewer investigative samples.

The general level of QC effort is summarized in Table 3-1.

QC samples will be collected at the same time and in the same manner as the field samples. Soil MS and MS/MSD samples to be analyzed for inorganic analytes volatile organic compounds (VOCs), or extractable organic compounds will require no additional sample volume. Aqueous MS samples must be collected at double the volume for inorganic analyses and MS/MSD samples must be collected at triple the volume for VOC analyses and double the volume for extractable organics.

The number of samples to be collected, including field and QC samples, are listed in Table 1-1. Sampling procedures are specified in the Field Sampling Plan (Appendix A).

All soil and groundwater samples will be sent to a Contract Laboratory Program (CLP) laboratory for analysis. The samples will be analyzed according to the special Routine Analytical Services (RAS) protocols that provide expedited sample results (2-week turnaround for DQO Level 4 data) for organic compounds and inorganic chemicals. The level of laboratory QC effort to be provided for these RAS analyses is specified in the current statements of work (SOW/OLM01.1 for organic and SOW/ILM01.0 for inorganic analyses). Quality control procedures for QTM from the CLP are specified in the draft SOW for quick turnaround analysis, dated March 1992. Tables 3-2 through 3-6 contain the quantitation levels for organic compounds and inorganic chemicals. The level of laboratory QC effort for the special analytical service (SAS) analyses is outlined individually in each SAS request contained in Appendix E.

The QC level of effort for the field measurements consists of pre-measurement calibration and a post-measurement verification of accuracy.

3.2 Accuracy, Precision, and Sensitivity Analyses

The fundamental QA objective with respect to accuracy, precision, and sensitivity of laboratory analytical data is to achieve the QC acceptance criteria of the analytical protocols.

The accuracy and precision requirements for the RAS from the CLP are specified in the current statements of work (SOW/OLM01.1 for organic compounds and SOW/ILM01.0 for inorganic chemicals). The sensitivities required for CLP analyses will be the contract-required detection limits shown in Tables 3-2 through 3-5 of this QAPjP.

Table 3-6
QTM Target Compound List (QTCL) and
Contract Required Quantitation Limits (CRQL)*

(Page 1 Of 5)

	Volatiles	CAS Number	Quantitation Limits Water µg/L	Quantitation Limits Soil/Solid** µg/kg
1.	Bromoform	75-25-2	20	40
2.	Bromodichloromethane	75-27-4	20	40
3.	Benzene	71-43-2	20	40
4.	Carbon Tetrachloride	56-23-5	20	40
5.	Chlorobenzene	108-90-7	20	40
6.	Chloroform	67-66-3	20	40
7.	1,1-Dichloroethane	75-34-3	20	40
8.	1,2-Dichloroethane	107-06-2	20	40
9.	1,1-Dichloroethene	75-35-4	20	40
10.	cis-1,2-Dichloroethene	156-59-4	20	40
11.	trans-1,2-Dichloroethene	156-60-5	20	40
12.	Ethylbenzene	100-41-4	20	40
13.	1,1,2,2-Tetrachloroethane	79-34-5	20	40
14.	Tetrachloroethene	127-18-4	20	40
15.	Toluene	108-88-3	20	40
16.	1,1,1-Trichloroethane	71-55-6	20	40
17.	Trichloroethene	79-01-6	20	40
18.	Vinyl Chloride	75-01-4	20	40
19.	ortho-Xylene	95-47-6	20	40
20.	meta-Xylene	108-38-3	20	40
21.	para-Xylene	106-42-3	20	40

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/solid are based on wet weight.

Table 3-6
QTM Target Compound List (QTCL) and
Contract Required Quantitation Limits (CRQL)*
(Page 2 of 5)(Cont'd.)

Polynuclear Aromatic Hydrocarbons (PAHs)		CAS Number	Quantitation Limits Water µg/L	Soil/Solid** µg/kg
22.	Acenaphthene	83-32-9	20	330
23.	Acenaphthylene	208-96-8	20	330
24.	Anthracene	120-12-7	20	330
25.	Benz [a] Anthracene	56-55-3	20	330
26.	Benzo [a] Pyrene	50-32-8	20	330
27.	Benzo [b] Fluoroanthene	205-99-2	20	330
28.	Benzo [k] Fluoroanthene	207-08-9	20	330
29.	Benzo [g,h,i] Perylene	191-24-2	20	330
30.	Chrysene	218-01-9	20	330
31.	Dibenz [a,h] Anthracene	53-70-3	20	330
32.	Fluoranthene	206-44-0	20	330
33.	Fluorene	86-73-7	20	330
34.	Indeno [1,2,3-cd] Pyrene	193-39-5	20	330
35.	Naphthalene	91-20-3	20	330
36.	Phenanthrene	85-01-8	20	330
37.	Pyrene	129-00-0	20	330

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/solid are based on wet weight.

Table 3-6
QTM Target Compound List (QTCL) and
Contract Required Quantitation Limits (CRQL)*
(Page 3 of 5) (Cont'd.)

	Phenols	CAS Number	Quantitation Limits Water µg/L	Quantitation Limits Soil/Solid** µg/kg
38.	2-Chlorophenol	95-57-8	50	1700
39.	4-Chloro-3-Methylphenol	59-50-7	50	1700
40.	2,4-Dichlorophenol	120-83-2	50	1700
41.	2,4-Dimethylphenol	105-67-9	50	1700
42.	4,6-Dinitro-2-Methylphenol	534-52-1	50	1700
43.	2,4-Dinitrophenol	51-28-5	50	1700
44.	o-cresol	95-48-7	50	1700
45	m-cresol	108-39-4	50	1700
46.	p-cresol	106-44-5	50	1700
47.	2-Nitrophenol	88-75-5	50	1700
48.	4-Nitrophenol	100-02-7	50	1700
49.	Pentachlorophenol	87-86-5	50	1700
50.	Phenol	108-95-2	50	1700
51.	2,3,4,6-Tetrachlorophenol	58-90-2	50	1700
52.	2,4,5-Trichlorophenol	95-95-4	50	1700
53.	2,4,6-Trichlorophenol	88-06-2	50	1700

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/solid are based on wet weight.

Table 3-6
QTM Target Compound List (QTCL) and
Contract Required Quantitation Limits (CRQL)*
(Page 4 of 5) (Cont'd.)

	Pesticides	CAS Number	Quantitation Limits Water µg/L	Quantitation Limits Soil/Solid** µg/kg
54.	Aldrin	309-00-2	0.1	3.3
55.	Alpha-BHC	319-84-6	0.1	3.3
56.	Beta-BHC	319-85-7	0.1	3.3
57.	alpha-Chlordane	5103-71-9	0.1	3.3
58.	gamma-Chlordane	5103-74-2	0.1	3.3
59.	Delta-BHC	319-86-8	0.1	3.3
60.	Dieldrin	60-57-1	0.1	3.3
61.	4,4'-DDD	72-54-8	0.1	3.3
62.	4,4'-DDE	72-55-9	0.1	3.3
63.	4,4'-DDT	50-29-3	0.1	3.3
64.	Endosulfan Sulfate	1031-07-8	0.1	3.3
65.	Endosulfan I	959-98-8	0.1	3.3
66.	Endosulfan II	33213-65-9	0.1	3.3
67.	Endrin	72-20-8	0.1	3.3
68.	Endrin Ketone	53494-70-5	0.1	3.3
69.	Endrin Aldehyde	7421-36-3	0.1	3.3
70.	Gamma-BHC (Lindane)	58-89-9	0.1	3.3
71.	Heptachlor	76-44-8	0.1	3.3
72.	Heptachlor Epoxide	1024-57-3	0.1	3.3
73.	Methoxychlor	72-43-5	0.1	3.3

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/solid are based on wet weight.

Table 3-6
QTM Target Compound List (QTCL) and
Contract Required Quantitation Limits (CRQL)*
(Cont'd.)
(Page 5 of 5)

	PCBs/Aroclors	CAS Number	Quantitation Limits Water µg/L	Quantitation Limits Soil/Solid** µg/kg
74.	Aroclor-1016	12674-11-2	1	33
75.	Aroclor-1221	11104-28-2	2	66
76.	Aroclor-1232	11141-16-5	1	33
77.	Aroclor-1242	53469-21-9	1	33
78.	Aroclor-1248	12672-29-6	1	33
79.	Aroclor-1254	11097-69-1	1	33
80.	Aroclor-1260	11096-82-5	1	33
81.	Toxaphene	8001-35-2	5	165

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/solid are based on wet weight.

The accuracy, precision, and sensitivity requirements for the QTM from the CLP are specified in the Draft Statement of Work dated March 1992.

The accuracy, precision, and sensitivity requirements for SAS for the CLP are specified in each individual SAS request contained in Appendix E.

The standard operating procedures (SOPs) for the field equipment used to measure pH, conductivity, temperature and volatile organic compounds are outlined in Appendix F. These SOPs provide the field screening analyses accuracy and precision requirements.

3.3 Completeness, Representativeness, and Comparability

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data that was expected to be obtained under normal conditions. It is expected that the CLP will provide data meeting QC acceptance criteria for 95 percent or more for all samples tested. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{completeness (\%)} = \frac{\text{number of valid data}}{\text{number of samples collected for each parameter analyzed}} \times 100$$

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter which is dependent upon the proper design of the sampling program and proper laboratory protocol. The sampling network was designed to provide data representative of site conditions. During development of this network, consideration was given to past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to the Superfund program. The rationale of the sampling network is discussed in detail in the Field Sampling Plan.

Representativeness will be satisfied by seeing that the FSP is followed, proper sampling techniques are used, proper analytical procedures are followed, and holding times of the samples are not exceeded in the laboratory. Analytical representativeness will be assessed by the analysis of field duplicated samples. Precision control limits are defined in the current Statement of Work (SOWs).

Comparability expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data, as documented in the QAPjP, are expected to provide comparable data.

3.0 Quality Assurance Objectives for Measurement Data

The overall QA objective is to develop and implement procedures for field sampling, chain of custody, laboratory analyses, and reporting that will provide results that are legally defensible in a court of law and meet project objectives. Specific procedures for QC sampling, chain of custody, instrument calibration, sample analyses, data reporting, internal and external audits, preventive maintenance, and corrective action are described in other sections of this QAPjP. The purpose of this section is to describe the extent of QC effort and to address the specific objectives for accuracy, precision, sensitivity, completeness, representativeness, and comparability.

3.1 Level of Quality Control Effort

Field blank, trip blank, field duplicate, and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling program. Field and trip blanks will be submitted to the analytical laboratories to assess the potential of contamination. Field blank samples are analyzed to check for procedural contamination at the site that may cause sample contamination. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage. Field duplicate samples are analyzed to check for sampling and analytical precision. Matrix spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. The organic matrix spike samples are performed in duplicate and are hereinafter referred to as MS/MSD samples. The inorganic matrix spike (MS) samples are collected in singular.

The general level of the QC effort will include the following:

- One field duplicate will be collected for every 10 or fewer investigative samples.

- One field blank will be collected for every 10 or fewer water investigative samples.

- One volatile organic analysis (VOA) trip blank, consisting of distilled deionized ultra pure water, will be included along with each shipment of VOA samples.

- One MS or one set of MS/MSD samples will be collected for every 20 or fewer investigative samples.

The general level of QC effort is summarized in Table 3-1.

QC samples will be collected at the same time and in the same manner as the field samples. Soil MS and MS/MSD samples to be analyzed for inorganic analytes volatile organic compounds (VOCs), or extractable organic compounds will require no additional sample volume. Aqueous MS samples must be collected at double the volume for inorganic analyses and MS/MSD samples must be collected at triple the volume for VOC analyses and double the volume for extractable organics.

The number of samples to be collected, including field and QC samples, are listed in Table 1-1. Sampling procedures are specified in the Field Sampling Plan (Appendix A).

All soil and groundwater samples will be sent to a Contract Laboratory Program (CLP) laboratory for analysis. The samples will be analyzed according to the special Routine Analytical Services (RAS) protocols that provide expedited sample results (2-week turnaround for DQO Level 4 data) for organic compounds and inorganic chemicals. The level of laboratory QC effort to be provided for these RAS analyses is specified in the current statements of work (SOW/OLM01.1 for organic and SOW/ ILM01.0 for inorganic analyses). Tables 3-2 through 3-5 contain the quantitation levels for organic compounds and inorganic chemicals. The level of laboratory QC effort for the special analytical service (SAS) analyses is outlined individually in each SAS request contained in Appendix E.

The QC level of effort for the field measurements consists of pre-measurement calibration and a post-measurement verification of accuracy.

3.2 Accuracy, Precision, and Sensitivity Analyses

The fundamental QA objective with respect to accuracy, precision, and sensitivity of laboratory analytical data is to achieve the QC acceptance criteria of the analytical protocols.

The accuracy and precision requirements for the RAS from the CLP are specified in the current statements of work (SOW/OLM01.1 for organic compounds and SOW/ ILM01.0 for inorganic chemicals). The sensitivities required for CLP analyses will be the contract-required detection limits shown in Tables 3-2 through 3-5 of this QAPjP.

The accuracy, precision, and sensitivity requirements for the QTM from the CLP are specified in the Draft Statement of Work dated March 1992.

Table 3-1
GENERAL LEVEL OF QC EFFORT

QC Check	Frequency: Organic Compounds	Frequency: Inorganic Compounds
MS or MS/MSD	1/20 samples	1/20 samples
Field Blanks[1]	1/10 samples	1/10 samples
Field Duplicates	1/10 samples	1/10 samples
Trip Blanks	1 per shipment of Volatile samples	NA

[1]Field Blanks will not be collected for soil samples
NA = not applicable

GLT338/020.51

Table 3-2
VOLATILE ORGANIC COMPOUND
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED
QUANTITATION LIMITS (CRQL)

ANALYTE	CAS. NOS.	Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	(ng)
Chloromethane	74-87-3	10	10	1200	(50)
Bromomethane	74-83-9	10	10	1200	(50)
Vinyl Chloride	75-01-4	10	10	1200	(50)
Chloroethane	75-00-3	10	10	1200	(50)
Methylene Chloride	75-09-2	10	10	1200	(50)
Acetone	67-64-1	10	10	1200	(50)
Carbon Disulfide	75-15-0	10	10	1200	(50)
1,1-Dichloroethene	75-35-4	10	10	1200	(50)
1,1-Dichloroethane	75-34-3	10	10	1200	(50)
1,2-Dichloroethene	540-59-0	10	10	1200	(50)
Chloroform	67-66-3	10	10	1200	(50)
1,2-Dichloroethane	107-06-2	10	10	1200	(50)
2-Butanone	78-93-3	10	10	1200	(50)
1,1,1-Trichloroethane	71-55-6	10	10	1200	(50)
Carbon Tetrachloride	56-23-5	10	10	1200	(50)
Bromodichloromethane	75-27-4	10	10	1200	(50)
1,2-Dichloropropane	78-87-5	10	10	1200	(50)
cis-1,3-Dichloropropene	10061-01-5	10	10	1200	(50)
Trichloroethene	79-01-6	10	10	1200	(50)
Dibromochloromethane	124-48-1	10	10	1200	(50)
1,1,2-Trichloroethane	79-00-5	10	10	1200	(50)
Benzene	71-43-2	10	10	1200	(50)
trans-1,3-Dichloropropene	10061-02-6	10	10	1200	(50)
Bromoform	75-25-2	10	10	1200	(50)
4-Methyl-2-pentanone	108-10-1	10	10	1200	(50)
2-Hexanone	591-78-6	10	10	1200	(50)
Tetrachloroethene	127-18-4	10	10	1200	(50)
Toluene	108-88-3	10	10	1200	(50)
1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200	(50)
Chlorobenzene	108-90-7	10	10	1200	(50)
Ethyl benzene	100-41-4	10	10	1200	(50)
Styrene	100-42-5	10	10	1200	(50)
Xylenes (total)	330-20-7	10	10	1200	(50)

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

Table 3-3
SEMIVOLATILE ORGANIC COMPOUND
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED
QUANTITATION LIMITS (CRQL)
(Page 1 of 3)

ANALYTE	CAS NOS.	Water ug/L	Low Soil ug/Kg	Med. Soil	(ng)
Phenol	108-95-2	10	330	10000	(20)
bis(2-Chloroethyl) ether	111-44-4	10	330	10000	(20)
2-Chlorophenol	95-57-8	10	330	10000	(20)
1,3-Dichlorobenzene	541-73-1	10	330	10000	(20)
1,4-Dichlorobenzene	106-46-7	10	330	10000	(20)
1,2-Dichlorobenzene	95-50-1	10	330	10000	(20)
2-Methylphenol	95-48-7	10	330	10000	(20)
4-Methylphenol	106-44-5	10	330	10000	(20)
2,2'-oxybis-(1-chloropropane)**	108-60-1	10	330	10000	(20)
N-Nitroso-di-n-dipropylamine	108-60-1	10	330	10000	(20)
Hexachloroethane	67-72-1	10	330	10000	(20)
Nitrobenzene	98-95-3	10	330	10000	(20)
Isophorone	78-59-1	10	330	10000	(20)
2-Nitrophenol	88-75-5	10	330	10000	(20)
2,4-Dimethylphenol	105-67-9	10	330	10000	(20)
bis(2-Chloroethoxy) methane	111-91-1	10	330	10000	(20)
2,4-Dichlorophenol	120-83-2	10	330	10000	(20)
1,2,4-Trichlorobenzene	120-82-1	10	330	10000	(20)
Naphthalene	91-20-3	10	330	10000	(20)
4-Chloroaniline	106-47-8	10	330	10000	(20)
Hexachlorobutadiene	87-68-3	10	330	10000	(20)
4-Chloro-3-methylphenol	59-50-7	10	330	10000	(20)
2-Methylnaphthalene	91-57-6	10	330	10000	(20)
Hexachlorocyclopentadiene	77-47-4	10	330	10000	(20)
2,4,6-Trichlorophenol	88-06-2	10	330	10000	(20)
2,4,5-Trichlorophenol	95-95-4	50	1700	50000	(100)
2-Chloronephthalene	91-58-7	10	330	10000	(20)
2-Nitroaniline	88-74-4	50	1700	50000	(100)
Dimethylphthalate	131-11-3	10	330	10000	(20)
Acenaphthylene	208-96-8	10	330	10000(20)	

Table 3-3
SEMIVOLATILE ORGANIC COMPOUND
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED
QUANTITATION LIMITS (CRQL)
(Page 2 of 3)

ANALYTE	CAS NOS.	Water ug/L	Low Soil ug/Kg	Med. Soil	(ng)
2,6-Dinitrotoluene	606-20-2	10	330	10000	(20)
3-Nitroaniline	99-09-2	50	1700	50000	(100)
Acenaphthene	83-32-9	10	330	10000	(20)
2,4-Dinitrophenol	51-28-5	50	1700	50000	(100)
4-Nitrophenol	100-02-7	50	1700	50000	(100)
Dibenzofuran	132-64-9	10	330	10000	(20)
2,4-Dinitrotoluene	121-14-2	10	330	10000	(20)
Diethylphthalate	84-66-2	10	330	10000	(20)
4-chlorophenyl-phenyl-ether	7005-72-3	10	330	10000	(20)
Fluorene	86-73-7	10	330	10000	(20)
4-Nitroaniline	100-01-6	25	1700	50000	(50)
4,6-Dinitro-2-methylphenol	534-52-1	25	1700	50000	(50)
N-Nitrosodiphenylamine	86-30-6	10	330	10000	(20)
4-Bromophenyl-phenyl-ether	101-55-3	10	330	10000	(20)
Hexachlorobenzene	118-74-110	10	330	10000	(20)
Pentachlorophenol	87-86-5	25	1700	50000	(50)
Phenanthrene	85-01-8	10	330	10000	(20)
Anthracene	120-12-7	10	330	10000	(20)
Carbazole	86-74-8	10	330	10000	(20)
Di-n-butylphthalate	86-74-2	10	330	10000	(20)
Fluoranthene	206-44-0	10	330	10000	(20)
Pyrene	129-00-0	10	330	10000	(20)
Butylbenzylphthalate	85-68-7	10	330	10000	(20)
3,3-Dichlorobenzidine	91-94-1	10	330	10000	(20)
Benzo(a)anthracene	56-55-3	10	330	10000	(20)
Chrysene	210-81-9	10	330	10000	(20)
bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000	(20)
Di-n-Octylphthalate	117-84-0	10	330	10000	(20)
Benzo(b)fluoranthene	205-99-2	10	330	10000	(20)
Benzo(k)fluoranthene	207-08-9	10	330	10000	(20)

Table 3-3
SEMIVOLATILE ORGANIC COMPOUND
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED
QUANTITATION LIMITS (CRQL)
(Page 3 of 3)

ANALYTE	CAS NOS.	Water ug/L	Low Soil ug/Kg	Med. Soil	(ng)
Benzo(a)pyrene	50-32-8	10	330	10000	(20)
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000	(20)
Dibenzo(a,h)anthracene	53-70-3	10	330	10000	(20)
Benzo(g,h,i)perylene	191-24-2	10	330	10000	(20)

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

** Previously known by the name of bis(2-chlorousipropyl) ether.

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Table 3-4
PESTICIDE/AROCHLORS
TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED
QUANTITATION LIMITS (CRQL)

		Quantitation Limits		
		Water	Soil	On Column
Pesticides/Aroclors	CAS. NOS.	ug/L	ug/Kg	ng
alpha-BHC	319-84-6	0.05	1.7	5
beta-BHC	319-85-7	0.05	1.7	5
delta-BHC	319-86-8	0.05	1.7	5
gamma-BHC (Lindane)	58-89-9	0.05	1.7	5
Heptachlor	76-44-8	0.05	1.7	5
Aldrin	309-00-2	0.05	1.7	5
Heptachlor epoxide	1024-57-3	0.05	1.7	5
Endosulfan I	959-98-8	0.05	1.7	5
Dieldrin	60-57-1	0.10	3.3	10
4,4'-DDE	72-55-9	0.10	3.3	10
Endrin	72-20-8	0.10	3.3	10
Endosulfan II	33213-65-9	0.10	3.3	10
4,4'-DDD	72-54-8	0.10	3.3	10
Endosulfan sulfate	1031-07-8	0.10	3.3	10
4,4'-DDT	50-29-3	0.10	3.3	10
Methoxychlor	72-43-5	0.50	17.0	50
Endrin ketone	53494-70-5	0.10	3.3	10
Endrin aldehyde	7421-36-3	0.10	3.3	10
alpha-Chlordane	5103-71-9	0.05	1.7	5
gamma-Chlordane	5103-74-2	0.05	1.7	5
Toxaphene	8001-35-2	5.0	170	500
Aroclor-1016	12674-11-2	1.0	33	100
Aroclor-1221	11104-28-2	2.0	67	200
Aroclor-1232	11141-16-5	1.0	33	100
Aroclor-1242	53469-21-9	1.0	33	100
Aroclor-1248	12672-29-6	1.0	33	100
Aroclor-1254	11097-69-1	1.0	33	100
Aroclor-1260	11096-82-5	1.0	33	100

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher. There is no differentiation between the preparation of low and medium soil samples in this method for the analysis of Pesticides/Aroclors.

Table 3-5
METAL AND CYANIDE
INORGANIC TARGET ANALYTE LIST (TAL)
(Page 1 of 2)

Required[1,2] Analyte	Contract Detection Limit (ug/L)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

(1) Subject to the restrictions specified in the first page of Part G, Section IV of Exhibit D (Alternate Methods—Catastrophic Failure) any analytical method specified in SOW Exhibit D may be utilized as long as the documented instrument or method detection limits meet the Contract Required Detection Limit (CRDL) requirements. Higher detection limits may only be used in the following circumstances:

Table 3-5
METAL AND CYANIDE
INORGANIC TARGET ANALYTE LIST (TAL)
(Page 2 of 2)

If the sample concentration exceeds five times the detection limit of the instrument or method in use, the values may be reported even though the instrument or method detection limit may not equal the Contract Required Detection Limit. This is illustrated in the example below:

For lead:

Method in use = ICP
Instrument Detection Limit (IDL) = 40
Sample concentration = 200
Contract Required Detection Limit (CRDL) = 3
The value of 200 may be reported even though instrument detection limit is greater than CRDL. The instrument or method detection limit must be documented as described in Exhibit E.

(2) The CRDL are the instrument detection limits obtained in pure water that must be met using the procedure in Exhibit E. The detection limits for samples may be considerably higher depending on the sample matrix.

The accuracy, precision, and sensitivity requirements for SAS for the CLP are specified in each individual SAS request contained in Appendix E.

The standard operating procedures (SOPs) for the field equipment used to measure pH, conductivity, temperature and volatile organic compounds are outlined in Appendix F. These SOPs provide the field screening analyses accuracy and precision requirements.

3.3 Completeness, Representativeness, and Comparability

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data that was expected to be obtained under normal conditions. It is expected that the CLP will provide data meeting QC acceptance criteria for 95 percent or more for all samples tested. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{completeness (\%)} = \frac{\text{number of valid data}}{\text{number of samples collected for each parameter analyzed}} \times 100$$

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter which is dependent upon the proper design of the sampling program and proper laboratory protocol. The sampling network was designed to provide data representative of site conditions. During development of this network, consideration was given to past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to the Superfund program. The rationale of the sampling network is discussed in detail in the Field Sampling Plan.

Representativeness will be satisfied by seeing that the FSP is followed, proper sampling techniques are used, proper analytical procedures are followed, and holding times of the samples are not exceeded in the laboratory. Analytical representativeness will be assessed by the analysis of field duplicated samples. Precision control limits are defined in the current Statement of Work (SOWs).

Comparability expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data, as documented in the QAPjP, are expected to provide comparable data.

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4.0 Sampling Procedures

Sampling procedures are described in the Field Sampling Plan (FSP).

The Field Sampling Plan is Appendix A of the QAPjP.

5.0 Sample Custody

It is U.S. EPA and Region 5 Policy to follow the U.S. EPA Region 5 sample custody, or chain of custody protocols as described in "NEIC Policies and Procedures", EPA-330/9-78-DDI-R, Revised June 1985. This custody is in three parts: Sample collection, Laboratory analysis, and Final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area.

A sample or evidence file is under your custody if they

- Are in your possession
- Are in your view, after being in your possession
- Are in your possession and you place them in a secured location, or
- Are in a designated secure area.

5.1 Field Chain of Custody Procedures

The sample packaging and shipment procedures summarized below will insure that the samples will arrive at the laboratory with the chain of custody intact. Detailed sample packing and shipping procedures and example forms are provided in Appendix G. The protocol for specific sample numbering using case numbers and traffic report numbers if applicable and other sample designations are included in the Data Management Plan, Appendix B of the QAPjP.

5.1.1 Field Procedures

(a) The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples.

(b) All bottles will be tagged with sample numbers and locations. The Sample Management Office (SMO) number and stickers will be affixed.

(c) Sample tags are to be completed for each sample using waterproof ink unless prohibited by weather conditions.

(d) The Field Team Leader will review all field activities to determine whether proper custody procedures were followed during the field work.

5.1.2 Field Logbooks/Documentation

Field logbooks will provide the means of recording data collecting activities performed. As such, entries will be described in as much detail as possible so that persons going to the site could re-construct a particular situation without reliance on memory.

Field logbooks will be bound, field survey books or notebooks. Each logbook will be identified by the project-specific document number.

The title page of each logbook will contain the following:

- Person to whom the logbook is assigned
- Logbook number
- Project name
- Project start date
- End date

Entries into the logbooks will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered.

Measurements made and samples collected will be recorded. All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected, a detailed description and a sketch will be made of the location of the station, the detailed description will include compass and distance measurements. Soil sample designations for soil collected from borings will be noted on the boring log form. The number of the photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in the Field Sample Plan (FSP), Appendix A of QAPjP. The equipment used to collect samples is noted in the FSP. The time of sampling, sample description, depth at which the sample was collected will be recorded on the boring log form, and sample volume and number of containers will be indicated on the chain of custody form. Sample identification number will be assigned prior to sample collection. Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

5.1.3 Transfer of Custody and Shipment Procedures

Sample Documentation and shipping procedures are explained in full detail in Appendix of this QAPjP. Noted below are the chain of custody procedures to be followed on the Carter-Lee Lumber RI project.

(a) Samples are to be accompanied by a properly completed chain of custody form. The sample numbers and locations will be listed on the chain of custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to the permanent laboratory, or to/from a secure storage area.

(b) Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in each sample box or cooler. Shipping containers will be locked and secured with strapping tape and EPA custody seals for shipment to the laboratory. The preferred procedure includes use of a custody seal attached to the front right and back left of the cooler. The custody seals are covered with clear plastic tape. The cooler is strapped shut with strapping tape in at least two locations.

(c) All shipments will be accompanied by the Chain of Custody Record identifying the contents. The original record will accompany the shipment, and the pink and yellow copies will be retained by the sampler for returning to the sampling office.

(d) If the samples are sent by common carrier, a bill of lading should be used. Receipts of bills of lading will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody form as long as the custody forms are sealed inside the sample cooler and the custody seals remain intact.

5.2 Laboratory Chain of Custody Procedures

The chain of custody procedures for the Contract Laboratory Program (CLP) are described in the Statements of Work (SOW) for Routine Analytical Services (RASs). The same custody procedure applies to Special Analytical Services (SASs). These custody procedures along with the holding time requirements for CLP samples are described in the appropriate SOW (OLM01.1 for organics and ILM01.0 for described in the appropriate SOW (OLM01.1 for organics and ILM01.0 for inorganics).

The chain of custody procedures for the quick turnaround method (QTM) described in the draft SOW for QTM dated March 1992.

5.3 Final Evidence Files Custody Procedures

CH2M HILL is the custodian of the evidence file and maintains the contents of evidence files for the RI, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, correspondence, laboratory logbooks, chain of custody form, and Laboratory Scientific Support Section (LSSS) of CRL's data reviews in a secured, limited access area and under custody of the contractor's site manager.

6.0 Calibration Procedures and Frequency

This section describes procedures for maintaining the accuracy of all the instruments and measuring equipment which are used for conducting field tests and laboratory analyses. These instruments and equipment should be calibrated prior to each use or on a scheduled, periodic basis.

6.1 Field Instruments and Equipment

Calibration of field instruments will be performed at the intervals specified by the manufacturer or more frequently if conditions dictate. Field instruments will include a pH meter, thermometer, specific conductivity meter, and Organic Vapor Photoionization Detector (HNu). In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned to the manufacturer for service.

Calibration of field instruments is governed by the specific Standard Operating Procedure (SOP), Appendix F of this QAPjP, for the applicable field analysis method, and such procedures take precedence over the following general discussion.

A general procedures for pH meter, specific conductivity meter and thermometer are described below:

6.1.1 pH Calibration

The pH meter will be calibrated with standard buffer solutions prior to a field trip. In the field, the meter will be calibrated daily with two buffers before use. Calibration procedures and frequency will be recorded in a field log book along with the lot numbers of the buffer.

A general procedure for instrument calibration is as follows:

- Check that temperature of sample and buffer are the same.
- Connect pH electrode into pH meter and turn on pH meter.
- Set temperature setting based on the temperature of buffer; place electrode in first buffer solution.
- After reading has stabilized, adjust "CALIB" knob to display correct value.

- Repeat procedure for second buffer solution.
- Place pH electrode in the sample and record the pH as displayed.
- Remove pH electrode from sample and rinse off with distilled water.
- The pH meter must be recalibrated every time it is turned off and turned back on, or if it starts giving erratic results.

The calibrations performed, standard used, and sample pH values are to be recorded in the field notebook. Appropriate new batteries will be purchased and kept with the meters to facilitate immediate replacement in the field as necessary.

6.1.2 Thermometer Calibration

Temperature measurements are carried out utilizing a thermometer. The thermometers must be inspected before use to ensure there is no mercury separation. The thermometers should be rechecked in the field before and after use to see if the readings are logical and the mercury is still intact. The thermometers should be checked biannually for calibration, by immersing them in a bath of known temperature until equilibrium is reached. They should be discarded if found to have more than 10 percent error. The reference thermometer used for the bath calibration should be National Bureau of Standards traceable.

6.1.3 Conductivity Meter Calibration

The conductivity cells of the specific conductivity meter will be cleaned and checked against known conductivity standards before each field trip. In the field, the instrument will be checked daily with NBS traceable standards.

The calibration procedure is described below.

- Place the probe in conductivity calibration standard solution.
- Set temperature knob for temperature of standard solution.
- Turn to appropriate scale and set the instrument for the value of calibration standard.
- Rinse off the electrode with distilled water.

- Measure the conductivity for distilled water to be used for a field blank, making sure temperature is set correctly for temperature of solution to be tested.

- If the conductivity of blank (distilled water) is high, it must be discarded and a new blank sample procured.

All readings and calibrations should be recorded in the field notebook.

6.1.4 HNu and OVA Calibration

The HNu and/or OVA will be calibrated daily with a gas of known concentration, as described in the HNu and OVA field SOP (Appendix F).

Equipment to be used during the field sampling will be examined to certify that it is in operating condition. This includes checking the manufacturer's operating manual and the instructions for each instrument to ensure that all maintenance requirements are being observed. Field notes from previous sampling trips will be reviewed so that the notation on any prior equipment problem are not overlooked, and all necessary repairs to equipment have been carried out. Spare electrodes, thermometers and other frequently used field equipment will be maintained at the sampling location.

6.2 Laboratory Instruments

6.2.1 Calibration Procedures and Frequency for RAS, SAS, and QTM Analyses

The CLP calibration procedure and frequencies are specified in the CLP organic and inorganic SOWs. Where analyses are conducted according to the U.S. Environmental Protection Agency (U.S. EPA) Contract Laboratory Program (CLP)/SW 846 protocols, the calibration procedures and frequencies specified in the applicable CLP Routine Analytical Services (RAS) Statement of Work (SOW) will be followed exactly.

6.2.1.1 Organic Analyses

Prior to calibration, the instrument(s) used for Gas Chromatograph/Mass Spectrometer (GC/MS) analyses are tuned by analysis of p-bromofluorobenzene (BFB) for volatile analyses and decafluorotriphenyl phosphine (DFTPP) for semi-volatile analyses. Once the tuning criteria for these reference compounds are met, the instrument should be initially calibrated by using a five point calibration curve.

Continuing calibration is verified as specified in the method, or at least each working day, using criteria specified by the method. The calibration standards will be U.S. EPA-or NBS-traceable and are spiked with internal standards and surrogate compounds.

6.2.1.2 Metals Analysis

The Atomic Absorption Spectrophotometer (AAS) and Inductively Coupled Plasma Emission Spectrophotometer (ICP) instruments are calibrated by use of a minimum of three calibration standards prepared by dilution of certified stock solutions. An analysis blank is prepared with one calibration standard at the quantitation limit for the metal. The other standards bracket the concentration range of the samples. Calibration standards will contain acids at the same concentration as the digestates.

A continuing calibration standard, prepared from a different stock solution than that used for preparation of the calibration standards, is prepared and analyzed after each ten samples or each two hours of continuous operation. The value of the continuing calibration standard concentration must agree with $\pm$ 10 percent of the initial value or the appropriate corrective action is taken which may include recalibrating the instrument and reanalyzing the previous ten samples.

For the ICP, linearity near the quantitation limit will be verified with a standard prepared at a concentration of two times the quantitation limit. This standard must be run at the beginning and end of each sample analysis run or a minimum of twice per 8-hour period.

6.2.2 SAS Calibration Procedure and Frequency

The SASs calibration procedures and frequency are specified in the SASs request. SAS requests are located in Appendix E of the QAPjP.

6.2.3 QTM Calibration Procedures and Frequency

The QTM calibration procedure and frequencies are specified in the QTM from the CLP draft SOW dated March 1992.

7.0 Analytical Procedures

The groundwater and soil samples collected during field sampling activities for the Carter-Lee Lumber RI will be analyzed by the CLP.

7.1 Laboratory Analytical Procedures

7.1.1 Routine Analytical Services Laboratory Procedures

If available, all samples for CLP TCL VOAs, semivolatiles and Pesticide/PCBs and CLP TAL inorganic (dissolved metals and cyanide) will be analyzed according to analytical procedures set forth in the modified RASs that provides results within two weeks of sample receipt. These modified RASs are the conventional SOWs (U.S. EPA CLP RAS SOW (OLM01.1) for organics analysis and RAS SOW (ILM01.0) for inorganic analysis) with the two week turn around requirement as the only change. If the quick result RASs are unavailable the samples will be analyzed as RAS plus SAS, with the SAS component being the two week turn around time for the results. The QAPjP is written as if the modified RASs will be available.

The samples for Volatile Organic Analyte (VOA) analysis shall be screened as recommended in VOA CLP RAS SOW/OLM01.1. Samples which, as a result of the screening, would normally be quantitated using the VOA CLP "Low" method, shall be analyzed by the SOP for Volatile with the Low Detection Limits. If the result of the screening indicate that the VOA CLP "Medium" method should be used, then the sample shall be quantitated according to the CLP SOW for Organic analysis, Multi-media, High Concentration, dated 9/88, revision 4/89. This screening and multi-method approach is necessitated by the very low detection limits required to meet project objectives while accommodating the potential for samples with high concentrations of VOAs.

7.1.2 Special Analytical Services Laboratory Procedures

The analytical procedures to be used for performing the SAS analyses are described in the SAS requests in Appendix E of this QAPP. SAS analysis will be performed by the CLP. Also specified in the SAS requests are calibration procedures, frequency of calibration, and the internal quality control checks required for each analysis.

7.1.3 Quick Turnaround Method Procedures

The analytical procedures to be used for performing the QTM analyses are described in the CLP draft statement of work for quick turnaround analysis, dated March 1992.

7.2 Field Screening Analytical Procedures

The procedures for field measurement of pH, specific conductivity, and volatile organics are described in the field measurement SOPs in Appendix F.

8.0 Internal Quality Control Checks

8.1 Field Sample Collection

The assessment of field sampling precision and accuracy will be made through collection of field duplicates, MS samples, MS/MSD samples, and trip and field blanks in accordance with the applicable procedures described in the FSP at the frequency indicated in Section 3 of the QAPjP.

8.2 Field Measurement

QC procedures for pH, conductivity, temperature and HNu measurements are limited to checking the reproducibility of the measurement by obtaining multiple readings on a single sample or standard and by calibrating the instruments. Field quality control check data will be recorded in the field log book.

8.3 Laboratory Analyses

8.3.1 RAS Internal Quality Control Checks - Routine Analytical Services

Internal quality control procedures for RAS from the CLP are specified in the Statement of Works (SOWs) for organics and inorganics. These specifications include the types of QC checks required (method blanks, reagent/preparation blanks, matrix spike and matrix spike duplicates, calibration standards, internal standards, surrogate standards, the frequency of each audit, the specific calibration check standards, laboratory duplicate/replicate analysis), compounds and concentrations to be used, and the quality control acceptance criteria for these audits.

8.3.2 SAS Internal Quality Control Checks

Quality control checks for SAS are identified in the QC requirements Section of the SAS requests Appendix E.

8.3.3 QTM Internal Quality Control Checks

Quality control procedures for QTM from the CLP are specified in the draft SOW for quick turnaround analysis, dated March 1992. These specifications include QC check requirements, compounds and concentrations to be used, and the quality control acceptance criteria.

9.0 Data Reduction, Validation, and Reporting

All samples collected at the Carter-Lee Lumber site will be sent to the CLP. Data reduction, evaluation, and reporting will be performed according to specifications outlined in the CLP RAS SOW (OLM01.1) for the organics and SOW (ILM01.1) for inorganics. The CLP will send the data to the EPA, Region 5, Laboratory Scientific Support Section (LSSS), for data validation. The LSSS will validate and provide the data to CH2M HILL on a priority one basis. CH2M HILL would like to receive the validated data within seven days after receipt at the LSSS.

9.1 Data Reduction

9.1.1 CLP Data Reduction

Data reduction, evaluation, and reporting for samples analyzed by the CLP performed according to specifications outlined in the CLP RAS SOW (OLM01.1) for the organics and SOW (ILM01.1) for inorganics.

Data resulting from SAS request will be reduced, evaluated and reported as described above unless special procedures are given in the actual SAS request.

No data reduction is required with the QTM program. The QTM program electronically provides result tables.

9.1.2 Field Measurements and Sample Collection

Raw data from field measurements and sample collection activities will be appropriately recorded in the field log book. If the field data are to be reported in a summarized format, the data will be tabulated by parameter, then by day of analysis.

9.2 Data Validation

Validation will be accomplished by comparing the contents of the data packages and QA/QC results to the requirements contained in the RAS and SAS methods. Raw data such as GC/MS Total Ion Current (TIC) chromatograms, GC chromatograms, and mass spectra, ICAP and FAA data reports, and data station printouts will be examined to ensure that reported results are accurate. The U.S. EPA Region 5 Laboratory Scientific Support Section (LSSS) will be responsible for this. The protocol for RAS analyte data validation as presented in:

- Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses—U.S. EPA, February 1988

- Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses—U.S. EPA, July 1988

The Data Review will identify any out-of-control data points and data omissions.

The QTM has an electronic data validation program build in. The electronic data validation is based on the functional guidelines, and will automatically flag qualified results prior to the result sheet being produced. The level of data supplied by the QTM program is that of level II(Field Analysis). The QTM data will undergo no additional data validation.

Decisions to repeat sample collection and analyses may be made by the Project Manager based on the extent of the deficiencies and their importance in the overall context of the project. Due to the similarity of analytical costs between the two investigative phases, if there are significant data lapses that would require substantial phase I resampling or reanalysis, the project would automatically move to phase II.

The Carter-Lee Lumber RI/FS data will be available through controlled access to the Project Manager, and authorized personnel only.

9.3 Data Reporting

The RAS and SAS analytical laboratories will prepare and submit full analytical and QC reports to EPA Region 5 in compliance with requirements of the CLP to include the following (as applicable):

1. Narrative including statement of samples received, description of any deviations from RAS or SAS standard procedures, explanation of qualifications regarding data quality, and any other significant problems encountered during analysis

2. Up to 20 extractable organic compounds not included in the RAS analytes, tentatively identified and quantified against the nearest internal standard

3. An organic QA/QC report including Forms I to X,, surrogate spike results for each sample, matrix spike and matrix spike duplicate results, method blank results, and initial and continuing calibration checks

4. An inorganic QA/QC report including Forms I to XIII spike and duplicate results, method blank results, and initial and continuing calibration checks

5. Field and laboratory chain-of-custody documentation pertaining to each sample delivery group analyzed

The CLP will submit QTM result sheets to EPA Region 5 and CH2M HILL in compliance with the requirements of the Draft SOW for Quick Turnaround Analysis, dated March 1992.

9.4 CH2M HILL Data Review

CH2M HILL will review the validated data to determine if overall QA objectives were met. All data generated for the Carter-Lee Lumber RI/FS will be computerized in a format organized to facilitate data review and evaluation. The computerized data set will include the data flags provided by CLP, as well as additional comments of the Data Reviewer. The laboratory-provided data flags will include such items as: 1) concentration below required detection limit, 2) estimated concentration due to poor below required detection limit, 2) estimated concentration due to poor spike recovery, and 3) concentration of chemical also found in laboratory blank. The Data Reviewer comments will indicate that the data are: 1) usable as a quantitative concentration, 2) usable with caution as an estimated concentration, or 3) unusable due to out-of-control QC results.

10.0 Performance and System Audits

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the FSP and QAPjP. The audits of field and laboratory activities include two separate independent parts: Internal and External audits.

10.1 Field Audits

Internal audits of field activities (sampling and measurements) will be conducted by CH2M HILL's Field Team Leader. The audits will include examination of field sampling records, field instrument operating records, sample collection, sample handling and packaging procedures, maintenance and QA procedures, and chain of custody procedures. An audit will occur at the onset of the project to verify that all established procedures are in place. A follow-up audit will be conducted to verify that QA procedures are maintained throughout the sampling.

An external audits will be conducted by U.S. EPA Region 5 Central Regional Laboratory (CRL) and/or Central District Office (CDO).

10.2 Laboratory Audits

Each CLP laboratory quality assurance director will perform their own internal quality control audits.

The U.S. EPA EMSL-Las Vegas conducts the external audits of the CLP laboratories on an annual basis. The external audits will include, at a minimum, examination of laboratory documentation on sample receiving, sample log-in, sample storage, chain of custody procedure, sample preparation and analysis, and instrument operating records.

The CLP also requires, on a quarterly basis, the analysis of performance samples. These performance audits consist of sending performance evaluation (PE) samples to the CLP laboratories for on-going assessment of laboratory precision and accuracy. The analytical results of the analysis of PE samples are evaluated by EPA to ensure the laboratory maintain a good performance.

Additional audits of the SAS laboratories may be conducted by the U.S. EPA Region 5 CRL.

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12.0 Specific Routine Procedures to Assess Data Precision, Accuracy, and Completeness

12.1 Field Measurements

Field data will be assessed by the Field Team Leader. The Field Team Leader will review the field results for compliance with the established QC criteria that are specified in the QAPjP and FSP. Accuracy of the field measurements will be assessed using daily instrument calibration, calibration check, and analysis of blanks (equation 12-2). Precision will be assessed on the basis of reproducibility by multiple reading of a single sample using equation 12-1. Data completeness will be calculated at the end of the field effort using Equation 12-3.

12.2 Laboratory Data

Laboratory results will be assessed for compliance with required precision, accuracy, completeness and sensitivity as follows:

12.2.1 Precision

Precision of laboratory analysis will be assessed by comparing the analytical results between MS/MSD for organic analysis, and laboratory duplicate analyses for inorganic analysis. The relative percent difference (%RPD) will be calculated for each pair of duplicate analysis using the Equation 12-1:

Eq. 12-1

$$\%RPD = \frac{S - D}{(S + D)/2} \times 100$$

Where: S = First sample value (original or MS value)
D = Second sample value (duplicate or MSD value)

12.2.2 Accuracy

Accuracy of laboratory results will be assessed for compliance with the established QC criteria that are described in Section 3 of the QAPjP using the analytical results of method blanks, reagent/preparation blank, MS, MS/MSD, surrogate recoveries, internal standards, field blank, and trip blanks. The percent recovery (%R) of matrix spike samples will be calculated using Equation 12-2:

Eq. 12-2 $$\%R = \frac{A - B}{C} \times 100$$

Where:

A = The analyte concentration determined experimentally from the spiked sample;

B = The background level determined by a separate analysis of the unspiked sample and;

C = The amount of the spike added.

12.2.3 Completeness

The data completeness of laboratory analyses results will be assessed against the established completion objective of 95 percent. The completeness is calculated using Equation 12-3:

Eq. 12-3 $$\text{Completeness} = \frac{\text{Number of Valid Data Obtained}}{\text{Number of Sample collected for each parameter analyzed}} \times 100$$

12.2.4 Sensitivity

The achievement of method detection limits depends on instrumental sensitivity and matrix effects. It is important to monitor the instrumental sensitivity to ensure the data quality through constant instrument performance. The instrumental sensitivity will be monitored through the analysis of method and instrument blanks, calibration check samples, and laboratory control samples.

11.0 Preventive Maintenance Procedures

11.1 Field Equipment and Instruments

The field equipment for this project includes thermometers, pH meter, conductivity meter and a HNu. Specific preventive maintenance procedures to be followed for field equipment are those recommended by the manufacturer.

Field instruments will be checked and calibrated in the Warehouse before they are delivered to the field. These instruments will be checked and calibrated daily before use.

Critical spare parts such as tape, paper, pH probes, electrodes and batteries will be kept on-site to minimize instrument down time. Backup instruments and equipment will be available within one-day to avoid delays in the field schedule.

11.2 Laboratory Instruments

The laboratories participating in the CLP are required under the CLP RAS SOW (OLM01.1) for organics and SOW (ILM01.0) for inorganics, to have SOPs on preventive maintenance for each measurement system and required support activity. All maintenance activities are required to be documented in log books to provide a history of maintenance records.

13.0 Corrective Actions

Corrective actions may be required for two classes of problems: analytical and equipment problems and noncompliance problems. Analytical and equipment problems may occur during sampling and sample handling, sample preparation, laboratory instrumental analysis, and data review.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the RPM. If the problem is analytical in nature, information on these problems will be promptly communicated to the U.S. EPA, Quality Assurance Section. Implementation of corrective action will be confirmed in writing through the same channels.

Any nonconformance with the established quality control procedures in the QAPjP or FSP will be identified and corrected in accordance with the QAPjP. The U.S. EPA, RPM or his designee will issue a Nonconformance Report for each nonconformance condition.

No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by a stop-work order by the RPM.

13.1 Sample Collection/Field Measurements

Technical staff and project personnel will be responsible for reporting all suspected technical or QA nonconformances or suspected deficiencies of any activity or issued document by reporting the situation to the Field Team Leader or designee. The Field Leader, in consultation with the Project QA Manager, will be responsible for assessing the suspected problems and making a decision on the potential for the situation to impact the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the Field Team Leader.

The Field Team Leader will be responsible for ensuring that corrective action for nonconformances are initiated by:

- Evaluating all reported nonconformances
- Controlling additional work on nonconforming items

- Determining disposition or action to be taken
- Maintaining a log of nonconformances
- Reviewing nonconformance reports and corrective actions taken
- Ensuring nonconformance reports are included in the final site documentation in project files

If appropriate, the Field Team Leader will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include, but will not be limited to:

- Repeat the measurement to check the error
- Check for all proper adjustments for ambient conditions such as temperature
- Check the batteries
- Check the calibration
- Re-Calibration
- Replace the instrument or measurement devices
- Stop work (if necessary)

The Field Team Leader or their designee is responsible for all site activities. In this role, the Field Team Leader at times is required to adjust the site programs to accommodate site specific needs. When it becomes necessary to modify a program, the responsible person notifies the PM of the anticipated change and implements the necessary changes after obtaining the approval of the RPM.

The Field Team Leader for the Carter-Lee Lumber site is responsible for the controlling, tracking, and implementation of the identified changes. Reports on all changes will be distributed to all affected parties which include the U.S. EPA RPM. The RPM will be notified whenever program changes in the field are made.

13.2 Laboratory Analyses

13.2.1 Laboratory Corrective Actions—CLP RASs

For the CLP RAS, Corrective action is implemented at several different levels. The laboratories participating in the CLP are required to have a written SOP specifying corrective action to be taken when an analytical error is discovered or the analytical system is determined to be out of control. The SOP requires documentation of the corrective action and notification by the analyst about the errors and corrective procedures.

The Sample Management Office also may request corrective action for any contractual nonconformance identified by audits or data validation. The CRL may request corrective action by the laboratories for any nonconformances identified in the data validation process through the Sample Management Office or, for minor problems, the lab may be contacted directly. Corrective action may include:

- Re-analyzing the samples, if holding time criteria permits
- Resampling and analyzing, and/or
- Evaluating and amending sampling procedures and/or Evaluating and amending analytical procedures
- Accepting data and acknowledging the level of uncertainty

If resampling is deemed necessary due to laboratory problems, RPM must identify the necessary approach including cost recovery from the CLP for the additional sampling effort.

13.2.2 Laboratory Corrective Actions—SASs

For Special Analytical Services (SASs) requests, corrective actions will be implemented according to the procedure described in the previous paragraph, Section 13.2.

13.2.3 Laboratory Corrective Action—QTMs

The laboratories participating in the QTM are required to follow corrective action described in the draft SOW for quick turnaround analysis, dated March 1992.

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14.0 Quality Assurance Reports to Management

In addition to the audit reports submitted to the site manager in accordance with QAPjP Section 12, a monthly progress report is submitted to the EPA RPM, and CH2M HILL's management which addresses all Quality Assurance issues. The final RI and FS report will contain a QA section that summarizes the data quality information collected during the project. The contents of the reports include, but will not be limited to:

- Performance and system audits conducted during the field sampling event
- Data validation narrative summary and data quality assessment
- QA problems and corrective action
- Qualified data summarized in a tabular format

APPENDIX A
FIELD SAMPLING PLAN

Appendix A
Field Sampling Plan

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Appendix A

Field Sampling Plan

1.0 Summary of Sampling Activity

A phased investigative approach will be used in the RI because only limited data are available from a previous field investigation and because the actual level of risk associated with the site has not been clearly established. The object of the first phase will be to determine if potential exposure to contaminants at the site presents potential risk to public health or the environment and whether that potential risk exceeds the U.S. EPA point of departure for acceptability. If past disposal activities at the site contribute to potential exposures and result in unacceptable risks caused by soil or groundwater contaminants, a second phase of field work will be performed. The objects of Phase 2 will be to determine the extent of contamination identified in Phase 1 and to quantify risks attributable to the site.

The Phase 1 investigation will consist of the following:

- Surface soil sampling to evaluate background contaminant concentrations and contaminant concentrations in the drainage ways
- Subsurface soil sampling within the following areas of reported disposal:
  - Area of suspected waste pickle liquor disposal
  - Area of red soil stockpile
  - Trench where site debris and potentially hazardous substances were disposed of
  - Area where the stockpiled red soil was spread and covered
  - Area where eroded site soil may accumulate and where railroad car dumping most likely would have occurred
- Installation and sampling of shallow monitoring wells
- Measurement of groundwater elevations

Soil samples will be analyzed for full Target Compound List (TCL) organic compounds and Target Analyte List (TAL) inorganic chemicals. A limited number of samples will be analyzed for total organic carbon (TOC) and cation exchange capacity (CEC). These samples will also be held for possible analysis of additional soil physical characteristics to be performed if a Phase 2 investigation is deemed necessary. Groundwater samples will be analyzed for the full TAL and TCL. Metals samples will be field filtered.

Background soil and groundwater analytical data from the Phase 1 investigation will be qualitatively and statistically evaluated to determine whether a Phase 2 investigation is necessary. During the evaluation, outliers in the Phase 1 data set will be eliminated. The upper 95 percent confidence interval (CI) of the mean will be calculated using the remaining data set. The onsite data will then be compared to the upper 95 percent CI. If the concentration of an onsite constituent falls below the upper 95 percent CI, it will be concluded that the constituent does not exceed its background concentration. The following factors will be considered during the preliminary evaluation of the need for a Phase 2 investigation:

- Background contaminant concentrations versus site contaminant concentrations using the upper 95-percent confidence level

- Soil ingestion criteria based on target numbers for 10^{-6} risk and a Hazard Index of 1

- Leachability of soil contaminants and potential effect on groundwater

- Drinking water MCLs and water ingestion criteria (again based on target numbers for 10^{-6} risk and a Hazard Index of 1)

Findings of the Phase 1 investigation will be reviewed with the EPA. The EPA will decide either to proceed with a Phase 2 field investigation or to prepare the RI Report, including a quantitative risk assessment, based solely on Phase 1 data. Potential Phase 2 work may include:

- Site mapping
- Additional surface and subsurface soil sampling
- Installation of shallow, intermediate, and deep monitoring wells
- Groundwater sampling
- Measurement of groundwater elevations

2.0 Sample Network Design and Rationale

This section presents the sample network by task and matrix, site maps showing sample locations, and the rationale for the selected sampling locations. A summary of the sample network is provided in Table A-1.

2.1 Sample Network by Task and Matrix, Site Maps, and Rationales of Selected Sampling Locations

2.1.1 Phase 1 Field Investigation

The specific objectives of the Phase 1 field investigation are:

- To establish background concentrations of contaminants in the soil and the groundwater
- To determine whether hazardous substances are present in soil and groundwater at concentrations above background or at concentrations that could pose unacceptable risks to public health or the environment

2.1.1.1 Background Soil Sampling

Background

To establish background concentrations of contaminants in the soil, soil samples will be collected from the site perimeter locations shown in Figure A-1 (locations BK-1 to BK-6). Samples will be collected from the upper 6 inches at locations BK-1 to BK-5 using a hand auger. At BK-6, two soil samples will be collected—one each at depths of 10 and 20 feet. This location is adjacent to Reichwein Avenue and is relatively uninfluenced by urban industrial settings. The boring will be logged on 5-foot intervals or changes in soil lithology (whichever is smaller) and sampled using a 2-foot-long, 3-inch O.D. split-spoon sampler. The background soil samples will be screened in the field for VOCs using an HNu or an organic vapor analyzer (OVA). Samples with elevated organic vapors will not be used for background characterization because the location may be contaminated from an isolated source not related to ubiquitous urban contamination. The samples will be analyzed for full TCL organic compounds and TAL inorganic chemicals on a quick turnaround basis. The results will be compared to onsite soil concentrations. Ten additional background samples to be selected in the field will also be obtained and stored pending results from the BK samples. If the relative differences in concentrations

Table A-1
Carter-Lee Lumber RI Sampling Program Elements for Chemical Analysis

TASK	Soil Borings		Soil Sampling				Groundwater Sampling				
				TAL and TCL Analysis				Monitoring Wells TAL and TCL Analy.			
	Locations	Boring Depth (ft.)	Sample Intervals (ft.)	Quick Turnaround Samples	CLP Samples	Additional Soil Param.(a)	Groundwater Grab Quick Turnaround Analysis	Quick Turnaround Analysis(b)	Round 2 CLP RAS Analysis(b)	Total MW Samples	Transport & Treatment Parameters Samples(c)
TASK F0—PHASE 1 FIELD INVESTIGATION											
FS—Source Characterization											
Water table soil borings	4	25	0-2,TBD,WT	12			4				
Shallow soil borings	7	4	0-2, 2-4	11							
Drainage-way	2	1	0-0.5, 0.5-1	4							
Background	6	0.5 to 25	0-0.5,10,20	7							
Hydrogeologic Investigation											
Downgradient MWs	3	35						3		3	
Upgradient MWs	2	35						2		2	
TASK F2—PHASE 2 FIELD INVESTIGATION											
FS—Source Characterization											
Shallow Soil Borings	10	2.5	1-1.5,1.5-2,2-2.5		30	6					
Drainage-way	6	0.5	0-0.5		6	3					
Schaffer garden, composite	3	0.75	0- 0.75		1						
FQ—Hydrogeologic Investigation											
Deep MWs	4	150					4		4	4	4
Intermediate MWs	4	75					4	1	5	6	4
Shallow MWs	10	35					10	4	14	18	10
Phase 1 MW Re-sampling									5	5	5
Total Samples				34	37	9	22	10	28	38	23

TBD—To be determined based on visual appearance and screening
WT—Water table
a. Additional soil parameters include TOC and cation exchange capacity for phase 1 samples. Phase 2 analysis is for: TCLP, grain size, Atterberg limits, porosity, percent moisture, and density.
b. Phase 2 investigation includes sampling of 4 shallow and 1 intermediate monitoring wells on the WABCO site south of the Carter-Lee Lumber site.
c. Groundwater transport and treatment parameters include: TOC, COD, TSS, TDS, *chloride, alkalinity, and hardness.*

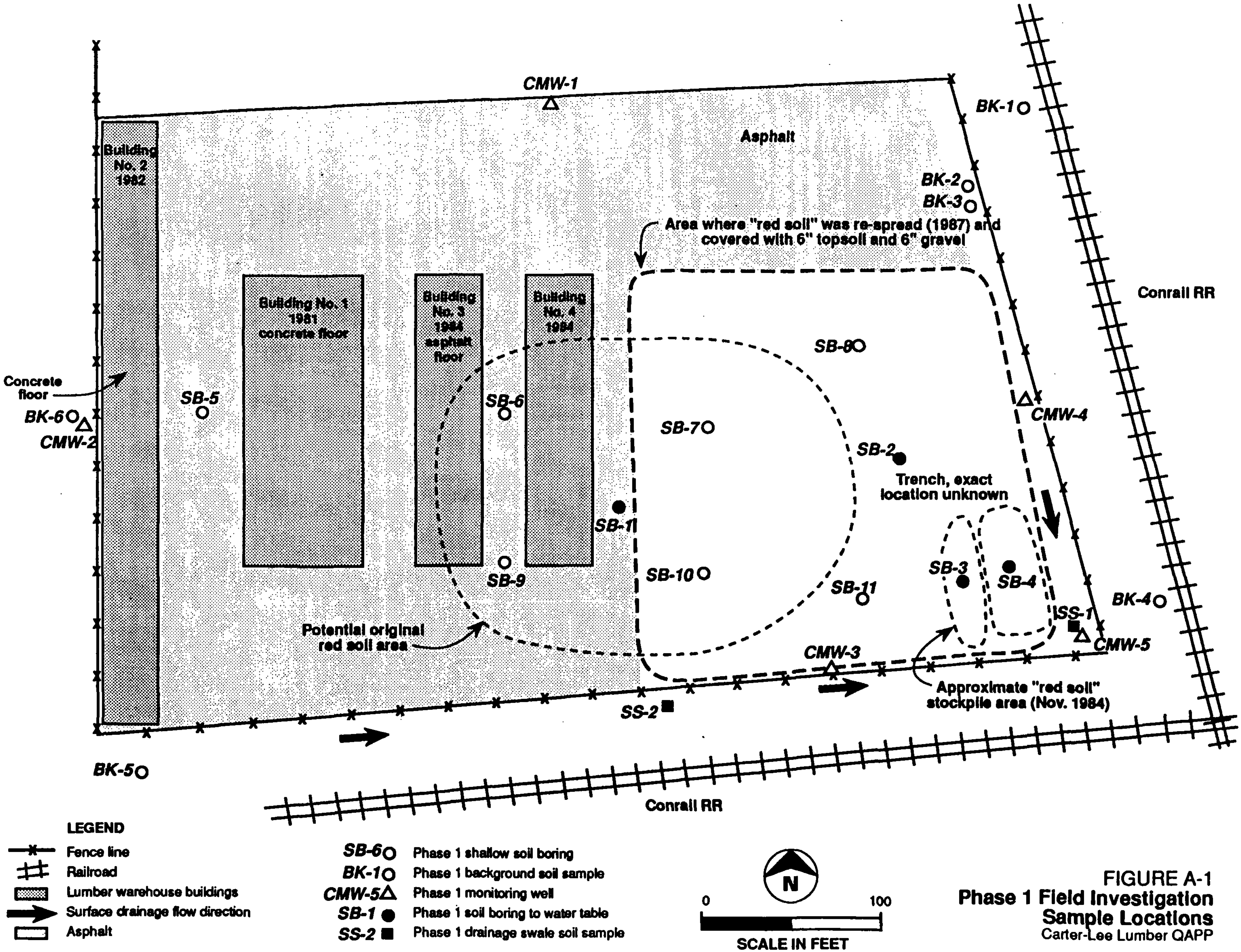


FIGURE A-1
Phase 1 Field Investigation Sample Locations
Carter-Lee Lumber QAPP

between background and onsite samples is small, those ten samples may also be analyzed.

Onsite

To determine whether hazardous substances are present in the soil at concentrations above background levels, soil sampling will be performed in the following onsite areas:

- Area of suspected waste pickle liquor disposal
- Area of red soil stockpile
- Trench where site debris and potentially hazardous substances were disposed of
- Area where the stockpiled red soil was spread and covered
- Area where eroded site soil may accumulate and where railroad car dumping most likely would have occurred

Proposed soil boring locations are shown in Figure A-1. Soil samples will be screened for VOCs in the field using an HNu or OVA.

Four of the soil borings (SB-1 to SB-4) will be drilled to the water table to evaluate the vertical extent of soil contamination in the areas of concern. Based on regional hydrogeologic data, the water table is estimated to be about 25 feet below the ground surface. The borings will be drilled and sampled using hollow-stem auger drilling techniques and a standard 3-inch O.D. split-spoon sampler. The borings will be logged on 5-foot intervals or changes in lithology. At each of the four borings, three soil samples will be selected for full Target Compound List (TCL) analyses and Target Analyte List (TAL) analyses from the following depths: (1) one from the upper 2 feet, (2) one discretionary sample from 2 to 10 feet based on visual appearance and HNu/OVA screening, and (3) one from the water table surface. Up to six soil samples will be collected and analyzed for total organic carbon (TOC) and cation exchange capacity (CEC). The samples will also be held for possible analysis of the following additional soil physical characteristic parameters if a Phase 2 investigation is deemed necessary:

- Grain size

- Atterberg limits
- Porosity
- Percent moisture
- Density

The above physical soil parameters are important for the evaluation of contaminant transport and soil remediation alternatives.

Seven shallow borings will be drilled to evaluate the distribution of contamination across the site (SB-5 to SB-11). Because the suspected contaminants are primarily metals and PAHs that would not be expected to migrate downward, these borings will be drilled to a depth of 4 feet. The borings will be sampled and logged on 2-foot intervals. One or two soil samples per boring will be selected for chemical analysis based on visual appearance and HNu/OVA screening. A total of 11 soil samples will be collected from the 7 shallow soil borings. Samples will be composites of the 2-foot interval unless the visual appearance or HNu/OVA screening indicates a potential for concentrated contamination. In that case, the sample will be composited over the interval of suspected elevated concentrations. The soil samples will be analyzed for full TCL organic compounds and TAL inorganic chemicals.

The potential for overland migration of site contaminants in surface runoff will be investigated at two locations in the drainage swales running parallel to the eastern and southern site boundaries (SS-1 and SS-2; see Figure A-1). Two soil samples will be collected at each location from the following intervals: the 0- to 6-inch interval and the 6- to 12-inch interval. The samples will be analyzed at the CLP for the full TAL and TCL.

2.1.1.2 Hydrogeologic Investigation.

Groundwater Grab Sampling.

To provide data on potential groundwater contamination, one grab sample will be collected from each of the following soil boring locations SB-1, SB-2, SB-3, and SB-4. The grab samples will be collected from within the hollow-stem auger at a depth of several feet below the water table. The groundwater samples will be analyzed at the CLP for the full TAL and TCL. Metal samples will be field filtered with 2.0 μm filter paper to remove suspended solids. Filtered metals will be analyzed because the high amounts of suspended particles of native soil may bias the results.

Monitoring Well Installation/Groundwater Sampling.

To define potentiometric relationships in the vicinity of the site and to determine whether groundwater is contaminated, five shallow monitoring wells will be installed at the locations shown in Figure A-1. The rationale for each location is as follows:

- CMW1 and CMW2 are assumed to be upgradient of the site.
- CMW3 and CMW4 are assumed to be downgradient of areas where the red soil was originally disposed of.
- CMW5 is assumed to be downgradient of the stockpile area and trench and within the surface runoff seepage area.

CMW1, CMW2, and CMW5 will be installed and surveyed, and water elevations will be measured before installation of the remaining two monitoring wells to allow optimal placement of the wells downgradient of possible sources.

The boreholes for the monitoring wells will be advanced using hollow-stem augers. If alternative drilling methods are required, only methods using clear water, air, or cable tool will be considered. Monitoring wells will be constructed of 2-inch-diameter PVC with factory slotted 10- to 15-foot screens. The wells will be installed so that the screened interval will intersect the water table. Each well will have a minimum 2-foot stickup with a 4- or 6-inch-diameter protective steel casing with locking cap. A concrete apron will be installed to promote runoff. Wells will be surrounded by three concrete filled, 4-inch-diameter guard posts. In traffic areas, monitoring wells will be flush mounted.

Following installation, each monitoring well will be developed until substantially free of sediment and until pH and conductivity are stable to the satisfaction of the CH2M HILL hydrogeologist. Wells will be developed using either the double tube air lift or surge-and-bail methods. It is assumed that well development water and purge water will be discharged to the Indianapolis Wastewater Treatment Plant sewer system.

All new monitoring wells will be surveyed by a local, subcontracted surveyor to establish the horizontal location and elevation of the measuring points. Elevation measurements will be taken on the riser pipe with the measuring point designated by a chisel mark. All elevations will be referenced to a bench mark established at the site. Vertical elevations of measuring points will be made to the nearest 0.01 foot.

All wells will be located horizontally to within ± 5 feet. Water levels will be collected once during Phase 1.

Groundwater samples will be collected from each of the newly installed monitoring wells about 24 hours following installation. Prior to groundwater sampling, groundwater levels will be measured and the wells will be purged to remove stagnant water and stratified contaminants. Metal samples will be field filtered. Monitoring well sampling procedures are described in detail in Section 7.0. Groundwater samples will be analyzed for the full TAL and TCL.

A summary table of the sample network is provided in Table A-1.

2.1.2 Phase 2 Field Investigation

Whether a Phase 2 investigation is necessary will be determined based on the evaluation of the data from the fast turnaround analyses of Phase 1 samples. The specific objectives of the Phase 2 field investigation are:

- To generate a topographic survey and base map of the Carter-Lee Lumber site
- To determine the extent of soil contamination
- To confirm or refine the conceptual model of the subsurface stratigraphic relationships
- To delineate the horizontal and vertical extent of groundwater contamination
- To estimate the risks to public health and the environment posed by site contamination

2.1.2.1 Site Mapping.

To generate a base map of the site, an aerial topographic survey of the site and surrounding area will be conducted and field checked by a ground survey crew. The site topographic map covering 4 acres of the site and immediate surrounding area will consist of contour lines on 1-foot intervals and use a scale of 1 inch = 50 feet. Significant features of the site will be identified on the map, including lumber buildings, asphalt and gravel areas, fencing, railroads to the south and east of the site, soil sampling locations, and monitoring well locations.

2.1.2.2 Soil Sampling.

To determine the extent of soil contamination, soil samples will be collected from the locations described below.

Ten shallow soil borings (SB2-1 to SB2-10) will be advanced to depths of about 2.5 feet across the site (Figure A-2) to determine the extent of contamination from the suspected disposal of spent and neutralized sulfuric acid pickle liquor. The borings will be advanced and soil samples collected using a hand auger. It is assumed that two soil samples will be collected from each boring for full TCL and TAL analyses. The actual analysis of soil samples will depend on the results of Phase 1. Selected soil samples will be analyzed for the following physical soil parameters that are important to evaluation of contaminant transport and soil remediation alternatives:

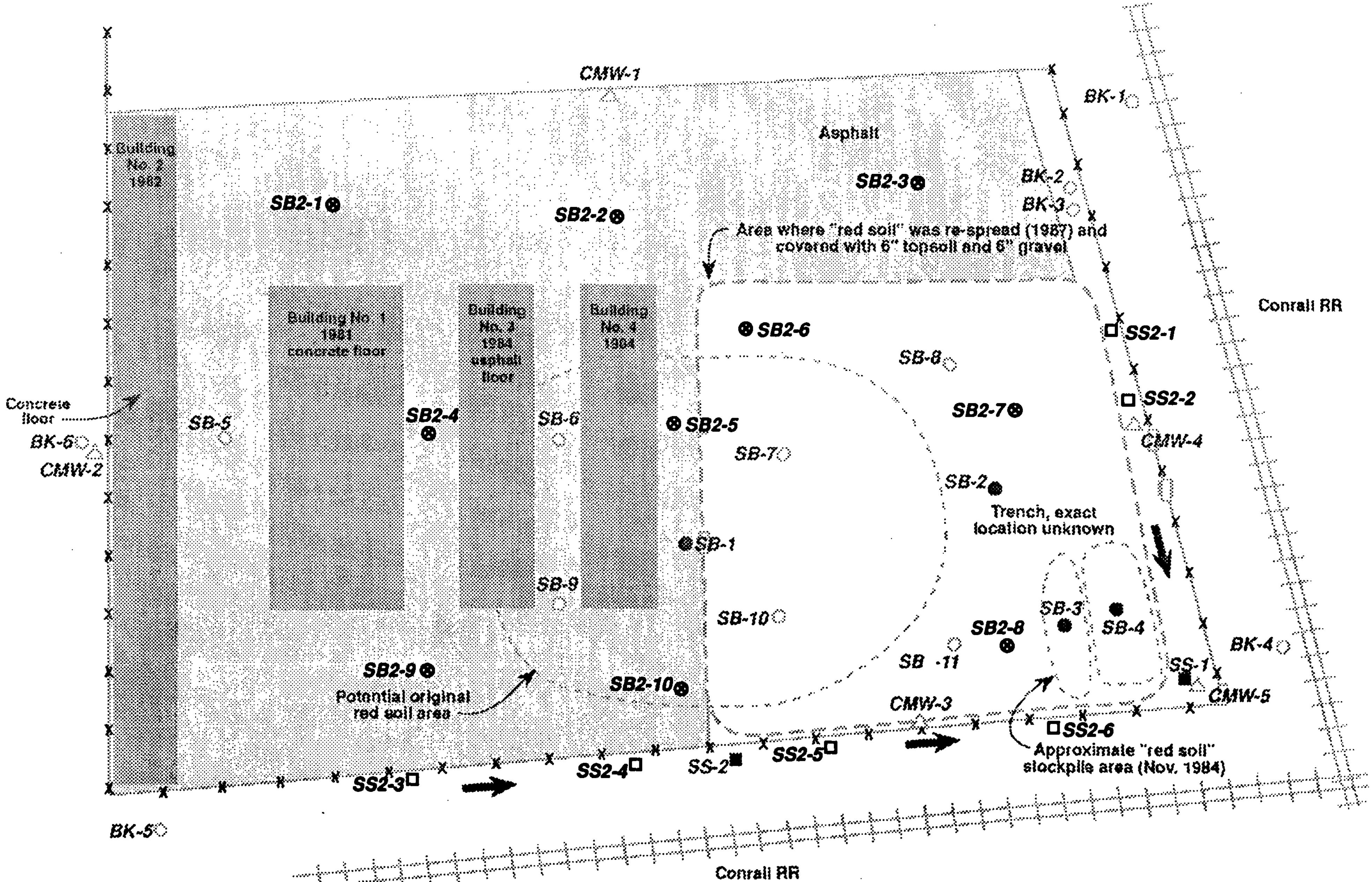
- Grain size
- Atterberg limits
- Porosity
- Percent moisture
- Density
- TOC
- Cation exchange capacity

In addition, TCLP organic and inorganic analysis of up to nine samples will be performed if Phase 1 sample results indicate that contaminants are present in concentrations that may leach to groundwater.

Six additional shallow soil samples (SS2-1 to SS2-6) will be collected along the eastern and southern drainage swales (Figure A-2) at assumed depths of 6-inches to identify the extent of soil contaminated from surface runoff.

Three locations in [redacted] garden (depth of 8 inches) will be sampled and composited for organic TCL (excluding VOCs) and inorganic TAL analyses. One of the three locations will be selected for analysis for VOCs based on HNu screening or visual appearance.

GLO65618.PP.QS PHASE 2 FIELD INVEST 6-11-92 vls



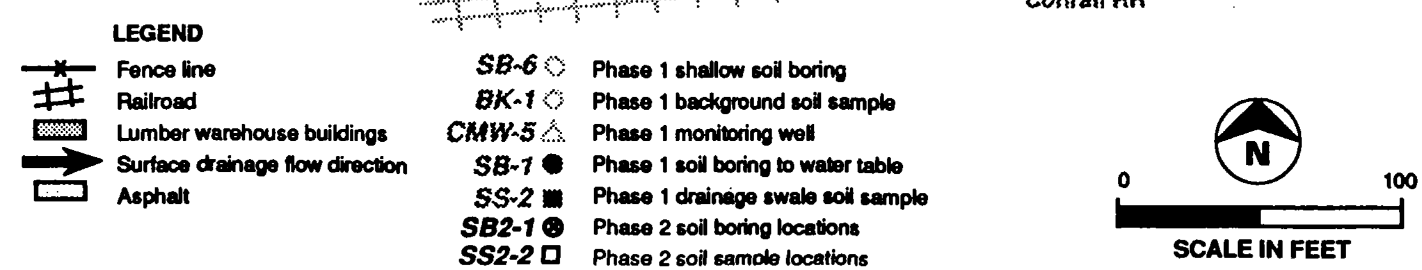


FIGURE A-2
Phase 2 Field Investigation Soil Sample Locations
Carter-Lee Lumber QAPP

2.1.2.3 Hydrogeologic Investigation.

The object of the Phase 2 hydrogeologic investigation is to confirm or refine the conceptual model of the subsurface stratigraphic relationships, to delineate the horizontal and vertical extent of groundwater contamination, and to estimate risks to public health and the environment. This object will be met through the drilling of additional soil borings, groundwater grab sampling in each boring, quick turnaround method (QTM) analysis (1 to 2 days), and monitoring well installation and sampling. Based on Phase 1 analytical results, the contaminants analyzed under QTM may be reduced. The location of initial Phase 2 borings and monitoring wells will not be identified until Phase 1 results are known. Subsequent Phase 2 sampling locations will depend on the evaluation of stratigraphic information and results of quick turnaround analysis of groundwater grab samples from the initial borings. The number of borings and monitoring wells needed was estimated based on experience at other similar sites and on professional judgment. The scope of the Phase 2 investigation also assumes that hazardous substances, in addition to the spent sulfuric acid, have been disposed of onsite. The major elements of the Phase 2 hydrogeologic investigation are:

- Four deep soil borings (assumed depth of 150 feet) will be sampled and logged for soil classification on 5-foot intervals or changes in soil lithology. Two borings will be located upgradient of the site. Deep (150 feet), intermediate (75 feet), and shallow (35 feet) monitoring wells will be installed at each location.

- Six shallow soil borings (assumed depth of 35 feet) will be sampled and logged as described above. Water table monitoring wells will be installed in each boring.

- Groundwater grab samples will be collected for quick turnaround analyses from below the lead auger at each monitoring well location.

- Four shallow and one intermediate FIT-installed monitoring wells will be sampled at the Westinghouse Air Brake Company site, and samples will be analyzed for the full TAL and TCL.

- The 18 Phase 2 and 5 Phase 1 monitoring wells will be sampled, and samples will be analyzed at the CLP for the full TAL, TCL, and transport and treatment parameters listed below:

- TOC
- COD
- TSS
- TDS
- Chloride
- Alkalinity
- Hardness

- Monitoring well groundwater elevations will be measured monthly for 4 months.

The Phase 2 sample network is summarized in Table A-1.

3.0 Sample Custody Procedures

3.1 Sample Identification System

The sample identification system to be employed during the Carter-Lee Lumber RI is described in the Data Records section of the Data Management Plan, Appendix B.

3.2 Initiation of Field Custody Procedures

It is U.S. EPA and Region 5 Policy to follow the U.S. EPA Region 5 sample custody, or chain of custody protocols as described in *NEIC Policies and Procedures, EPA-330/9-78-DDI-R*, Revised June 1985. These custody procedures are described in Section 5.0.

3.3 Field Activity Documentation/Logbook

Field logbooks will be used as the means of recording data collecting activities. Logbook entries will be in as much detail as possible so that persons going to the site could re-construct a particular situation without reliance on memory.

Entries into the logbooks will contain a variety of information. The date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be logged at the beginning of each account. Examples of other information to be included in the logbook include:

- Measurements made and samples collected
- Detailed description of the location of the station including compass and distance measurements
- All equipment used to make measurements will be identified, along with the date of calibration
- The number of the photographs taken of a station, if any, will also be noted

All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark.

3.4 Sample Shipment and Transfer of custody

Sample documentation and shipping procedures are explained in full detail in Appendix G. Transfer of custody procedures are explained in Section 5.1.3.

4.0 Sample Container Preparation, Sample Preservation, and Maximum Holding Time

Table A-2 contains information on sample bottle types, preservatives, and sample holding times. Certified precleaned sample bottles will be procured and used for this project.

5.0 Sample Handling, Packaging, and Shipment

Sample handling and shipping procedures are explained in full detail in Appendix G.

6.0 Decontamination Procedures

This section provides the general guidelines for the decontamination of personnel, sampling and monitoring equipment, and sample bottles.

The following equipment will be needed onsite:

TABLE A -2
SAMPLE TYPES, BOTTLES, AND PRESERVATIVES
CARTER-LEE LUMBER

Sample Type	Analysis	Bottles	Preservation	Holding Time (turnaround time may vary)
Water				
	RAS Organics			
	- Extractables, Pesticides/PCBs	Two 80-oz amber glass bottles (Teflon lined-caps)	Iced to 4 C	5 days for extraction 40 days for analysis
	- Volatiles	Two 40-ml septum cap vials	HCl to pH<2 Iced to 4 C	10 days
	RAS Inorganics			
	- Metals	One 1-liter polyethylene bottle	HNO3 to pH <2,	6 months (mercury: 28 days)
	- Cyanide	One 1-liter polyethylene bottle	NaOH to pH>12 Iced to 4 C	6 months
	QTM Organics			
	- Extractables	One 80-oz amber glass bottle	Iced to 4 C	(Turnaround time: 48 hours)
	- Volatiles	Two 40-ml septum cap vial	Iced to 4 C	(Turnaround time: 48 hours)
	SAS Methods			
	- COD, TOC - Hardness	One 1-liter polyethylene bottle	H2SO4 to pH <2, Iced to 4 C	28 days 6 months
	- Alkalinity - Chloride	One 1-liter polyethylene bottle	Iced to 4 C	14 days 28 days
	- TSS	One 1-liter polyethylene bottle	Iced to 4 C	7 days

Note: Water samples for organic matrix spike/matrix spike duplicate analyses must be collected at double the specified volume for extractables and triple the specified volume of volatiles. No extra volume is required for inorganic analyses.

TABLE A-2
SAMPLE TYPES, BOTTLES, AND PRESERVATIVES
CARTER-LEE LUMBER

Sample Type	Analysis	Bottles	Preservation	Holding Time (turnaround time may vary)
Soil				
	RAS Organics			
	- Extractables, Pesticides/PCBs	One 8-oz wide mouth glass jar	Iced to 4 C	Extract within 10 days Analyze within 40 days
	- Volatiles	Two 120-ml wide mouth glass vials	Iced to 4 C	Extract within 10 days Analyze within 10 days
	RAS Inorganics			
	- Metals	One 8-oz wide mouth glass jar	Iced to 4 C	6 months (mercury: 28 days)
	- Cyanide	One 8-oz wide mouth glass jar	None required	14 days
	SAS Methods			
	- TOC	One 4-oz wide mouth glass jar	None required	28 days
	- Cation Exchange	One 4-oz wide mouth glass jar	None required	—
	- TCLP	One 32-oz amber wide mouth glass jar	None required	Extract within 7 days Analyze within 40 days
	- Grain Size - Atterberg Limits - Porosity - %Moisture - Density	One 32-oz wide mouth glass jar	None required	28 days

Note: No extra volume is required for soil matrix spike/matrix spike duplicate analyses.

- Demonstrated analyte-free deionized (DI) water
- Distilled water
- 2.5 percent (W/W) trisodium phosphate (TSP) and water solution
- 10 percent (V/V) methanol or isopropanol and water solution (DO NOT USE ACETONE.)
- 10 percent (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

Key items to be noted:

- Clean with solutions of TSP, methanol (or isopropanol) and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate sample bottles before relinquishing them to anyone.

6.1 Personnel

The following procedures are to be performed after completion of tasks whenever the potential for contamination exists, and upon leaving the contaminated area. Some of the following procedures are for equipment not anticipated to be used at the Carter-Lee Lumber site, but are included in case hazardous materials are encountered and a increase in personnel protective equipment is required.

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.

2. Wash outer gloves in TSP solution, rinse, remove, and discard.

3. Remove disposable coveralls ("Tyveks") and discard.

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).

6.2 Sample Bottles

Sample bottles or containers filled in the field must be decontaminated before being packed for shipment or handled by personnel without dermal hand protection as follows:

1. Wipe container with a paper towel dampened with TSP solution.

2. Wipe container with a paper towel dampened with potable water.

6.3 Sampling and Monitoring Equipment

6.3.1 Field Equipment Decontamination

1. Wash all equipment surfaces that contacted potentially contaminated soil or water with TSP solution.

2. Rinse with potable water.

3. Rinse with 10 percent HNO_3 solution when sampling for inorganic chemicals. (The split spoons will be rinsed with a 1 percent solution).

4. Rinse with methanol solution (DO NOT USE ACETONE) and air dry.

5. Rinse with distilled water and air dry.

6. Collect all rinsate and dispose in a DOT approved 55-gallon drum.

The split-barrel sampler will be decontaminated using the following procedure when chemical sampling is being performed:

1. Scrape soils from split spoon.
2. Wash split spoon in a 2.5 percent (W/W) solution of nonphosphate detergent (Liquinox or equivalent) in tap water.
3. Rinse with tap water.
4. Spray rinse with 10 percent isopropanol solution.
5. Spray rinse three times with distilled water.
6. Place on plastic and allow to air dry.

6.3.2 Monitoring Equipment Decontamination

1. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with TSP solution.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with methanol solution.
3. Wipe three times with a towel wet distilled water.
4. Dispose of all used paper towels in a DOT approved 55-gallon drum.

7.0 Sampling Equipment and Procedures

7.1 Groundwater Sampling Procedures

7.1.1 Monitoring Well Installation

Five monitoring wells will be installed as part of the Phase 1 Site Investigation. The well screens will intersect the water table. If a Phase 2 investigation is deemed necessary, it is estimated that 18 additional monitoring wells may be installed: four wells to bedrock, ten wells intersecting the water table, and four wells screened about halfway between the water table and the top of bedrock.

7.1.1.1 Drilling Equipment.

Phase 1 soil borings will be advanced using 4.25-inch I.D. hollow-stem augers. The lead auger will be fitted with a center plug, or stinger bit if needed, to minimize the effects of coring or sand heave into the center of the auger while advancing the boring. The center plug will be removed between successive drives of the split-spoon sampler. An alternative drilling method may be used for intermediate and deep soil borings during the Phase 2 investigation.

7.1.1.2 Well Construction Material.

The monitoring wells will be constructed of 2-inch-diameter, threaded, flush joint, schedule 40 PVC casing with O-ring joint seals. Each well will be fitted with a 10-foot length of 0.010-inch factory slotted screen. The screen length may need to be adjusted depending on field conditions.

The driller will introduce a filter pack into the annular space around the screened interval to a height about 2 feet above the top of the screen. Two feet of fine sand (Ottawa sand or equivalent) will be placed above the filter pack to inhibit migration of annular seal material into the filter pack. The depth of the filter pack will be accurately determined using a weighted tape or a rigid rod or small diameter rigid tube. The remaining annular space will be filled with a bentonite slurry introduced by the tremie method to within 5 feet of the ground surface. The well riser stickup above the ground surface will be at least 2 feet. A minimum 4-inch-diameter, locking steel protective casing will be placed and surrounded by concrete to a depth of at least 5 feet. The concrete will be mounded around the casing to promote surface water runoff. Wells will be surrounded by three concrete-filled, 4-inch-diameter guard posts. In traffic areas, monitoring wells will be flush mounted.

The drilling rig and all equipment, tools, and materials that have either entered the borehole or come into contact with potentially contaminated soils or water shall be steam cleaned before leaving the site.

7.1.1.3 Well Drilling and Development.

Boreholes for shallow monitoring wells will be advanced using 4.25-inch I.D. hollow-stem augers. Augers of this diameter allow sufficient annular space to construct a monitoring well. The monitoring well borings will be sampled and logged every 5 feet or at changes in lithology to obtain stratigraphic information. Upon reaching the target depth, the drill rods will be removed and the monitoring well installed. An alternate drilling method may be used for intermediate and deep boreholes during the Phase 2 investigation.

Following installation, the driller will develop the wells by pumping, bailing, or air lift methods and surging until the discharge is substantially free of sediment to the satisfaction of the hydrogeologist or until a constant rate of turbidity is achieved.

7.1.2 Sample Collection

Groundwater samples will be collected as part of the Carter-Lee Lumber RI. Groundwater grab samples will be collected from several soil borings. In addition monitoring wells installed during Phase 1 and 2 will be sampled.

7.1.2.1 Sampling Devices.

Either a stainless steel bailer or pump will be used to collect groundwater samples.

7.1.2.2 Water Level Measurements.

Groundwater level will be measured periodically throughout the RI to monitor changes in gradients over time. The groundwater level will also be measured before groundwater sampling. Water level measurements will be taken with an electric tape. The following procedure will be used to measure static water levels:

1. Lower the probe or electrode into the well by unreeling cable from the hand-held reel.

2. Continue lowering until the bulb lights, the beeper beeps, or the meter needle deflects, indicating that the water table has been reached.

3. Read measurements directly to the nearest 0.01-foot. The length of cable in the well from the top of casing or other reference point to the

probe (depth to the water table) will be subtracted from the measuring point elevation to determine the groundwater level elevation.

4. Decontaminate water level indicator equipment between wells.

*7.1.2.3 **Well Purging.***

Wells screened in low permeability formations (i.e., wells that can be purged dry):

1. Pump (or bail) the well dry.

2. Measure temperature, specific conductance, and pH while purging. These measurements will provide an indication of stable groundwater conditions.

3. Wait 15 minutes, allowing the well to recover after purging. If well recovers to 80 percent of its original level, then the sample team may begin sampling.

4. Collect the sample as soon as there is a sufficient volume of water for the intended analyses. It is not necessary to wait for the well to fully recover.

Wells screened in high permeability formations:

1. Remove five well volumes (calculate this volume as shown below).

$$V = (\pi \times r^2) H \times 5 \text{ well volumes} \times 7.48$$

Where:

V = Total volume of water needed to purge (gallons)

r = Inside radius of well (ft)
H = Height of water column in well (ft)
(depth to bottom of well minus depth to water)

2. Purge wells by pumping or bailing from as near the water surface as possible so that no stagnant water remains in the well above the well screen after purging.

3. Introduce as little air and turbulence into the formation as possible to prevent alteration of the samples.

7.1.2.4 Sample Field Filtration and Procedures.

1. Set up the filtering apparatus.

2. Place a 0.5-micron membrane filter on the apparatus (using tweezers). If the sample contains a lot of sediment as indicated by a leaking filtration apparatus or visual evidence, use a pre-filter to prevent clogging.

3. Flush a minimum of 500 mL of reagent grade water through the filtering apparatus before filtering the sample.

4. Pump the sample through the filter discarding the first 150 mL (if you have enough extra volume).

5. Collect the remaining volume of sample needed into sample containers.

6. Remove the filter membrane (and the pre-filter, if used) after the sample is collected and discard. **Do not reuse filter paper for another sample.**

7. Flush the filtering apparatus and tubing with a minimum of 500 mL of reagent grade water.

8. Reassemble the filtering apparatus.

7.1.2.5 Sampling Procedures.

Before Sampling.

1. Use a stainless steel bailer to collect the groundwater sample.

2. Withdraw samples shortly after purging (as soon as a volume of water sufficient for the intended analyses reenters the well).

3. Sample the least contaminated wells first, the more contaminated wells last (i.e., sample in increasing order of contamination). If the degree of contamination is unknown, sample the upgradient wells first, the downgradient wells last.

4. Withdraw samples from within or just above the screened section of the well.

Sampling with a Bailer.

1. Rinse the bailer and monofilament line with reagent grade water.

2. Place a large clean plastic bag or cloth on the ground around the well to prevent the bailer line from touching the ground.

3. Lower the bailer slowly and gently into the water in the well. Do not simply let the bailer fall free into the well while holding the end of the rope. Do not allow the bailer to touch the bottom of the well.

4. Lower the bailer to approximately the same depth in the well each time, preferably within or just above the screened interval.

5. Retrieve the bailer smoothly (do not allow the bailer rope to touch the ground). Empty the water in a slow steady stream in the following order, making sure to fill VOC vials first:

    a. Use a bottom discharging device to provide an unfiltered portion to fill sample containers for VOC analyses and screening (as necessary). Collect samples for VOCs from a bailer full of water as soon as it is brought to the surface.

       See below for special procedures to be followed when sampling for VOCs.

    b. Slowly pour an unfiltered portion of the sample into a sample container for the required in-field analyses. One person should perform the in-field analyses immediately while the other continues collecting samples for other analyses.

c. Slowly pour a portion into the sample containers for all other unfiltered analyses (as necessary). Preserve and cap quickly.

d. Slowly pour a portion of the sample into a transfer bottle for analyses requiring field filtering. Fill to the top to minimize aeration of the sample. Perform field filtering immediately. Draw the sample through the filter into the collection bottles. Preserve and cap immediately.

6. Decontaminate the bailer. Use new line for each well.

Sampling with a Pump.

1. Rinse the pump and associated apparatus with reagent grade water.

2. Position the pump inlet in the well such that water is removed from the same portion of the well each time, preferably within or just above the screened interval.

3. Set the discharge of the pump to slow rate.

4. Direct the sample into the containers in the same order as with a bailer:

   a. Use a bottom discharging device to provide an unfiltered portion to fill sample containers for VOC analyses and screening (as necessary). Collect samples for VOCs from a bailer full of water as soon as it is brought to the surface.

   See below for special procedures to be followed when sampling for VOCs.

   b. Slowly pour an unfiltered portion of the sample into a sample container for the required in-field analyses. One person should perform the in-field analyses immediately while the other continues collecting samples for other analyses.

c. Slowly pour a portion into the sample containers for all other unfiltered analyses (as necessary). Preserve and cap quickly.

d. Slowly pour a portion of the sample into a transfer bottle for analyses requiring field filtering. Fill to the top to minimize aeration of the sample. Perform field filtering immediately. Draw the sample through the filter into the collection bottles. Preserve and cap immediately.

Note: The tubing that comes into contact with the water should be coated with Teflon.

Groundwater Grab Sampling

Groundwater grab samples will be collected from the soil borings designated in Section 2.0. The grab samples will be collected by driving a 2-foot-long, 2-inch-diameter wellpoint or equivalent device about 3 feet into the formation ahead of the lead auger. The wellpoint will be evacuated of three casing volumes of water using a bailer or pump. The water level will be allowed to stabilize and a groundwater grab sample will be collected using a stainless steel bailer. The sample will be placed in bottles on ice in a cooler. The depth interval, date, and time of collection will be written on the label along with the boring number.

Special Procedures when Sampling for VOCs

1. Before sampling, 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, suntan lotion, and automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) Keep the caps off the sample vials for as short a time as possible.

2. Wear clean gloves (latex or surgical) when sampling for VOCs.

3. Use a bottom-emptying device when using a bailer to sample for VOCs.

4. Do not use a suction pump when sampling for VOCs. Do not filter samples collected for VOC analysis.

5. Keep the VOC sample bottles and the containers used for mailing the bottles tightly sealed to prevent possible contamination.

6. Two 40-mL vials with teflon septum tops should be filled.

7. Remove the cap ring from the first sample vial. Make sure that the Teflon liner does not fall out. If the liner falls out, replace it in the cap ring and flush the cap with reagent grade water.

8. 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 vial before filling.** Fill the sample vial, with a minimum of turbulence, until the water forms a positive meniscus at the brim. Allow the vial to overflow slightly.

9. Replace the cap quickly by gently setting it on the water meniscus. Tighten firmly, but **do not overtighten.** 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. If bubbles form in the sample, repeat the procedure until you obtain a proper sample.

10. Repeat this procedure for the second VOC sample.

7.2 Surface Soil Sampling Procedures

The method for surface soil sample collection is described below.

7.2.1 Sampling Devices

A hand auger or stainless steel trowel will be used to collect surface soil samples. Where the ground is compacted and hard, a pick or shovel may be used to break up the ground.

7.2.2 Sampling Procedures

A decontaminated stainless steel trowel will be used to scrape away surficial organic material (grass, leaves, etc.). Samples will be collected with the hand auger or trowel.

For VOC and semivolatile sampling, sample jars will be filled directly with the trowel and capped immediately upon filling. Samples for VOC analysis will be collected first, followed by samples for semivolatiles and all other parameters.

Where composite samples will be taken, the samples will be placed into a decontaminated steel pan and mixed using a decontaminated stainless steel utensil. The sample will be placed into appropriate containers for analysis with a decontaminated utensil. Samples to be analyzed for VOCs will not be composited because of the potential for VOC loss during sample homogenization.

7.3 Subsurface Soil Sampling Procedures

7.3.1 Sampling Devices

Soil borings will be sampled using 2-foot-long, 3-inch O.D. (2.5-inch I.D.) split-barrel samplers. The large diameter sampler will be used because it collects a larger volume of soil than the standard split-spoon sampler. This meets the volume quantity required for samples submitted for chemical analysis.

7.3.2 Sampling Procedures.

The split-spoon sampler will be driven its entire length using a 140-pound hammer freely falling a distance of 30 inches. Blow counts will be recorded on the boring log. Blow counts during 3-inch split spoon sampling will not give true standard penetration test blow counts because a 2-inch spoon would normally be used. After completing the drive, the sampler will be removed from the borehole and opened by the driller's assistant. The supervising hydrogeologist will examine the sample and its description will be logged.

The sample volume will be split between sampling containers and reserved for analytical testing. Samples to be collected from each boring are described in Section 2.0. Sample jars will be labeled as to boring number, depth of sampling interval, and time and date of sample collection. Samples will be stored in iced coolers pending selection and shipment.

7.3.3 Borehole Abandonment

Each soil boring that is not also a monitoring well borehole will be properly abandoned either by filling the hole with bentonite pellets or granules or by grouting from the bottom of the borehole to the ground surface using the tremie method.

8.0 Field Measurements/Screening

Standard operating procedures (SOPs) for the field measurement and screening techniques are provided in Appendix F.

9.0 Preventive Maintenance Procedures and Schedules

Field team members will refer to the field procedure SOP and/or the manufacturers' instrument manuals for the appropriate preventive maintenance procedures for the field equipment used at the site.

10.0 Sample Disposal

10.1 Soil

Cuttings or field screening samples shall be incorporated into the slurry backfill for the boring of origin.

10.2 Groundwater

Groundwater purged from a well prior to sampling and water aliquots taken for field sampling or screening will be contained onsite pending analytical results. If results show the groundwater is non-hazardous, the water will be discharged to the Indianapolis Wastewater Treatment Plant. If the water is hazardous, it will be managed as such per Indiana's Administrative Code for hazardous waste management.

Appendix A

Field Sampling Plan

1.0 Summary of Sampling Activity

A phased investigative approach will be used in the RI because only limited data are available from a previous field investigation and because the actual level of risk associated with the site has not been clearly established. The object of the first phase will be to determine if potential exposure to contaminants at the site presents potential risk to public health or the environment and whether that potential risk exceeds the U.S. EPA point of departure for acceptability. If past disposal activities at the site contribute to potential exposures and result in unacceptable risks caused by soil or groundwater contaminants, a second phase of field work will be performed. The objects of Phase 2 will be to determine the extent of contamination identified in Phase 1 and to quantify risks attributable to the site.

The Phase 1 investigation will consist of the following:

- Surface soil sampling to evaluate background contaminant concentrations and contaminant concentrations in the drainage ways
- Subsurface soil sampling within the following areas of reported disposal:
  - Area of suspected waste pickle liquor disposal
  - Area of red soil stockpile
  - Trench where site debris and potentially hazardous substances were disposed of
  - Area where the stockpiled red soil was spread and covered
  - Area where eroded site soil may accumulate and where railroad car dumping most likely would have occurred
- Installation and sampling of shallow monitoring wells
- Measurement of groundwater elevations

Soil samples will be analyzed for full Target Compound List (TCL) organic compounds and Target Analyte List (TAL) inorganic chemicals. A limited number of samples will be analyzed for total organic carbon (TOC) and cation exchange capacity (CEC). These samples will also be held for possible analysis of additional soil physical characteristics to be performed if a Phase 2 investigation is deemed necessary. Groundwater samples will be analyzed for the full TAL and TCL. Metals samples will be field filtered.

Soil and groundwater analytical data from the Phase 1 investigation will be qualitatively and statistically evaluated to determine whether a Phase 2 investigation is necessary. During the evaluation, outliers in the Phase 1 data set will be eliminated. Outliers will be identified through the use of a box plot, a non-parametric statistical method. A box plot is a graphical tool that identifies the median (50th percentile), the lower and upper quartiles (25th and 75th percentiles), and the range of the data. The edges of the box demarcate the 25th and 75th percentiles, and so represent the middle 50 percent range (interquartile range) of the parameter values for the data. Outliers are defined as outside values which lie 1½ or more interquartile ranges away from the nearest box edge. A 95 percent upper tolerance limit (UTL) of the mean will be calculated using the background data which is assumed to be lognormally distributed. The parametric method to calculate the UTL will require the log transformation of the data. The tolerance limit defines a value that bounds a specified fraction of the distribution of observations. Therefore, the 95 percent UTL is a value below which you can expect 95 percent of the distribution of sample values to lie. The onsite data will then be compared to the 95 percent UTL. If the concentration of an onsite constituent falls below the 95 percent UTL, it will be concluded that the constituent does not exceed its background concentration. The following factors will be considered during the preliminary evaluation of the need for a Phase 2 investigation:

- Background contaminant concentrations versus site contaminant concentrations using the 95-percent UTL

- Soil ingestion criteria based on target numbers for 10^{-6} risk and a Hazard Index of 1

- Leachability of soil contaminants and potential effect on groundwater

- Drinking water MCLs and water ingestion criteria (again based on target numbers for 10^{-6} risk and a Hazard Index of 1)

Findings of the Phase 1 investigation will be reviewed with the EPA. The EPA will decide either to proceed with a Phase 2 field investigation or to prepare the RI Report, including a quantitative risk assessment, based solely on Phase 1 data. Potential Phase 2 work may include:

- Site mapping
- Additional surface and subsurface soil sampling
- Installation of shallow, intermediate, and deep monitoring wells
- Groundwater sampling
- Measurement of groundwater elevations

2.0 Sample Network Design and Rationale

This section presents the sample network by task and matrix, site maps showing sample locations, and the rationale for the selected sampling locations. A summary of the sample network is provided in Table A-1.

2.1 Sample Network by Task and Matrix, Site Maps, and Rationales of Selected Sampling Locations

2.1.1 Phase 1 Field Investigation

The specific objectives of the Phase 1 field investigation are:

- To establish background concentrations of contaminants in the soil and the groundwater

- To determine whether hazardous substances are present in soil and groundwater at concentrations above background or at concentrations that could pose unacceptable risks to public health or the environment

2.1.1.1 Background Soil Sampling

Background

To establish background concentrations of contaminants in the soil, nine soil samples (CLBK01 to CLBK07) will be collected from the site perimeter locations shown in Figure A-1. Samples will be collected from the upper 6 inches at CLBK02 to CLBK07 using a hand auger. At CLBK01, three soil samples will be collected—one

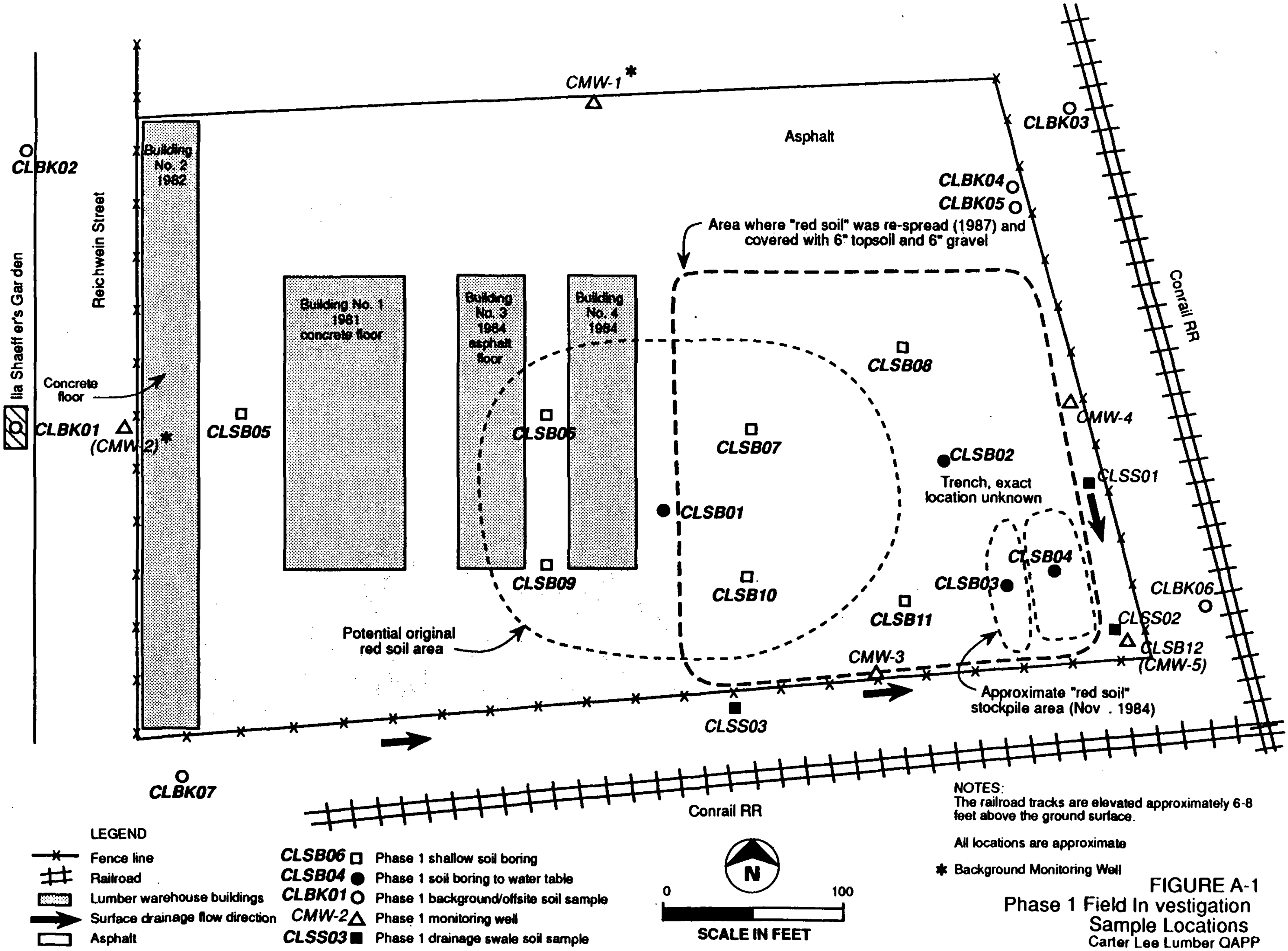


FIGURE A-1
Phase 1 Field In vestigation
Sample Locations
Carter Lee Lumber QAPP

each at depths of 0.5, 10, and 20 feet. This location is adjacent to Reichwein Avenue and is relatively uninfluenced by urban industrial settings. The boring will be logged continuously and sampled using a 2-foot-long, 3-inch O.D. split-spoon sampler. The background soil samples will be screened in the field for VOCs using an HNu or an organic vapor analyzer (OVA). Samples with elevated organic vapors will not be used for background characterization because the location may be contaminated from an isolated source not related to ubiquitous urban contamination. The samples will be analyzed for full TCL organic compounds and TAL inorganic chemicals. The results will be compared to onsite soil concentrations. Ten additional background samples to be selected in the field will also be collected. The samples will be submitted to the CLP for analysis of PAHs and metals and compared to onsite soil concentrations.

Onsite

To determine whether hazardous substances are present in the soil at concentrations above background levels, soil sampling will be performed in the following onsite areas:

- Area of suspected waste pickle liquor disposal
- Area of red soil stockpile
- Trench where site debris and potentially hazardous substances were disposed of
- Area where the stockpiled red soil was spread and covered
- Area where eroded site soil may accumulate and where railroad car dumping most likely would have occurred

Proposed soil boring locations are shown in Figure A-1. Soil samples will be screened for VOCs in the field using an HNu or OVA.

Four soil borings (CLSB01 to CLSB04) will be drilled to the water table to evaluate the vertical extent of soil contamination in the areas of concern. Based on regional hydrogeologic data, the water table is estimated to be about 25 feet below the ground surface. The borings will be drilled and continuously logged and sampled using hollow-stem auger drilling techniques and a standard 2-foot-long, 3-inch O.D. split-spoon sampler. At each of the four borings, three soil samples will be selected for full Target Compound List (TCL) analyses and Target Analyte List (TAL) analyses from the following depths: (1) one from the upper 2 feet, (2) one discretionary sample from 2 to 10 feet based on visual appearance and HNu/OVA screening, and (3) one from the water table interface. Up to six soil samples will be collected and analyzed for total organic carbon (TOC) and cation exchange capacity (CEC). The samples will also be held for possible analysis of the following additional soil physical characteristic parameters if a Phase 2 investigation is deemed necessary:

- Grain size
- Atterberg limits
- Porosity
- Percent moisture
- Density

The above physical soil parameters are important for the evaluation of contaminant transport and soil remediation alternatives.

Seven shallow borings (CLSB05 to CLSB11) will be drilled to evaluate the distribution of contamination across the site. Because the suspected contaminants are primarily metals and PAHs that were surface applied, these borings will be drilled to a depth of 4 feet. The borings will be sampled and logged on 2-foot intervals as described above. One or two soil samples per boring will be selected for full chemical analysis based on visual appearance and HNu/OVA screening. A total of 11 soil samples will be collected from the 7 shallow soil borings. Samples will represent the 2-foot interval unless the visual appearance or HNu/OVA screening indicates a potential for concentrated contamination at a narrower interval. In that case, the sample will be collected over the interval of suspected elevated concentrations.

The potential for overland migration of site contaminants in surface runoff will be investigated at two locations in the drainage swale running parallel to the eastern site boundary and at one location in the drainage swale running parallel to the southern site boundary (CLSS01 to CLSS02). See Figure A-1 for sample locations. Two soil samples will be collected at each location from the following intervals: the 0- to 6-inch interval and the 6- to 12-inch interval. The samples will be analyzed at the CLP for the full TAL and TCL. An additional boring (CLSB12) will be drilled at the low elevation confluence of the eastern and southern drainages. The boring will be sampled at depths of 0.5, 10, and 20 feet and analyzed for the full TAL and TCL.

One soil sample from the vegetable garden on the [redacted] property (approximately 110 feet west of the site) will be collected at a depth of about 8 inches and analyzed for full TAL and TLC parameters. The results will be compared with levels found on the site.

2.1.1.2 Hydrogeologic Investigation.

Groundwater Grab Sampling.

To provide data on potential groundwater contamination, one grab sample will be collected from each of the following soil boring locations CLSB01, CLSB02, CLSB03, and CLSB04. The grab samples will be collected from within the hollow-stem auger at a depth of several feet below the water table. The groundwater samples will be analyzed at the CLP for the full TAL and TCL. Metal samples will be field filtered with 0.45 μm filter paper to remove suspended solids. Filtered metals will be analyzed because the high amounts of suspended particles of native soil may bias the results.

Monitoring Well Installation/Groundwater Sampling.

To define potentiometric relationships in the vicinity of the site and to determine whether groundwater is contaminated, five shallow monitoring wells will be installed at the locations shown in Figure A-1. The rationale for each location is as follows:

- CMW1 and CMW2 are assumed to be upgradient of the site and will be used for background analysis of groundwater.
- CMW3 and CMW4 are assumed to be downgradient of areas where the red soil was originally disposed of.
- CMW5 is assumed to be downgradient of the stockpile area and trench and within the surface runoff seepage area.

CMW1, CMW2, and CMW5 will be installed and surveyed, and water elevations will be measured before installation of the remaining two monitoring wells to allow optimal placement of the wells downgradient of possible sources.

The boreholes for the monitoring wells will be advanced using hollow-stem augers. If alternative drilling methods are required, only methods using clear water, air, or cable tool will be considered. Monitoring wells will be constructed of 2-inch-diameter PVC with factory slotted 10- to 15-foot screens. The wells will be installed so that the screened interval will intersect the water table. Each well will have a minimum 2-foot stickup with a 4- or 6-inch-diameter protective steel casing with locking cap. A concrete apron will be installed to promote runoff. Wells will be surrounded by three concrete filled, 4-inch-diameter guard posts. In traffic areas, monitoring wells will be flush mounted.

Following installation, each monitoring well will be developed until substantially free of sediment and until pH and conductivity are stable to the satisfaction of the CH2M HILL hydrogeologist. Wells will be developed using either the double tube air lift or surge-and-bail methods. It is assumed that well development water and purge water will be discharged to the Indianapolis Wastewater Treatment Plant sewer system.

All new monitoring wells will be surveyed by a local, subcontracted surveyor to establish the horizontal location and elevation of the measuring points. Elevation measurements will be taken on the riser pipe with the measuring point designated by a chisel mark. All elevations will be referenced to a bench mark established at the site. Vertical elevations of measuring points will be made to the nearest 0.01 foot. All wells will be located horizontally to within ± 5 feet. Water levels will be collected once during Phase 1.

Groundwater samples will be collected from each of the newly installed monitoring wells about 24 hours following installation. Prior to groundwater sampling, groundwater levels will be measured and the wells will be purged to remove stagnant water and stratified contaminants. Metal samples will be field filtered. Monitoring well sampling procedures are described in detail in Section 7.0. Groundwater samples will be analyzed for the full TAL and TCL.

A summary table of the sample network is provided in Table A-1.

2.1.2 Phase 2 Field Investigation

Whether a Phase 2 investigation is necessary will be determined based on the evaluation of the data from the fast turnaround analyses of Phase 1 samples. The specific objectives of the Phase 2 field investigation are:

- To generate a topographic survey and base map of the Carter-Lee Lumber site

- To determine the extent of soil contamination

Table A-1
Carter-Lee Lumber RI Sampling Program Elements for Chemical Analysis

TASK	Soil Borings		Soil Sampling			Groundwater Sampling					
								Monitoring Wells TAL and TCL Analy.			
	Locations	Boring Depth (ft.)	Sample Intervals (ft.)	TAL and TCL Analysis CLP Samples	Additional Soil Param.(a)	Groundwater Grab CLP RAS Analysis	Groundwater Grab Quick Turnaround Analysis	Quick Turnaround Analysis(b)	Round 2 CLP RAS Analysis(b)	Total MW Samples	Transport & Treatment Parameters Samples(c)
TASK F0--PHASE 1 FIELD INVESTIGATION											
FS--Source Characterization											
Water table soil borings	4	25	0-2,TBD,WT	12		4					
Shallow soil borings	7	4	0-2, 2-4	11							
Drainage-way	3	1	0-0 5, 0 5-1	6							
Offsite/Background	7	0 5 to 25	0-0 5,10,20	9							
Schaffer garden	1	0 75	0-0 75	1							
Hydrogeologic Investigation											
Downgradient MWs	3	35	0-0.5,10,20	3					3	3	
Upgradient MWs	2	35							2	2	
TASK F2--PHASE 2 FIELD INVESTIGATION											
FS--Source Characterization											
Shallow Soil Borings	10	2 5	1-1 5,1.5-2,2-2.5	30	6						
Drainage-way	6	0.5	0-0.5	6	3						
FQ--Hydrogeologic Investigation											
Deep MWs	4	150					4		4	4	4
Intermediate MWs	4	75					4	1	5	6	4
Shallow MWs	10	35					10	4	14	18	10
Phase 1 MW Re-sampling									5	5	5
Total Samples				78	9	4	18	5	33	38	23

TBD--To be determined based on visual appearance and screening
WT--Water table
a. Additional soil parameters include TOC and cation exchange capacity for phase 1 samples. Phase 2 analysis is for: TCLP, grain size, Atterberg limits, porosity, percent moisture, and density
b. Phase 2 investigation includes sampling of 4 shallow and 1 intermediate monitoring wells on the WABCO site south of the Carter-Lee Lumber site.
c. Groundwater transport and treatment parameters include: TOC, COD, TSS, TDS, chloride, alkalinity, and hardness.

- To confirm or refine the conceptual model of the subsurface stratigraphic relationships

- To delineate the horizontal and vertical extent of groundwater contamination

- To estimate the risks to public health and the environment posed by site contamination

2.1.2.1 Site Mapping.

To generate a base map of the site, an aerial topographic survey of the site and surrounding area will be conducted and field checked by a ground survey crew. The site topographic map covering 4 acres of the site and immediate surrounding area will consist of contour lines on 1-foot intervals and use a scale of 1 inch = 50 feet. Significant features of the site will be identified on the map, including lumber buildings, asphalt and gravel areas, fencing, railroads to the south and east of the site, soil sampling locations, and monitoring well locations.

2.1.2.2 Soil Sampling.

To determine the extent of soil contamination, soil samples will be collected from the locations described below.

Ten shallow soil borings (CLSB201 to CLSB210) will be advanced to depths of about 2.5 feet across the site (Figure A-2) to determine the extent of contamination from the suspected disposal of spent and neutralized sulfuric acid pickle liquor. The borings will be advanced and soil samples collected using a hand auger. It is assumed that two soil samples will be collected from each boring for full TCL and TAL analyses. The actual analysis of soil samples will depend on the results of Phase 1. Selected soil samples will be analyzed for the following physical soil parameters that are important to evaluation of contaminant transport and soil remediation alternatives:.

- Grain size
- Atterberg limits
- Porosity
- Percent moisture
- Density
- TOC

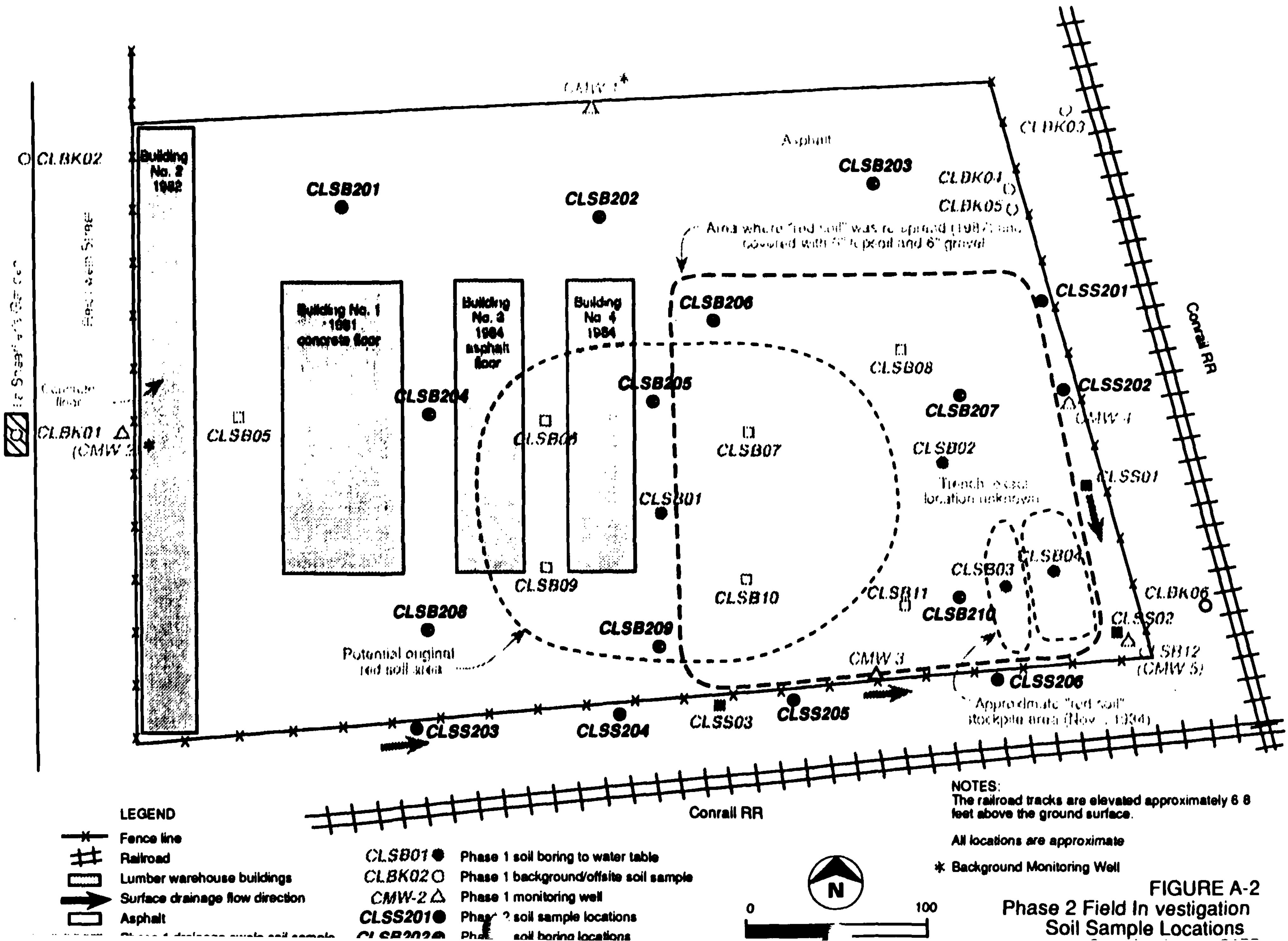


FIGURE A-2
Phase 2 Field In vestigation
Soil Sample Locations

- Cation exchange capacity

In addition, TCLP organic and inorganic analysis of up to nine samples will be performed if Phase 1 sample results indicate that contaminants are present in concentrations that may leach to groundwater.

Six additional shallow soil samples (CLSS201 to CLSS206) will be collected along the eastern and southern drainage swales (Figure A-2) at assumed depths of 6-inches to identify the extent of soil contaminated from surface runoff.

2.1.2.3 Hydrogeologic Investigation.

The object of the Phase 2 hydrogeologic investigation is to confirm or refine the conceptual model of the subsurface stratigraphic relationships, to delineate the horizontal and vertical extent of groundwater contamination, and to estimate risks to public health and the environment. This object will be met through the drilling of additional soil borings, groundwater grab sampling in each boring, quick turnaround method (QTM) analysis (1 to 2 days), and monitoring well installation and sampling. Based on Phase 1 analytical results, the contaminants analyzed under QTM may be reduced. The location of initial Phase 2 borings and monitoring wells will not be identified until Phase 1 results are known. Subsequent Phase 2 sampling locations will depend on the evaluation of stratigraphic information and results of quick turnaround analysis of groundwater grab samples from the initial borings. The number of borings and monitoring wells needed was estimated based on experience at other similar sites and on professional judgment. The scope of the Phase 2 investigation also assumes that hazardous substances, in addition to the spent sulfuric acid, have been disposed of onsite. The major elements of the Phase 2 hydrogeologic investigation are:

- Four deep soil borings (assumed depth of 150 feet) will be sampled and logged for soil classification on 5-foot intervals or changes in soil lithology. Two borings will be located upgradient of the site. Deep (150 feet), intermediate (75 feet), and shallow (35 feet) monitoring wells will be installed at each location.

- Six shallow soil borings (assumed depth of 35 feet) will be sampled and logged as described above. Water table monitoring wells will be installed in each boring.

- Groundwater grab samples will be collected for quick turnaround analyses from below the lead auger at each monitoring well location.

- Four shallow and one intermediate FIT-installed monitoring wells will be sampled at the Westinghouse Air Brake Company site, and samples will be analyzed for the full TAL and TCL.

- The 18 Phase 2 and 5 Phase 1 monitoring wells will be sampled, and samples will be analyzed at the CLP for the full TAL, TCL, and transport and treatment parameters listed below:

  - TOC
  - COD
  - TSS
  - TDS
  - Chloride
  - Alkalinity
  - Hardness

- Monitoring well groundwater elevations will be measured monthly for 4 months.

The Phase 2 sample network is summarized in Table A-1.

3.0 Sample Custody Procedures

3.1 Sample Identification System

The sample identification system to be employed during the Carter-Lee Lumber RI is described in the Data Records section of the Data Management Plan, Appendix B.

3.2 Initiation of Field Custody Procedures

It is U.S. EPA and Region 5 Policy to follow the U.S. EPA Region 5 sample custody, or chain of custody protocols as described in *NEIC Policies and Procedures, EPA-330/9-78-DDI-R*, Revised June 1985. These custody procedures are described in Section 5.0.

3.3 Field Activity Documentation/Logbook

Field logbooks will be used as the means of recording data collecting activities. Logbook entries will be in as much detail as possible so that persons going to the site could re-construct a particular situation without reliance on memory.

Entries into the logbooks will contain a variety of information. The date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be logged at the beginning of each account. Examples of other information to be included in the logbook include:

- Measurements made and samples collected
- Detailed description of the location of the station including compass and distance measurements
- All equipment used to make measurements will be identified, along with the date of calibration
- The number of the photographs taken of a station, if any, will also be noted

All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark.

3.4 Sample Shipment and Transfer of custody

Sample documentation and shipping procedures are explained in full detail in Appendix G. Transfer of custody procedures are explained in Section 5.1.3.

4.0 Sample Container Preparation, Sample Preservation, and Maximum Holding Time

Table A-2 contains information on sample bottle types, preservatives, and sample holding times. Certified precleaned sample bottles will be procured and used for this project.

TABLE A -2
SAMPLE TYPES, BOTTLES, AND PRESERVATIVES
CARTER-LEE LUMBER

Sample Type	Analysis	Bottles	Preservation	Holding Time (turnaround time may vary)
Water				
	RAS Organics			
	- Extractables, Pesticides/PCBs	Two 80-oz amber glass bottles (Teflon lined-caps)	Iced to 4 C	5 days for extraction 40 days for analysis
	- Volatiles	Two 40-ml septum cap vials	HCl to pH<2 Iced to 4 C	10 days
	RAS Inorganics			
	- Metals a)	One 1-liter polyethylene bottle	HNO3 to pH <2, Iced to 4 C	6 months (mercury: 28 days)
	- Cyanide	One 1-liter polyethylene bottle	NaOH to pH>12 Iced to 4 C	6 months
	QTM Organics			
	- Extractables	One 80-oz amber glass bottle	Iced to 4 C	(Turnaround time: 48 hours)
	- Volatiles	Two 40-ml septum cap vial	Iced to 4 C	(Turnaround time: 48 hours)
	SAS Methods			
	- COD, TOC	One 1-liter polyethylene bottle	1 ml/L H2SO4 to pH <2, Iced to 4 C	28 days
	- Alkalinity	One 1-liter polyethylene bottle	Iced to 4 C	14 days
	- Chloride	One 1-liter polyethylene bottle	Iced to 4 C	28 days
	- Hardness	One 1-liter polyethylene bottle	50% HNO3 to pH <2, Iced to 4 C	14 days
	- TSS, TDS	One 1-liter polyethylene bottle	Iced to 4 C	7 days

Note: Water samples for organic matrix spike/matrix spike duplicate analyses must be collected at double the specified volume for extractables and triple the specified volume of volatiles. CRL requires extra volume for inorganic analyses.

a) CRL requires metal samples to be filtered within 15 minutes of collection.

TABLE A -2
SAMPLE TYPES, BOTTLES, AND PRESERVATIVES
CARTER-LEE LUMBER

Sample Type	Analysis	Bottles	Preservation	Holding Time (turnaround time may vary)
Soil				
	RAS Organics			
	- Extractables, Pesticides/PCBs	One 8-oz wide mouth glass jar	Iced to 4 C	Extract within 10 days Analyze within 40 days
	- Volatiles	Two 120-ml wide mouth glass vials	Iced to 4 C	Extract within 10 days Analyze within 10 days
	RAS Inorganics			
	- Metals	One 8-oz wide mouth glass jar	Iced to 4 C	6 months *(mercury: 28 days)*
	- Cyanide	One 8-oz wide mouth glass jar	None required	14 days
	SAS Methods			
	- TOC	One 4-oz wide mouth glass jar	None required	28 days
	- Cation Exchange	One 4-oz wide mouth glass jar	None required	---
	- TCLP	One 32-oz amber wide mouth glass jar	None required	Extract within 7 days Analyze within 40 days
	- Grain Size - Atterberg Limits - Porosity - %Moisture - Density	One 32-oz wide mouth glass jar	None required	28 days

Note: No extra volume is required for soil matrix spike/matrix spike duplicate analyses.

Table 1-1
SOIL AND GROUNDWATER ANALYSIS NUMBERS

Parameter	Number Samples	Sample Duplicates	Field Blanks	Trip Blanks	MS/MSD Samples 1,2,3	Total Analyses
PHASE 1						
Soil						
RAS/SAS- CLP Organic: VOA, SVOA, Pest/PCB	44	5	0	0	(2)	49
RAS/SAS - CLP Inorganic	44	5	0	0	(2)	49
SAS a	6	1	0	0	(1)	7
Water						
RAS/SAS- CLP Organic: VOA, SVOA, Pest/PCB	9	1	2	5	(1)	17
RAS/SAS - CLP Inorganic	9	1	2	0	(1)	12
PHASE 2						
Soil						
RAS/SAS- CLP Organic: VOA, SVOA, Pest/PCB	37	4	0	0	(2)	41
RAS/SAS - CLP Inorganic	37	4	0	0	(2)	41
SAS b	9	1	0	0	(1)	10
Water						
RAS/SAS- CLP Organic: VOA, SVOA, Pest/PCB	28	3	3	10	(2)	44
RAS/SAS - CLP Inorganic	28	3	3	0	(2)	34
QTM Organic: VOA, SVOA, Pest/PCB	23	3	3	0	(2)	29
Water - SAS c	23	3	3	0	(2)	29

SAS:
a) TOC, Cation Exchange
b) TCLP Metals, Grain Size, Atterberg Limits, Porosity, % Moisture, Density
c) TOC, COD, TSS, TDS, Chloride, Alkalinity, Hardness

MS/MSD:
1) Matrix spike/matrix spike duplicate (MS/MSD) samples are required for organic analysis. Aqueous samples designated for MS/MSD analysis will be collected, with extra sample volumes. Triple the normal sample volumes will be collected for VOAs, and double the normal sample volumes will be collected for extractable organics, pesticides and PCBs.
2) MS for inorganic water analyses require an additional sample volume be collected.
3) MS/MSD for inorganic and organic soils do not require the collection of additional sample.

RAS/SAS: Two week turnaround time required.

5.0 Sample Handling, Packaging, and Shipment

Sample handling and shipping procedures are explained in full detail in Appendix G.

6.0 Decontamination Procedures

This section provides the general guidelines for the decontamination of personnel, sampling and monitoring equipment, and sample bottles.

The following equipment will be needed onsite:

- Demonstrated analyte-free deionized (DI) water
- Distilled water
- 2.5 percent (W/W) trisodium phosphate (TSP) and water solution
- 10 percent (V/V) methanol or isopropanol and water solution (DO NOT USE ACETONE.)
- 10 percent (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

Key items to be noted:

- Clean with solutions of TSP, methanol (or isopropanol) and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate sample bottles before relinquishing them to anyone.

6.1 Personnel

The following procedures are to be performed after completion of tasks whenever the potential for contamination exists, and upon leaving the contaminated area. Some of the following procedures are for equipment not anticipated to be used at the Carter-Lee Lumber site, but are included in case hazardous materials are encountered and a increase in personnel protective equipment is required.

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.

2. Wash outer gloves in TSP solution, rinse, remove, and discard.

3. Remove disposable coveralls ("Tyveks") and discard.

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).

6.2 Sample Bottles

Sample bottles or containers filled in the field must be decontaminated before being packed for shipment or handled by personnel without dermal hand protection as follows:

1. Wipe container with a paper towel dampened with TSP solution.

2. Wipe container with a paper towel dampened with potable water.

6.3 Sampling and Monitoring Equipment

6.3.1 Field Equipment Decontamination

1. Wash all equipment surfaces that contacted potentially contaminated soil or water with TSP solution.

2. Rinse with potable water.

3. Rinse with 10 percent HNO_3 solution when sampling for inorganic chemicals. (The split spoons will be rinsed with a 1 percent solution).

4. Rinse with methanol solution (DO NOT USE ACETONE) and air dry.

5. Rinse with distilled water and air dry.

6. Collect all rinsate and dispose in a DOT approved 55-gallon drum.

The split-barrel sampler will be decontaminated using the following procedure when chemical sampling is being performed:

1. Scrape soils from split spoon.

2. Wash split spoon in a 2.5 percent (W/W) solution of nonphosphate detergent (Liquinox or equivalent) in tap water.

3. Rinse with tap water.

4. Spray rinse with 10 percent isopropanol solution.

5. Spray rinse three times with distilled water.

6. Place on plastic and allow to air dry.

6.3.2 Monitoring Equipment Decontamination

1. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with TSP solution.

2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with methanol solution.

3. Wipe three times with a towel wet distilled water.

4. Dispose of all used paper towels in a DOT approved 55-gallon drum.

7.0 Sampling Equipment and Procedures

7.1 Groundwater Sampling Procedures

7.1.1 Monitoring Well Installation

Five monitoring wells will be installed as part of the Phase 1 Site Investigation. The well screens will intersect the water table. If a Phase 2 investigation is deemed necessary, it is estimated that 18 additional monitoring wells may be installed: four wells to bedrock, ten wells intersecting the water table, and four wells screened about halfway between the water table and the top of bedrock.

7.1.1.1 Drilling Equipment.

Phase 1 soil borings will be advanced using 4.25-inch I.D. hollow-stem augers. The lead auger will be fitted with a center plug, or stinger bit if needed, to minimize the effects of coring or sand heave into the center of the auger while advancing the boring. The center plug will be removed between successive drives of the split-spoon sampler. An alternative drilling method may be used for intermediate and deep soil borings during the Phase 2 investigation.

7.1.1.2 Well Construction Material.

The monitoring wells will be constructed of 2-inch-diameter, threaded, flush joint, schedule 40 PVC casing with O-ring joint seals. Each well will be fitted with a 10-foot length of 0.010-inch factory slotted screen. The screen length may need to be adjusted depending on field conditions.

The driller will introduce a filter pack into the annular space around the screened interval to a height about 2 feet above the top of the screen. Two feet of fine sand (Ottawa sand or equivalent) will be placed above the filter pack to inhibit migration of annular seal material into the filter pack. The depth of the filter pack will be accurately determined using a weighted tape or a rigid rod or small diameter rigid tube. The remaining annular space will be filled with a bentonite slurry introduced by the tremie method to within 5 feet of the ground surface. The well riser stickup above the ground surface will be at least 2 feet. A minimum 4-inch-diameter, locking steel protective casing will be placed and surrounded by concrete to a depth of at least 5 feet. The concrete will be mounded around the casing to promote surface water runoff. Wells will be surrounded by three concrete-filled, 4-inch-diameter guard posts. In traffic areas, monitoring wells will be flush mounted.

The drilling rig and all equipment, tools, and materials that have either entered the borehole or come into contact with potentially contaminated soils or water shall be steam cleaned before leaving the site.

7.1.1.3 Well Drilling and Development.

Boreholes for shallow monitoring wells will be advanced using 4.25-inch I.D. hollow-stem augers. Augers of this diameter allow sufficient annular space to construct a monitoring well. The monitoring well borings will be sampled and logged every 5 feet or at changes in lithology to obtain stratigraphic information. Upon reaching the target depth, the drill rods will be removed and the monitoring well installed. An alternate drilling method may be used for intermediate and deep boreholes during the Phase 2 investigation.

Following installation, the driller will develop the wells by pumping, bailing, or air lift methods and surging until the discharge is substantially free of sediment to the satisfaction of the hydrogeologist or until a constant rate of turbidity is achieved.

7.1.2 Sample Collection

Groundwater samples will be collected as part of the Carter-Lee Lumber RI. Groundwater grab samples will be collected from several soil borings. In addition monitoring wells installed during Phase 1 and 2 will be sampled.

7.1.2.1 Sampling Devices.

Either a stainless steel bailer or pump will be used to collect groundwater samples.

7.1.2.2 Water Level Measurements.

Groundwater level will be measured periodically throughout the RI to monitor changes in gradients over time. The groundwater level will also be measured before groundwater sampling. Water level measurements will be taken with an electric tape. The following procedure will be used to measure static water levels:

1. Lower the probe or electrode into the well by unreeling cable from the hand-held reel.

2. Continue lowering until the bulb lights, the beeper beeps, or the meter needle deflects, indicating that the water table has been reached.

3. Read measurements directly to the nearest 0.01-foot. The length of cable in the well from the top of casing or other reference point to the probe (depth to the water table) will be subtracted from the measuring point elevation to determine the groundwater level elevation.

4. Decontaminate water level indicator equipment between wells.

7.1.2.3 Well Purging.

Wells screened in low permeability formations (i.e., wells that can be purged dry):

1. Pump (or bail) the well dry.

2. Measure temperature, specific conductance, and pH while purging. These measurements will provide an indication of stable groundwater conditions.

3. Wait 15 minutes, allowing the well to recover after purging. If well recovers to 80 percent of its original level, then the sample team may begin sampling.

4. Collect the sample as soon as there is a sufficient volume of water for the intended analyses. It is not necessary to wait for the well to fully recover.

Wells screened in high permeability formations:

1. Remove five well volumes (calculate this volume as shown below).

$$V = (\pi \times r^2)\ H \times 5 \text{ well volumes} \times 7.48$$

Where:

V = Total volume of water needed to purge (gallons)

r = Inside radius of well (ft)
H = Height of water column in well (ft)
(depth to bottom of well minus depth to water)

2. Purge wells by pumping or bailing from as near the water surface as possible so that no stagnant water remains in the well above the well screen after purging.

3. Introduce as little air and turbulence into the formation as possible to prevent alteration of the samples.

7.1.2.4 Sample Field Filtration and Procedures.

1. Set up the filtering apparatus.

2. Place a 0.45-micron membrane filter on the apparatus (using tweezers). If the sample contains a lot of sediment as indicated by a leaking filtration apparatus or visual evidence, use a pre-filter to prevent clogging.

3. Flush a minimum of 500 mL of reagent grade water through the filtering apparatus before filtering the sample.

4. Pump the sample through the filter discarding the first 150 mL (if you have enough extra volume).

5. Collect the remaining volume of sample needed into sample containers.

6. Remove the filter membrane (and the pre-filter, if used) after the sample is collected and discard. **Do not reuse filter paper for another sample.**

7. Flush the filtering apparatus and tubing with a minimum of 500 mL of reagent grade water.

8. Reassemble the filtering apparatus.

7.1.2.5 Sampling Procedures.

Before Sampling.

1. Use a stainless steel bailer to collect the groundwater sample.

2. Withdraw samples shortly after purging (as soon as a volume of water sufficient for the intended analyses reenters the well).

3. Sample the least contaminated wells first, the more contaminated wells last (i.e., sample in increasing order of contamination). If the degree of contamination is unknown, sample the upgradient wells first, the downgradient wells last.

4. Withdraw samples from within or just above the screened section of the well.

Sampling with a Bailer.

1. Rinse the bailer and monofilament line with reagent grade water.

2. Place a large clean plastic bag or cloth on the ground around the well to prevent the bailer line from touching the ground.

3. Lower the bailer slowly and gently into the water in the well. Do not simply let the bailer fall free into the well while holding the end of the rope. Do not allow the bailer to touch the bottom of the well.

4. Lower the bailer to approximately the same depth in the well each time, preferably within or just above the screened interval.

5. Retrieve the bailer smoothly (do not allow the bailer rope to touch the ground). Empty the water in a slow steady stream in the following order, making sure to fill VOC vials first:

a. Use a bottom discharging device to provide an unfiltered portion to fill sample containers for VOC analyses and screening (as necessary). Collect samples for VOCs from a bailer full of water as soon as it is brought to the surface.

   See below for special procedures to be followed when sampling for VOCs.

b. Slowly pour an unfiltered portion of the sample into a sample container for the required in-field analyses. One person should perform the in-field analyses immediately while the other continues collecting samples for other analyses.

c. Slowly pour a portion into the sample containers for all other unfiltered analyses (as necessary). Preserve and cap quickly.

d. Slowly pour a portion of the sample into a transfer bottle for analyses requiring field filtering. Fill to the top to minimize aeration of the sample. Perform field filtering immediately. Draw the sample through the filter into the collection bottles. Preserve and cap immediately.

6. Decontaminate the bailer. Use new line for each well.

Sampling with a Pump.

1. Rinse the pump and associated apparatus with reagent grade water.

2. Position the pump inlet in the well such that water is removed from the same portion of the well each time, preferably within or just above the screened interval.

3. Set the discharge of the pump to slow rate.

4. Direct the sample into the containers in the same order as with a bailer:

   a. Use a bottom discharging device to provide an unfiltered portion to fill sample containers for VOC analyses and screening (as necessary). Collect samples for VOCs from a bailer full of water as soon as it is brought to the surface.

See below for special procedures to be followed when sampling for VOCs.

b. Slowly pour an unfiltered portion of the sample into a sample container for the required in-field analyses. One person should perform the in-field analyses immediately while the other continues collecting samples for other analyses.

c. Slowly pour a portion into the sample containers for all other unfiltered analyses (as necessary). Preserve and cap quickly.

d. Slowly pour a portion of the sample into a transfer bottle for analyses requiring field filtering. Fill to the top to minimize aeration of the sample. Perform field filtering immediately. Draw the sample through the filter into the collection bottles. Preserve and cap immediately.

Note: The tubing that comes into contact with the water should be coated with Teflon.

Groundwater Grab Sampling.

Groundwater grab samples will be collected from the soil borings designated in Section 2.0. The grab samples will be collected by driving a 2-foot-long, 2-inch-diameter wellpoint or equivalent device about 3 feet into the formation ahead of the lead auger. The wellpoint will be evacuated of three casing volumes of water using a bailer or pump. The water level will be allowed to stabilize and a groundwater grab sample will be collected using a stainless steel bailer. The sample will be placed in bottles on ice in a cooler. The depth interval, date, and time of collection will be written on the label along with the boring number.

Special Procedures when Sampling for VOCs

1. Before sampling, 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, suntan lotion, and automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) Keep the caps off the sample vials for as short a time as possible.

2. Wear clean gloves (latex or surgical) when sampling for VOCs.

3. Use a bottom-emptying device when using a bailer to sample for VOCs.

4. Do not use a suction pump when sampling for VOCs. Do not filter samples collected for VOC analysis.

5. Keep the VOC sample bottles and the containers used for mailing the bottles tightly sealed to prevent possible contamination.

6. Two 40-mL vials with teflon septum tops should be filled.

7. Remove the cap ring from the first sample vial. Make sure that the Teflon liner does not fall out. If the liner falls out, replace it in the cap ring and flush the cap with reagent grade water.

8. 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 vial before filling.** Fill the sample vial, with a minimum of turbulence, until the water forms a positive meniscus at the brim. Allow the vial to overflow slightly.

9. Replace the cap quickly by gently setting it on the water meniscus. Tighten firmly, but **do not overtighten.** 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. If bubbles form in the sample, repeat the procedure until you obtain a proper sample.

10. Repeat this procedure for the second VOC sample.

7.2 Surface Soil Sampling Procedures

The method for surface soil sample collection is described below.

7.2.1 Sampling Devices

A hand auger or stainless steel trowel will be used to collect surface soil samples. Where the ground is compacted and hard, a pick or shovel may be used to break up the ground.

7.2.2 Sampling Procedures

A decontaminated stainless steel trowel will be used to scrape away surficial organic material (grass, leaves, etc.). Samples will be collected with the hand auger or trowel.

For VOC and semivolatile sampling, sample jars will be filled directly with the trowel and capped immediately upon filling. Samples for VOC analysis will be collected first, followed by samples for semivolatiles and all other parameters.

Where composite samples will be taken, the samples will be placed into a decontaminated steel pan and mixed using a decontaminated stainless steel utensil. The sample will be placed into appropriate containers for analysis with a decontaminated utensil. Samples to be analyzed for VOCs will not be composited because of the potential for VOC loss during sample homogenization.

7.3 Subsurface Soil Sampling Procedures

7.3.1 Sampling Devices

Soil borings will be sampled using 2-foot-long, 3-inch O.D. (2.5-inch I.D.) split-barrel samplers. The large diameter sampler will be used because it collects a larger volume of soil than the standard split-spoon sampler. This meets the volume quantity required for samples submitted for chemical analysis.

7.3.2 Sampling Procedures.

The split-spoon sampler will be driven its entire length using a 140-pound hammer freely falling a distance of 30 inches. Blow counts will be recorded on the boring log. Blow counts during 3-inch split spoon sampling will not give true standard penetration test blow counts because a 2-inch spoon would normally be used. After completing the drive, the sampler will be removed from the borehole and opened by the driller's assistant. The supervising hydrogeologist will examine the sample and its description will be logged.

The sample volume will be split between sampling containers and reserved for analytical testing. Samples to be collected from each boring are described in Section 2.0. Sample jars will be labeled as to boring number, depth of sampling interval, and time and date of sample collection. Samples will be stored in iced coolers pending selection and shipment.

7.3.3 Borehole Abandonment

Each soil boring that is not also a monitoring well borehole will be properly abandoned either by filling the hole with bentonite pellets or granules or by grouting from the bottom of the borehole to the ground surface using the tremie method.

8.0 Field Measurements/Screening

Standard operating procedures (SOPs) for the field measurement and screening techniques are provided in Appendix F.

9.0 Preventive Maintenance Procedures and Schedules

Field team members will refer to the field procedure SOP (Appendix F) and/or the manufacturers' instrument manuals for the appropriate preventive maintenance procedures for the field equipment used at the site.

10.0 Sample Disposal

10.1 Soil

Cuttings or field screening samples shall be incorporated into the slurry backfill for the boring of origin.

10.2 Groundwater

Groundwater purged from a well prior to sampling and water aliquots taken for field sampling or screening will be contained onsite pending analytical results. If results show the groundwater is non-hazardous, the water will be discharged to the Indianapolis Wastewater Treatment Plant. If the water is hazardous, it will be managed as such per Indiana's Administrative Code for hazardous waste management.

CH2M HILL

Engineers
Planners
Economists
Scientists

June 16, 1993

GLO65616.PP.PM

Ms. Deborah Orr
Regional Project Manager
U.S. Environmental Protection Agency, Region 5
77 West Jackson Blvd. (5HSRL-6J)
Chicago, IL 60604-3590

RECEIVED
JUN 17 1993
REMEDIAL RESPONSE BR.
IL/IN SECTION 2

Dear Ms. Orr:

Subject: Addendum to Appendix A (Field Sampling Plan) of the Quality Assurance Project Plan for Remedial Investigation Carter-Lee Lumber Site, Indianapolis, Indiana Contract No. 68-W8-0040, W.A. No. 49-5LBD

Enclosed for your review are four copies of the addendum to Appendix A (Field Sampling Plan) of the Quality Assurance Project Plan (June 1992) for the remedial investigation at the Carter-Lee Lumber site. The addendum describes the fieldwork to be performed in the Phase 2 investigation.

Sincerely,

CH2M HILL

Laura Peterson

Laura Peterson
Assistant Site Manager

1001224A.GLO

cc: Stephen Nathan/PO/U.S. EPA/Region 5 (w/o enclosure)
Martin Sandoval/CO/U.S. EPA/Region 5 (w/o enclosure)
Denise Boone/Chemist/U.S. EPA/Region 5 (w/o enclosure)
Bob Schaible/IDEM (2 copies)
Alpheus Sloan III/PM/Milwaukee
Ike Johnson/APM-OPNS/Milwaukee
John Fleissner/QAM/Milwaukee
Phil Smith/PC RVW/Milwaukee
Cindi Cruciani/QC RVW/Milwaukee
Cherie Wilson/PA/Milwaukee (w/o enclosure)
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Addendum No. 1 to Appendix A
Field Sampling Plan of the
Quality Assurance Project Plan (June 1992)

At the Carter-Lee Lumber Site
Indianapolis, IN

This is an addendum to the existing Quality Assurance Project Plan (QAPP) for the Carter-Lee Lumber (CLL) site dated June 1992. The EPA has requested a limited Phase 2 site investigation to address potential impacts to groundwater at the CLL site. Additional work beyond that originally described in the Field Sampling Plan (FSP) of the QAPP will be undertaken to further define background conditions and identify impacts on potential groundwater users. This addendum has been written to describe the additional work to be performed as agreed upon with the EPA. The additional work will be completed according to procedures and methods already approved in the June 1992 QAPP.

Phase 2 Investigation

The following sections replace the corresponding sections in the QAPP dated June 1992. A summary of the sample network is provided in Table A-1. The table has been revised to reflect the scope of work in Phase 2 reduced from the original work plan.

2.1.2 Phase 2 Field Investigation

The specific objectives of the Phase 2 field investigation are:

- To determine the impacts pumping by large industrial users may have on groundwater flow direction

- To evaluate the impacts groundwater fluctuations (seasonal and/or those fluctuations produced by industrial pumping) may have on contaminant migration

- To determine the concentrations of potential contaminants in soil adjacent to the railroad tracks

2.1.2.2 Hydrogeologic Investigation.

Two rounds of groundwater sampling will be conducted to supplement the data collected during the Phase 1 site investigation. The first round of sampling will occur in early

Table A-1 (Revised 8/26/93)
Carter-Lee Lumber RI Sampling Program Elements for Chemical Analysis

TASK	Soil Borings		Soil Sampling				Groundwater Sampling			
	Locations	Boring Depth (ft.)	Sample Intervals (ft.)	TAL and TCL Analysis CLP Samples	TOC Analysis	Additional Soil Param. (a)	Groundwater Grab CLP RAS Analysis	Phase 1 TCL and TAL CLP Analyses	Phase 2 TCL and TAL CLP Analysis	Transport & Treatment Parameters Samples(b)
TASK F0--PHASE 1 FIELD INVESTIGATION										
FS--Source Characterization										
Water table soil borings	4	25	0-2,TBD,WT	12	6		4			
Shallow soil borings	7	4	0-2, 2-4	11						
Drainage-way	3	1	0-0.5, 0.5-1	6						
Offsite/Background	5	0.5 to 25	0-0.5,10,20	17						
Schaffer garden	1	0.75	0-0.75	1						
Hydrogeologic Investigation										
Downgradient MWs	3	35	0-0.5,10,20	3				3	3	
Upgradient MWs	2	35						2	2	
TASK F2--PHASE 2 FIELD INVESTIGATION										
FS--Source Characterization										
Offsite/Background	2	0.5	0-0.5	2						2
FQ--Hydrogeologic Investigation										
Phase 1 MW Re-sampling									10	5
Total Samples				52	6		4	5	15	7

TBD--To be determined based on visual appearance and screening
WT--Water table
a. TCLP, grain size, Atterberg limits, porosity, percent moisture, and density.
b. Groundwater transport and treatment parameters include: TOC, COD, TSS, TDS, chloride, sulfate, alkalinity, and hardness.
Note: TAL analyses are to include cyanide. Phase II TCL and TAL CLP analyses are 35-day turn around.

June 1993. The second round of sampling is anticipated to take place in early fall 1993. However, the actual date of the fall sampling is dependent on the outcome of the groundwater users survey.

In both sampling rounds, the five monitoring wells (see Figure A-1) will be analyzed for the full TAL and TCL. Transport and treatment parameters listed below will be analyzed in the second of these Phase 2 rounds:

- TOC
- COD
- TSS
- TDS
- Chloride
- Alkalinity
- Hardness

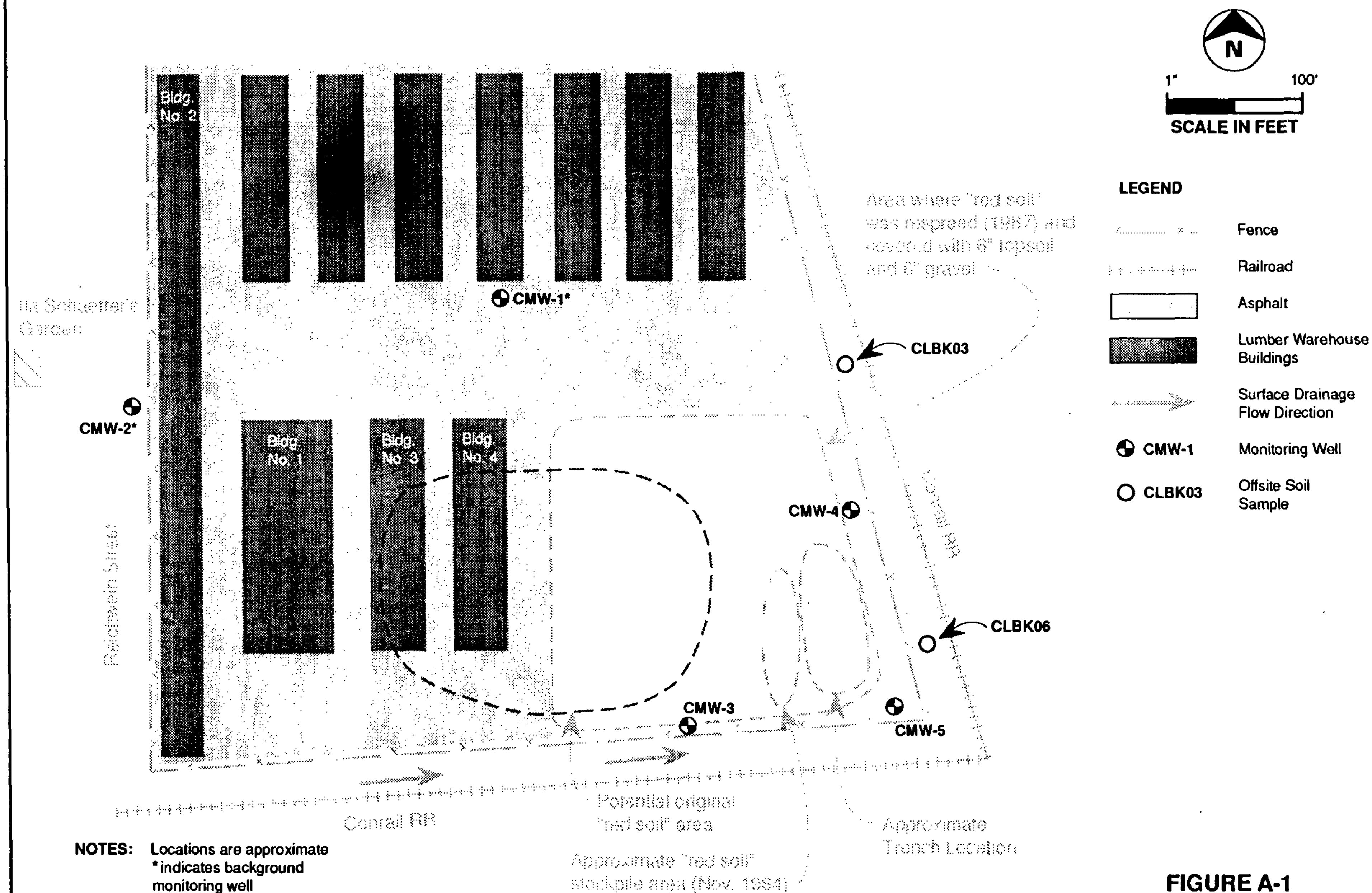
Monitoring well groundwater elevations will be measured during the two sampling rounds. A third set of groundwater elevation data (no lab samples) will be collected in mid-summer 1993.

2.1.2.3 Soil Sampling

Two soil samples were originally planned to be collected in Phase 1 to help evaluate the impact the adjacent Conrail tracks may have had on the CLL site. Because access could not be obtained in Phase 1, these samples will be collected in Phase 2. Two shallow soil samples (CLBK03 and CLBK06) will be collected from the approximate locations shown in Figure A-1. The soil samples will be collected during the Round 2 groundwater sampling event (anticipated for early fall). The samples will be collected from the upper 6-inches using a hand auger. The samples will be analyzed for full TCL organic and TAL inorganic compounds. It is assumed access to the Conrail properties will be secured by EPA.

1001224B.GLO

GLO65616.PP.PM Figure A-1 5-20-93 LML



NOTES: Locations are approximate
* indicates background monitoring well

The railroad tracks are elevated about 6-8 ft. above the relative ground surface

FIGURE A-1
Phase 2 Field Investigation
Monitoring Well and Soil Sample Locations
Carter-Lee Lumber
Indianapolis, IN

CH2M HILL

APPENDIX B
DATA MANAGEMENT PLAN

Appendix B

Data Management Plan

Introduction

This Data Management Plan (DMP) outlines the procedures that will be used to track, manage, store and retrieve water level data, water quality data and soil quality data collected during the work associated with the RI at the Carter-Lee Lumber Site.

A variety of technical data will be generated (geologic, hydrogeologic, geochemical, and chemical) during the RI. The procedures outlined in the DMP are designed so that the integrity of this data can be maintained for subsequent use. Tracking of data and completed work (e.g., scheduling and progress reports) will be done in order to monitor, manage and document the progress of the RI.

Procedures for controlling the receipt and distribution of incoming analytical data and outgoing results associated with this DMP are outlined below. In addition, data documentation records, RI file requirements, and the format to be used to present raw data are also noted.

Data Records

The data record, entered into a MS-DOS ASCII and/or Excel spreadsheet, will include the following:

- Sample or field measurement identification code
- Sample or field measurement location by source area and data type
- Sample or field measurement raw data
- Laboratory sample identification number (uniquely assigned)
- Specific property or component measured
- Results of analysis (concentration or field meter reading or descriptive logging)
- Units of analysis, where applicable (pH is unitless)

Chemical data may be received from the contracted laboratory in both hard copy and computerized form. The computerized data will be in a Lotus compatible spreadsheet format (*Lotus 1-2-3, Symphony, Excel*).

A hypothetical example of a typical database entry is shown below:

Header	
Sample/Field Measurement I.D. CodCL	CLSB02
Laboratory I.D. Number:	87HJ02
Sample Location:	Drainage Swale
Sample Type:	Soil
HNu Reading:	1 ppm (meter units)
Analyte Concentration Units:	μg/kg

Compound	**Raw Data**	**Qualifier or Conversion Factor (if necessary)**	**Concentration**
Mercury, Total	10	X	10
Mercury, Dissolved	0.001	X	0.001

As an additional identifier for logging of samples, each sample collected will have a self-explanatory sample code (determined by CH2M HILL) which includes the matrix designation and identification number.

A two-symbol alpha-code designation (-CL-) will be used to identify that the sample was collected at the Carter-Lee Lumber site under this plan.

Each sample collected will be identified by an alpha-code corresponding to the sample type, followed by the sample location number. The alpha-codes are to be used as follows:

- GW—groundwater
- SB—soil boring

- BK—background soil sample
- FB—field blank
- TB—trip blank
- FR—field replicate

Field blanks will have an FB followed by the alpha-code for the type of matrix the field blank was collected from (i.e., a soil boring blank will be FBSB). Trip blanks will be designated as TB. Duplicate samples will have the letter D following the two or four digit code described below.

Some samples will have a two or four digit number as the last component of the sample identifier. The first two digits will be used to complete the identification of the sample location within a specific sample type (reg. CLSB01). The second two digits (CLSB0102) will signify that this sample is the second sample taken at location CLSB01. Four digits will only be necessary at locations where sampling with depth occurs. In this case the depth of the sample corresponding to CLSB0102 will be recorded in the field log book and on soil boring logs, where applicable.

For example:

CLSB0102 = Carter-Lee Lumber, Soil sample two from soil boring No. 1. (The depth of the sample will be noted in the log book of the field person taking the sample.)

Tabular Displays

The following data will be presented in report tables:

- Sample location summary for a specific source area and for the facility-wide program

- All raw data

- Summary of the applicable analytical results for each source area investigated and the data subdivided by media (i.e., soil, groundwater, surface water)

- Summary of the results developed from the analytical data

- Water (surface water and groundwater) level measurements

- Results of any statistical analyses of the final data
- Final data that has been sorted by appropriate stratification factors

Graphic Displays

The following types of data will be presented:

- Area or plan maps of the boundaries of the Carter-Lee Lumber Site and specific source areas investigated under the RI
- Area or plan maps showing the locations of soil borings and monitóring wells, and if applicable, any grid arrangements and groundwater direction arrows
- Isopleth plots of water table elevations and topography where applicable
- Cross sectional diagrams of subsurface features and soil stratigraphy, including features potentially affecting intramedia transport where applicable
- Area or plan maps of contaminants
- Maps showing potential areas for further investigation as determined after evaluation of RI results
- Maps showing potential receptors in those areas surrounding and within the Carter-Lee Site.
- Three dimensional representation of changes in concentration with time and depth and distance from each source (if applicable)

File Organization

Files, including computerized data, for all original RI analytical data obtained during this investigation will be maintained according to procedures outlined below. In accordance with the ACO, all records will be retained for 6 years after the pendency of the Consent Order.

Receipt of Data and Reports

For CH2M HILL, all incoming data and reports will be logged in to the central file as incoming documents and then will be appropriately placed on the central file system discussed in the QAPP. All analytical results from the laboratories will be keyed to the same sample identification numbers assigned by CH2M HILL during sample collection. The RI team members will work from copies of incoming documents. The original documents will be kept in the central files. Field log books will also be kept as part of the central file and considered original documents.

Outgoing Data and Reports

All outgoing data, maps and reports will be reviewed by the project manager prior to delivery to any outside party.

Document Filing and Access

Access to the CH2M HILL central file will be limited to the RI team and other authorized individuals. The removal of information or documents from this file will be controlled by CH2M HILL through the use of a signout card. In addition, an up-to-date marker index will be maintained by CH2M HILL to record all additions or deletions to this central file. This index will enable the RI team to track the location of all files. It will be the responsibility of each RI team member or other user of these files to ensure that all project documents are properly signed out and returned promptly. All original field notebooks, log sheets and other information will be returned to a locked, fire-proof file cabinet at Carter-Lee from the CH2M HILL central file upon project completion.

Computer Data Storage

All chemical and physical data generated during this RI "project" will be stored in paper document form. In addition, any data that is not electronically transferred (such as field data) will be computerized and stored in a spreadsheet program. Data entry will be performed by a data processing technician and all data entered on the computer will be checked against the original hard copy of the data to ensure that they were entered correctly. This computer database will include a list for each media or event of the parameters listed in the Field Sampling Plan (Appendix A).

This data base and all data analyses output will be stored in both hard copy and 3½ inch floppy disk forms (with backup). Updated versions of previously recorded data will be noted at the top of each file using a header notation containing the date of last file entry and the user's name.

GLT338/017.511

Appendix B

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Sample/Field Measurement I.D. CodCL	CLSB02
Laboratory I.D. Number:	87HJ02
Sample Location:	Drainage Swale
Sample Type:	Soil
HNu Reading:	1 ppm (meter units)
Analyte Concentration Units:	μg/kg

Compound	Raw Data	Qualifier or Conversion Factor (if necessary)	Concentration
Mercury, Total	10	X	10
Mercury, Dissolved	0.001	X	0.001

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- Summary of the results developed from the analytical data

- Water (surface water and groundwater) level measurements

- Results of any statistical analyses of the final data
- Final data that has been sorted by appropriate stratification factors

Graphic Displays

The following types of data will be presented:

- Area or plan maps of the boundaries of the Carter-Lee Lumber Site and specific source areas investigated under the RI
- Area or plan maps showing the locations of soil borings and monitoring wells, and if applicable, any grid arrangements and groundwater direction arrows
- Isopleth plots of water table elevations and topography where applicable
- Cross sectional diagrams of subsurface features and soil stratigraphy, including features potentially affecting intramedia transport where applicable
- Area or plan maps of contaminants
- Maps showing potential areas for further investigation as determined after evaluation of RI results
- Maps showing potential receptors in those areas surrounding and within the Carter-Lee Site.
- Three dimensional representation of changes in concentration with time and depth and distance from each source (if applicable)

File Organization

Files, including computerized data, for all original RI analytical data obtained during this investigation will be maintained according to procedures outlined below. In accordance with the ACO, all records will be retained for 6 years after the pendency of the Consent Order.

Receipt of Data and Reports

For CH2M HILL, all incoming data and reports will be logged in to the central file as incoming documents and then will be appropriately placed on the central file system discussed in the QAPP. All analytical results from the laboratories will be keyed to the same sample identification numbers assigned by CH2M HILL during sample collection. The RI team members will work from copies of incoming documents. The original documents will be kept in the central files. Field log books will also be kept as part of the central file and considered original documents.

Outgoing Data and Reports

All outgoing data, maps and reports will be reviewed by the project manager prior to delivery to any outside party.

Document Filing and Access

Access to the CH2M HILL central file will be limited to the RI team and other authorized individuals. The removal of information or documents from this file will be controlled by CH2M HILL through the use of a signout card. In addition, an up-to-date marker index will be maintained by CH2M HILL to record all additions or deletions to this central file. This index will enable the RI team to track the location of all files. It will be the responsibility of each RI team member or other user of these files to ensure that all project documents are properly signed out and returned promptly. All original field notebooks, log sheets and other information will be returned to a locked, fire-proof file cabinet at Carter-Lee from the CH2M HILL central file upon project completion.

Computer Data Storage

All chemical and physical data generated during this RI "project" will be stored in paper document form. In addition, any data that is not electronically transferred (such as field data) will be computerized and stored in a spreadsheet program. Data entry will be performed by a data processing technician and all data entered on the computer will be checked against the original hard copy of the data to ensure that they were entered correctly. This computer database will include a list for each media or event of the parameters listed in the Field Sampling Plan (Appendix A).

This data base and all data analyses output will be stored in both hard copy and 3½ inch floppy disk forms (with backup). Updated versions of previously recorded data will be noted at the top of each file using a header notation containing the date of last file entry and the user's name.

1001046E.GLO

Appendix C

Endangerment Assessment Plan

Introduction

This Endangerment Assessment Plan (EAP) outlines the procedures that will be used in the Endangerment Assessment and the data collection activities necessary to identify risks associated with exposure scenarios for the Carter-Lee Lumber site.

Identification of Chemical of Potential Concern

The existing FIT sample results and the site history were reviewed to develop a list of chemicals that will be analyzed and potentially be evaluated in the risk assessment. The complete organic TCL and inorganic TAL were selected for analysis based on:

- Elevated PAHs and inorganics in FIT soil samples
- Reported dumping of unknown substances from railroad tank cars

Based on the results of the RI, chemicals of potential concern will be developed that will be the focus of the risk assessment.

Selection of the chemicals used in the risk assessment will include the following steps:

- Identify useable data
- Identify and compare onsite chemical concentrations to their background concentrations
- Identify onsite chemicals exceeding background RfDs or slope factors
- Identify onsite chemicals exceeding background environmental standards and criteria
- Review remaining onsite chemicals exceeding background based on concentration, toxicity, mobility, frequency of detection, or other issues
- Review chemicals used at the site
- Select onsite chemicals of potential concern that exceed background

Toxicity Assessment

For each chemical of potential concern, toxicity information and quantitative toxicity values, human health and environmental effects, and standards and criteria will be identified. Those chemicals with slope factors and RfDs will be identified and their values summarized. Sources for these data will include:

- IRIS
- Health Effects Assessment Summary Tables (HEAST)
- Toxicological Literature/EPA

The applicable environmental standards and criteria for the chemicals of potential concern, in the appropriate media (e.g., soil or groundwater) will be determined. TOXSYS will be consulted for the summary of U.S. EPA values. Appropriate state values will also be obtained.

The human health effects of the chemicals of potential concern will be summarized using the existing toxicity summary tables. If appropriate, the environmental effects of the chemicals of potential concern will be addressed and summarized.

Exposure Assessment

An exposure assessment will be made to identify how people may be exposed to contaminants of potential concern from the site, both under current and future site uses. The mechanism for contaminant release and transport will be identified and if appropriate, modeled. Exposure pathways will be identified. The populations at risk will be identified. The data used to identify potentially exposed populations, land use, and exposure patterns may include:

- Census data for the area
- Land use plans
- Zoning
- Population and growth projections
- Weather service data
- State and federal endangered species list
- Locations of well users
- Locations of hospitals, schools, nursing homes

To identify how people may come in contact with contaminants of potential concern from the site under current and future site use, the following tasks will be done:

- Identify sources of contaminants of potential concern
- Analyze release and transport mechanisms of contaminants of potential concern
- Identify potential exposure points
- Identify potential routes of exposure
- Identify potential receptors

Potential exposure pathways will be screened based on site-specific chemical and physical data to identify those potentially viable exposure pathways.

The exposure levels for each exposure pathway will be estimated based on the following information:

- Concentrations of contaminants of potential concern at the point of exposure
- Exposed individual/population
- Route of exposure
- Intake rates
- Frequency and duration of exposure
- Chemical specific absorption rates and bioavailability

The final result will be an estimate of contaminant intake.

Based on a preliminary site evaluation of the Carter-Lee Lumber site, potential exposure pathways associated with the site include future occupational/residential exposure to the soil at the site, occupational/residential exposure to groundwater downgradient of the site, and exposure of aquatic life to discharges of groundwater to the White River. Existing occupational/residential scenarios do not appear to be exposure pathways based on the preliminary site evaluation.

To estimate risks associated with dermal contact with, or inhalation of, contaminated soils at the site, surface and subsurface soil samples will be collected at several locations across the site from depths ranging from 0 to 12 inches (current exposures) to 25 feet (for potential future site development scenarios).

To estimate risks associated with ingestion of contaminated groundwater, groundwater samples will be collected from onsite wells and downgradient wells. Analysis of unfiltered samples will be performed to account for ingestion of suspended matter. Analysis of filtered samples for dissolved fractions will be included.

If groundwater is contaminated and is being used for industrial purposes, the Phase 2 investigation may be modified to include sampling and analysis to address existing occupational exposures to the groundwater (e.g. inhalation of VOCs volatilized from groundwater used as cooling water) and aquatic exposures to discharges of the industrially used groundwater to the White River.

Public Health Risk Characterization

The potential human health risks posed by the site will be assessed. This assessment combines information derived from the toxicity and exposure assessment to yield quantitative and qualitative estimates of risk.

The concentrations of potential concern at potential exposure points will be compared to applicable or relevant and appropriate standards for human health protection. For each quantified exposure pathway, the exposure estimates will be combined with the critical toxicity values to estimate the quantitative risks. For noncarcinogens, the intakes will be compared to RfDs, and individual excess lifetime cancer risks will be estimated for exposures to carcinogens.

Environmental Evaluation

The potential environmental effects associated with the site will be identified. Sampling and analysis of biota is not currently planned because of the industrial urban location of the site and because of the minimal potential for offsite contaminant migration (based on the current understanding of the site). Sampling and analysis of surface water, sediments, and biota may be necessary during Phase 2 if Phase 1 demonstrates potential for offsite migration, or if the Phase 1 environmental evaluation finds unique or sensitive environmental receptors.

Uncertainty Analysis

The major uncertainties associated with the risk assessment will be identified and their impacts on the risk estimation process evaluated.

GLT338/018.51

Appendix D
Health and Safety Plan

Appendix D
Health and Safety Plan

CH2M HILL HEALTH AND SAFETY PLAN

This plan will be kept onsite during field activities and will be reviewed and updated as necessary. This plan adopts, by reference, the standards of practice (SOP) contained in the CH2M HILL *Waste Management and Industrial Processes Discipline Health and Safety Manual, Volumes 1 and 2,* and other applicable CH2M HILL SOPs as appropriate. The Site Safety Coordinator (SSC) is to be familiar with these SOPs. In addition, this plan adopts procedures contained in the work plan for the project.

1.0 PROJECT INFORMATION AND DESCRIPTION

CLIENT OR OWNER: U.S. EPA Region 5 **PROJECT NO:** GLO65616.PP.QS

PROJECT MANAGER: Dale Cira/STL **OFFICE:** GLO/STL

SITE NAME: Carter-Lee Lumber Company

SITE ADDRESS: 1621 West Washington Street
Indianapolis, IN

DATE HEALTH AND SAFETY PLAN PREPARED: June 5, 1992

DATE(S) OF INITIAL VISIT: April 27, 1992

DATE(S) OF SITE WORK: Phase 1: November 2-8, 1992
Phase 2: December 7-20, 1992

SITE ACCESS: The investigative area of the property is accessed by traversing the active lumber retail area at the north of the site. The property entrance is on Washington Street. Access agreements are being negotiated by U.S. EPA.

SITE SIZE: Approximately 4 acres

SITE TOPOGRAPHY: Relatively flat, gentle slope to the southeast; paved 3/4 with asphalt, 1/4 with compacted gravel.

SITE DESCRIPTION AND HISTORY: Carter-Lee is an active, retail lumber yard. The "site" is 4 acres located at the southern portion of the property. It has been developed with 4 storage buildings and has been paved in asphalt and gravel, and is currently used for the storage of lumber and building materials. The primary concerns at this site are the presence of heavy metals and polynuclear aromatic hydrocarbons in shallow soils. Neutralized metal cleaning acids had been disposed at the site through land application and sources for PAHs have not been identified.

GLO65616.PP.QS SITE MAP NO FIT 6-11-92 vls

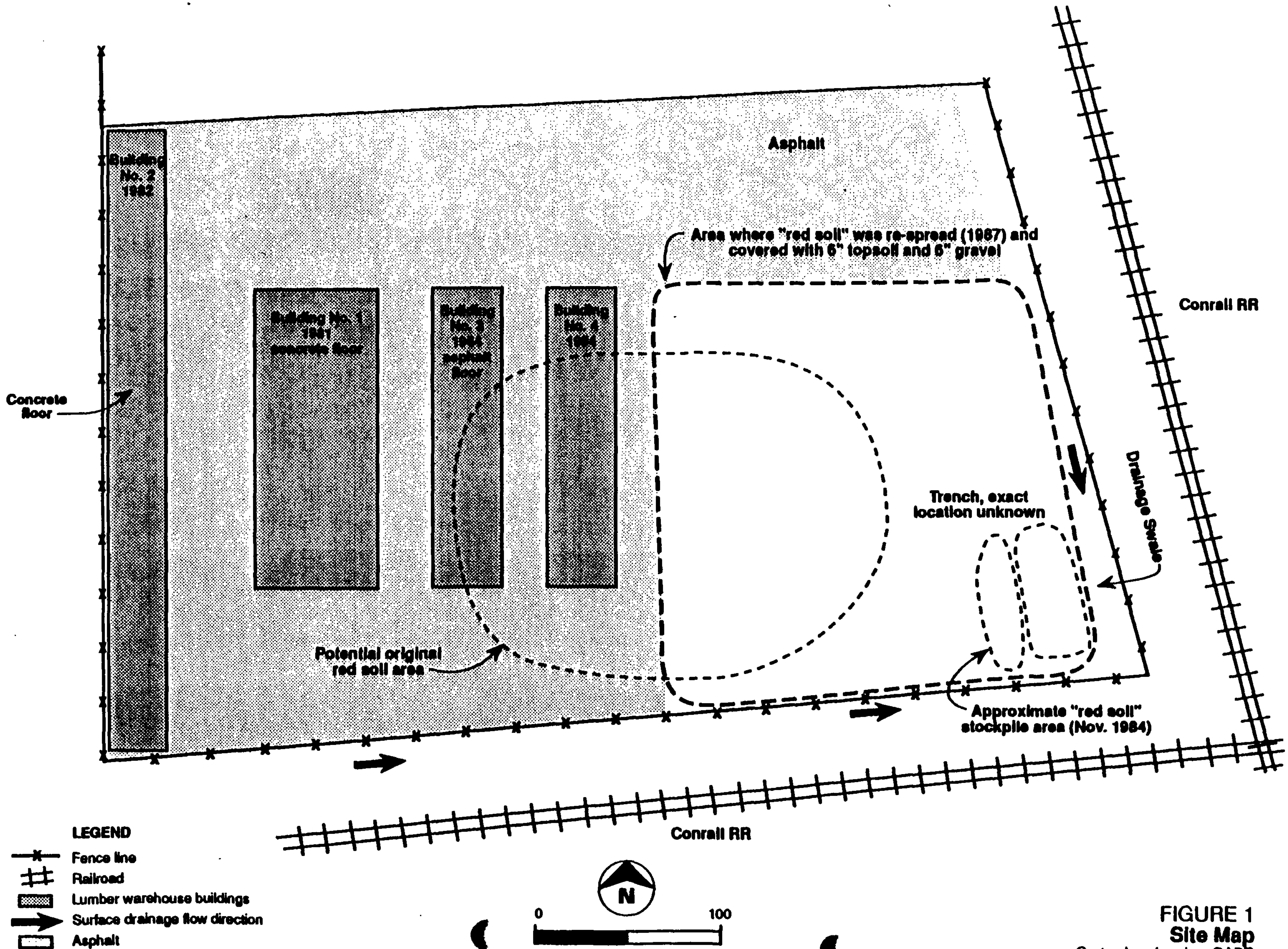


FIGURE 1
Site Map
Carter-Lee Lumber QAPP

2.0 PROJECT ORGANIZATION AND TASKS TO BE PERFORMED UNDER THIS PLAN

2.1 PROJECT ORGANIZATION

The U.S. EPA is the client on this project. CH2M HILL is performing the site investigation under ARCS V contract. A description of the field team is provided below.

Bill Bolen	Regional Project Manager for EPA
Dale Cira	CH2M HILL Project Manager
Dave Shekoski	Site Safety Coordinator
Laura Peterson	Field Team Leader
Tom Miller	Alternate field team leader/field support

Others to be assigned as field support

2.2 DESCRIPTION OF TASKS

Field activity will be broken down into two phases. Phase 1 will be implemented as a preliminary investigative phase. If Phase 1 findings warrant, a phase 2 field investigation will be implemented within a few weeks.

Phase 1 tasks:

- Collect shallow (0–12 inches) soil samples using hand auger methods
- Drill soil borings for the collection of deep subsurface soil samples (to be performed by others)
- Drill and install monitor wells (to be performed by others)
- Oversight of drilling
- Survey for elevation control (to be performed by others)
- Collect groundwater samples and obtain water level measurements

Phase 2 tasks:

- Additional shallow soil samples
- Additional soil borings
- Additional well installation and monitoring
- additional surveying

3.0 HAZARD EVALUATION AND CONTROL

3.1 HEAT AND COLD STRESS (REFERENCE CH2M HILL SOP HS-09)

3.1.1 GUIDELINES FOR WORKING IN TEMPERATURE EXTREMES WHILE WEARING PERSONAL PROTECTIVE EQUIPMENT (PPE)

Temperature	Work Cycle	Rest Cycle	Control Measures
< 32° F or < 55° F & raining	2 hrs	15 min	Review cold stress in safety meeting. Rest in a warm area. Drink at least 8 ounces of warm non-caffeinated, non-alcoholic beverage at each rest break. Schedule a mid-day lunch break of at least 30 minutes in a warm area to begin not later than 5 hours after startup.
72° to 77° F	2 hrs	5 min	Review heat stress in safety meeting. Take resting pulse rate before beginning work. Drink 8 ounces of cool water before beginning work, and 4 ounces at rest break. Have ice available.
77° to 82° F	2 hrs	5 min	As above, but seated rest break. Monitor pulse rate. (See below.)
82° to 87° F	60 min	15 min	As above, but rest area to be shaded.
87° to 90° F	30 min	15 min	As above. Try to provide a shaded work area.
> 0° F	15 min	15 min	As above. Provide a shaded area with seats in the work area for team members to use as needed. Try to reschedule work to avoid mid-day heat.

PULSE CRITERIA. Tace resting radial (wrist) pulse at start of work day; record it. Measure radial pulse for 30 seconds as rest period begins. Pulse not to exceed 110 beats per minute (bpm), or 20 bpm above resting pulse. If pulse exceeds this criteria, reduce work load and/or shorten the work cycle by one third, and observe for signs of heat stress. No team member is to return to work until his/her pulse has returned to < 110 bpm, or resting pulse +20 bpm.

3.1.2 SYMPTOMS AND TREATMENT OF HEAT AND COLD STRESS

Heat Stroke	Heat Exhaustion	Frostbite	Hypothermia
Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high body temperature.	Pale, clammy, moist skin; profuse sweating; weakness; normal temperature; headache; dizzy; vomiting.	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.
Cool victim rapidly by soaking in cool (not cold) water. Get medical attention immediately!!	Remove victim to a cool, air conditioned place. Loosen clothing, place in head low position. Have victim drink cool (not cold) water.	Remove victim to a warm place. Rewarm area quickly in warm (not hot) water. Have victim drink warm fluids—not coffee or alcohol. Do not break any blisters. Elevate the injured area and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids—not coffee or alcohol. Get medical attention.

3.2 PHYSICAL (SAFETY) HAZARDS AND CONTROLS (REFERENCE CH2M HILL SOP HS-03)

Hazard	Engineering or Administrative Controls
Flying debris/objects	Provide shielding and PPE.
Build-up of static electricity	No spark sources within 50 feet of an excavation, heavy equipment, or UST removal. Ground as appropriate.
High pressure hose rupture	Check to see that fitting and pressurized lines are in good repair before using.
Electrical shock	Make certain third wire is properly grounded. Do not tamper with electrical wiring unless qualified to do so.
Moving vehicles	Back-up alarm required for heavy equipment. Observer remains in contact with operator and signals safe back-up. Personnel to remain outside of turning radius.
Overhead electrical wires	Heavy equipment (e.g. drill rig) to remain at least 15 feet from overhead powerline for powerlines of 50 kV or less. For each Kv > 50 increase distance 1/2 foot.
Buried utilities, drums, tanks, and so forth.	Locate buried utilities, drums, tanks, etc., prior to digging or drilling and mark location (see Section 3.3).
Slip, trip, fall hazards due to muddy work areas	Use wood pallets or similar devices in muddy work areas.
Back injury	Use proper lifting techniques, or provide mechanical lifting aids.
Protruding objects	Flag visible objects.

3.3 PROCEDURES TO LOCATE BURIED UTILITIES

The preliminary investigation information indicates the site has been undeveloped prior to its purchase and the potential for the presence of underground utilities is not considered likely.

CH2M HILL will work with the property owner and U.S. EPA to clear underground utilities with the local utility companies and coordinate with the property owners to obtain information on utilities that may have been installed by the owner.

3.4 HAZARDS POSED BY CHEMICALS BROUGHT ONSITE

Refer to CH2M HILL *Hazard Communication Program Manual* which is available from the Corporate Human Resources Department in Denver. The Project Manager is to request Material Safety Data Sheets (MSDSs) from the client, or contractors and subcontractors for chemicals that CH2M HILL employees are potentially exposed to.

Chemical	Location
HNu or OVA calibration gas (isobutylene)	Work Area
CGI Calibration Gas (2% methane in air)	Work Area

3.5 KNOWN CONTAMINANTS OF CONCERN (See Table 1 (Attachment 4) of Preliminary Site Evaluation Report)

Contaminant	Location and Highest Concentration (solid media: mg/kg or liquid media: $\mu g/L$)	OSHA PEL, TWA	IDLH (ppm)	Symptoms and Effects of Exposure	PIP
Benzo(a)pyrene	SX-2, SX-5			•	
Methyl ethyl ketone	SX-3, SX-4	200 ppm		Irritant to eyes and nose	9.54
Chrysene	SX-2 SX-5			•	
Diethylphthalate	SX-1, SX-2	5 mg/m^3			
Naphthalene	SX-2, SX-5	10 ppm		Irritant to eyes	8.12
Tetrachloroethane	SX-1, SX-2, SX-3, SX-5	1 ppm		Irritant to eyes	11.1
Toluene	SX-1, SX-2, SX-5	100 ppm		Fatigue, weakness	
Aluminum	SX-1, 2, 3, 4, 5	10 mg/m^3			
Arsenic	SX-1, 2, 3, 4, 5	0.2 mg/m^3		•	
Cadmium	SX-1, 2, 3, 4	0.05 mg/m^3		•	
Chromium	SX-1, 2, 3, 4, 5	0.05 mg/m^3		•	
Copper	SX-1, 2, 3, 4, 5	1 mg/m^3			
Cyanide	SX-1, 2, 3, 4, 5	5 mg/m^3			
Lead	SX-1, 2, 3, 4, 5	0.15 mg/m^3		•	
Mercury	SX-1, 2, 3, 4, 5	0.1 mg/m^3			
Nickel	SX-1, 2, 3, 4	1 mg/m^3		•	
Silver	SX-1, SX-3	1 mg/m^3			
Zinc	SX-1, 2, 3, 4, 5	0.01 mg/m^3		•	

Note 1: Lower value of PEL, REL, or TLV listed.
Note 2: NL = no limit found in reference materials.
Note 3: PIP = photoionization potential

Note 4: Location refers to physical location. Abbreviations specify media:
A (AIR) D (DRUMS) F (FLYASH) GW (GROUNDWATER) L (LAGOON) TK (TANK)
S (SOIL) SL (SLUDGE) SW (SURFACE WATER)
•Suspected human carcinogen. Exposure: as low as reasonably achievable.

3.6 POTENTIAL ROUTES OF EXPOSURE

DERMAL:	INHALATION:	OTHER:
Organics (see Table 1 in Attachment 4)	Organics and inorganics (see Table 1 in Attachment 4)	

4.0 PERSONNEL

4.1 CH2M HILL EMPLOYEES (REFERENCE CH2M HILL SOP HS-01 AND HS-02)

Employees listed below are enrolled in the CH2M HILL chemical protection program (CPP) and meet the medical surveillance, 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training requirements of OSHA 29CFR1910.120. Employees designated "SSC" have received 8 hours of supervisor and 8 hours of instrument training and can serve as site safety coordinator (SSC) for the level of protection indicated. There must be one SSC present during any task performed in exclusion or decontamination zones with the potential for exposure to safety and health hazards. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. There must be one FA-CPR designated employee present during any task performed in exclusion or decontamination zones with the potential for exposure to safety and health hazards. The "buddy system" requirements of OSHA 29CFR1910.120 are to be met at all times.

Employee Name	Office	Responsibility	SSC/FA-CPR
Laura Peterson	GLO	Field Team Leader	
Dave Shekoski	GLO	Site Safety Coordinator	Level (C) SSC; FA-CPR
Dale Cira	STL	Project Manager	
Tom Miller	STL	Field Support	

4.2 HEALTH AND SAFETY AND FIELD TEAM CHAIN OF COMMAND AND PROCEDURES

4.2.1 CLIENT

U.S. EPA Region 5

4.2.2 CH2M HILL

Al Sloan
ARCS 5 Program Manager

5.0 PERSONAL PROTECTIVE EQUIPMENT (PPE) SPECIFICATION[1] (Reference CH2M HILL SOP HS-07 and HS-08)

Task	Level	Body	Foot	Head[2]	Eye	Hand	Respirator
All	D	Tyvek or Equal	Rubber boots or steel toed	Hardhat	Safety glasses	Vinyl inner neoprene outer	None required.
	C	Tyvek or Equal	Rubber boots or steel toed	Hardhat	Safety glasses	Vinyl inner neoprene outer	APR, full face, MSA Ultratwin or equivalent, cartridges:

Note 1: Modifications:
Note 2: The SSC shall specify hardhat areas.
Note: Hearing protection is to be used when working near drill rigs, compressors, etc.

5.1 REASONS TO UPGRADE OR DOWNGRADE LEVEL OF PROTECTION

Upgrade	Downgrade
• Request of individual performing task. • Change in work task that will increase contact or potential contact with hazardous materials. • Occurrence of dust airborn. • Known or suspected presence of dermal hazards. • Instrument action levels (Section 6.0) 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.

6.0 AIR MONITORING EQUIPMENT SPECIFICATION (Reference CH2M HILL SOP HS-06)

Instrument	Tasks	Action Levels		Frequency	Calibration
CGI:		0–10% LEL 10–25% LEL > 25% LEL	No expl.[1] hazard Pot.[2] expl. hazard Expl. hazard; evacuate or vent	See 6.2	Daily prior to work
Photoionization Detection (PID)		0–1.0 ppm[ab4] 1.0–10 ppm[ab]	Level D Level C	See 6.2	Daily prior to work

Note 1: expl = explosion Note 2: pot = potential Note 3: def = deficient Note 4: ab = above background

6.1 CALIBRATION SPECIFICATION

Instrument	Gas	Span	Reading	Method
PID: HNU. 11.7 eV probe	100 ppm isobutylene	5.0 ± 2.0	68 ppm	1.5 l/m reg T-tubing 0.25 l/m reg direct tubing
CGI: MSA 260. 261. 360. or 361	0.75% pentane	N/A	50% LEL ± 5 % LEL	1.5 l/m reg direct tubing

6.2 AIR SAMPLING

Method and Description:

Explosimeter (requires an inhibitor filter for leaded gasoline)

Leaded gasoline will poison the detector filament, rendering the instrument useless if a filter is not available. Monitor continuously during soil disturbance, tank work, and other operations in the exclusion zone that may involve release of petroleum or natural gas vapors. (If the explosimeter does not have an inhibitor filter for leaded gasoline, take readings at least every 15 minutes, then purge the instrument in clean air.) The explosimeter is required to be used in concert with the HNu, TIP, or OVA in order to monitor the flammability/explosivity hazard at the source (i.e., borehole). The organic vapor meter is used primarily for breathing zone measurements to assess potential exposure.

HNu with 11.7 eV Probe

Take background readings in an upwind position in an area without suspected contamination. Take readings in the breathing zone upon initiating site work. Record readings at least every half hour in the breathing zone. The instrument should be consulted more frequently than every half hour to determine if action levels are met. Spikes above level do not call for an upgrade, but do require continuous monitoring until levels stabilize. During continuous monitoring, record levels every 10 minutes. Recharge at the end of each day.

7.0 DECONTAMINATION SPECIFICATION (Reference CH2M HILL SOP HS-13)

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: collect in 55-gallon drum for authorized disposal	Water disposal method: onsite sewer to Indianapolis Wastewater Treatment Plant
Body suit removal		
Inner glove removal		
Respirator Removal		
Hand wash/rinse		
Face wash/rinse		
Shower ASAP		
PPE disposal method: Place in 55-gallon drum for future disposal by Carter-Lee Lumber		
Water disposal method: onsite sewer to Indianapolis Wastewater Treatment Plant		

8.0 WORK PROCEDURES

8.1 WORK PRACTICES

- No spark sources within exclusion or decontamination zones.
- Avoid visibly contaminated areas.
- No eating, drinking, or smoking in contaminated areas, or exclusion or decontamination zones.
- SSC to establish areas for eating, drinking, smoking.
- No contact lenses in exclusion or decontamination zones.
- No facial hair that would interfere with respirator fit if Level C or B is anticipated.

- Site work will be performed during daylight hours whenever possible. Any work conducted during hours of darkness will require enough illumination intensity "to read a newspaper without difficulty."

8.2 SITE CONTROL MEASURES

- Site safety coordinator (SSC) to conduct site safety briefing (see below) before starting field activities, or as tasks and site conditions change.
- SSC records safety briefing attendance in logbook, and documents topics discussed.
- Post OSHA job site poster in a central and conspicuous location at the site.
- Determine wind direction.
- Chemicals to be stored in proper containers.
- MSDSs are available for onsite chemicals employees exposed to.
- Establish offsite communications.
- Establish procedures for disposal of material generated onsite.
- Initial air monitoring conducted by SSC in appropriate level of protection.
- SSC to conduct periodic inspections of work practices to determine effectiveness of this plan. Deficiencies to be noted, reported to DHSM or RHSM, and corrected.
- Site safety briefing topics: general discussion of health and safety plan; site specific hazards; location of work zones; PPE requirements; equipment; special procedures; emergencies.

9.0 EMERGENCY RESPONSE PLAN (REFERENCE CH2M HILL SOP HS-12)

9.1 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.

- Locate nearest telephone to the site and inspect onsite communications.
- Locate chemical, safety, radiological, biological hazards.
- Confirm and post emergency telephone numbers and route to hospital.
- Post site map marked with location of emergency equipment and supplies.
- Review emergency response plan for applicability to any changed site conditions, alterations in onsite operations, or personnel availability.
- Evaluate capabilities of local response teams.

- 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 and supplies.

- Review emergency procedures for personnel injury, exposures, fires, explosions, chemical and vapor releases with field personnel.

- Locate onsite emergency equipment and supplies of clean water.

- Verify local emergency contacts, hospital routes, evacuation routes, and assembly points.

- Drive route to hospital.

- Review names of onsite personnel trained in first aid and CPR.

- Review notification procedures for contacting CH2M HILL's medical consultant and team member's occupational physician.

- Rehearse the emergency response plan once prior to site activities.

- Brief new workers on the emergency response plan.

9.2 EMERGENCY EQUIPMENT AND SUPPLIES

The SSC marks the locations of emergency equipment on the site map and posts the map in the support zone.

- ABC fire extinguisher
- Industrial first aid kit
- Additional emergency equipment: portable emergency eyewashes will be kept within 100 feet of the work area

9.3 EMERGENCY MEDICAL TREATMENT

- The SSC will assume charge during a medical emergency until the ambulance arrives, or the injured person is admitted to the emergency room.

- Prevent further injury.

- Initiate first aid and CPR.

- Call the ambulance and hospital.

- Determine if decontamination will make injury worse. Yes—seek medical treatment immediately.

- Make certain that injured person is accompanied to emergency room.

- Notify the Project Manager of the injury.
- Notify the District or Regional Health and Safety Manager.

- Notify the injured person's human resources department.

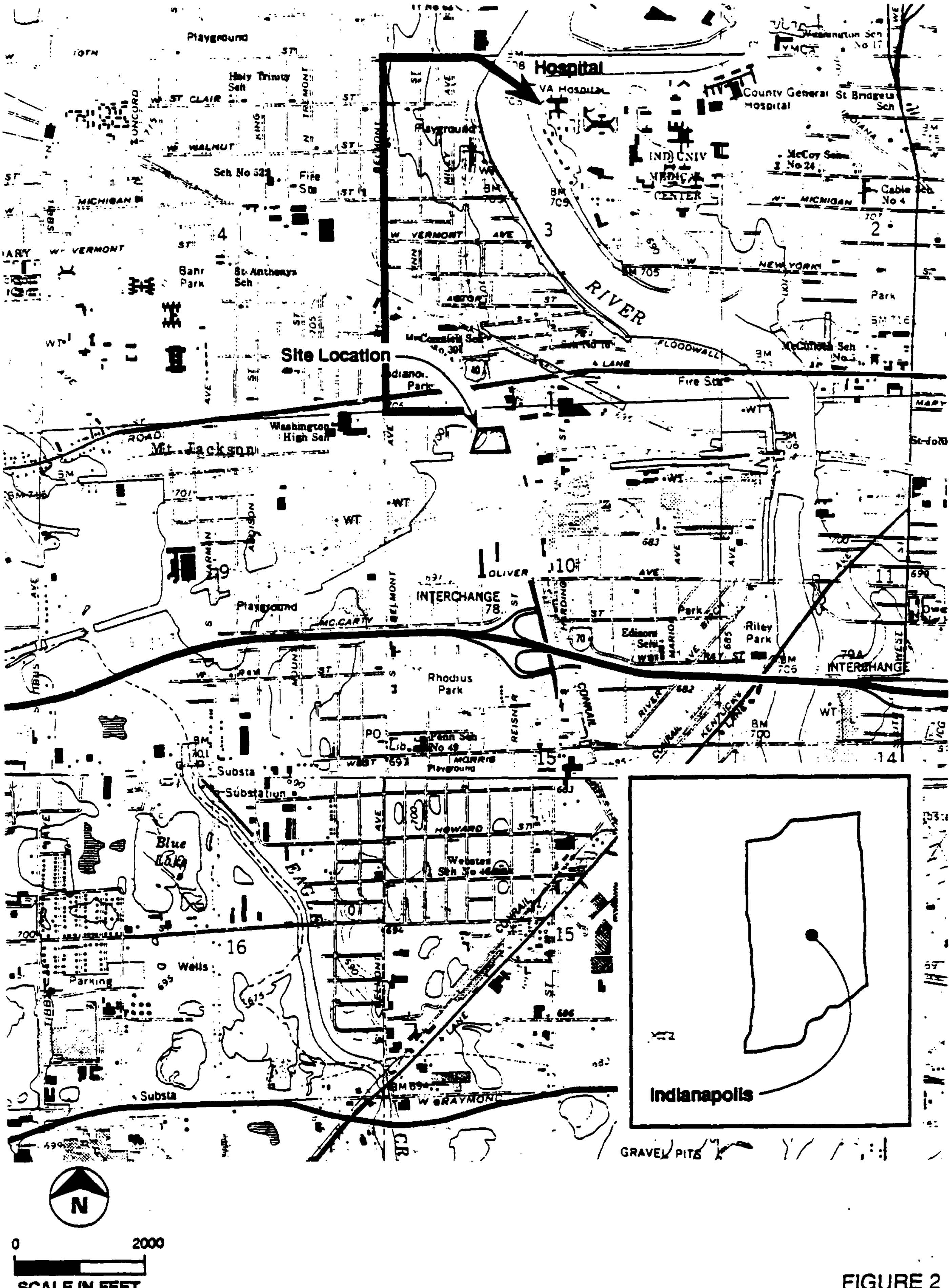
10.0 EMERGENCY RESPONSE TELEPHONE NUMBERS

Site Address:	1621 Washington Street Indianapolis, IN	**Phone:**	
Police: **Address:**		**Phone:**	911
Fire: **Address:**		**Phone:**	911
Ambulance: **Address:**		**Phone:**	911
Water:	Indianapolis Water Co.	**Phone:**	317/631-1431
Gas:	Citizens Gas & Coke Utility	**Phone:**	317/924-3311
Electric:	Indianapolis Power & Light Co.	**Phone:**	317/261-8111
Hospital: **Address:**	University Hospital 1100 West Michigan St Indianapolis, IN 46223	**Phone:**	635/8431

Route To Hospital: **(Refer to map Page 17.)**

10.1 GOVERNMENT AGENCIES INVOLVED IN PROJECT

Federal:	U.S. EPA	**Phone:**	312/353-6316
State:	IDEM	**Phone:**	317/232-3210
Local:		**Phone:**	



Map Source: USGS Indianapolis West, Ind. 7.5 Min. Quadrangle, 1967

FIGURE 2
Route to Hospital
Carter-Lee Lumber

11. EMERGENCY CONTACTS

CH2M HILL Medical Consultant Dr. Kenneth Chase Washington Occupational Health Associates 202/463-6698 (8 AM to 5 PM EST) 202/463-6440 (after hours answering service: physician will return call within 30 minutes)	**Occupational Physician (Regional or Local)** Park Crest Medical Clinic 2665 South Moorland Road New Berlin, WI 53151 414/786-1199
Corporate Director Health and Safety Name: Marty Mathamel/WDC Phone: 703/471-1441	
District Health and Safety Manager (DHSM) Name: Jane Stansfield Phone: 303/771-0900	**Regional Manager** Name: Gary Beech Phone: 414/272-2426
Regional Health and Safety Manager (RHSM) Name: Curt Poutsch Phone: 414/272-2426	**Project Manager** Name: Dale Cira Phone: 314/421-0900
Radiation Health Manager (RHM) Name: George Stephens/ORO Phone: 615/483-9032	**Regional Human Resources Department** Name: Marty Oldham Phone: 414/272-2426
Client Name: Deborah Orr U.S. EPA 312/886-7576	**Corporate Human Resources Department** Name: Beth Brown/DEN Phone: 303/771-0952 If an injury occurs, notify the injured person's personnel office as soon as possible after obtaining medical attention for the injured. Notification MUST be made within 24 hours of the injury.

12.0 PLAN APPROVAL

This site safety plan has been written for use by CH2M HILL. CH2M HILL claims no responsibility for its use by others, unless 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 these conditions change.

PLAN WRITTEN BY: Dale Cira/STL **DATE:** June 5, 1992

PLAN APPROVED BY: **DATE:**

12.1 PLAN AMENDMENTS

DATE: **CHANGES MADE BY:**

CHANGES TO PLAN:

APPROVED: **DATE:**

12.2 PLAN AMENDMENTS

DATE: **CHANGES MADE BY:**

CHANGES TO PLAN:

APPROVED: **DATE:**

13.0 Attachments TO PLAN

Attachment 1: Employee signoff

Attachment 2: Form 533

Attachment 3: Applicable MSDSs

Attachment 4: Table 1

Note: Once approved, a copy of this plan should be forwarded to Marty Mathamel/ WDC.

10010409.GLO

Attachment 1

EMPLOYEE SIGNOFF

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

EMPLOYEE NAME	EMPLOYEE SIGNATURE /DATE

:0010409.GLO

ATTACHMENT 2

FORM 533
RECORD OF HAZARDOUS WASTE FIELD ACTIVITY

SITE NAME:
SITE SAFETY COORDINATOR:
PROJECT NUMBER:
RECORD OF ACTIVITIES FOR (DATES):

EMPLOYEE NAME / NUMBER	TOTAL DAYS ONSITE	DAYS IN LEVEL B	DAYS IN LEVEL C	DAYS IN LEVEL D	DAYS AS SSC LEVEL B	DAYS AS SSC LEVEL C	DAYS AS SSC LEVEL D	ACTIVITIES PERFORMED

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 674

ISOBUTYLENE

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: ISOBUTYLENE

Description (Origin/Uses): Obtained from refinery steams by absorption on 65% sulfuric acid (H_2SO_4) at 59°F (15°C). Used primarily to produce diisobutylene, trimers, butyl rubber, and other polymers; also used to produce antioxidants for foods, plastics, and packaging food supplements.

NFPA: 4 (flammability), 1 (health), 0 (reactivity), - (special)

Other Designations: Isobutene; 2-Methylpropene; gamma-Butylene; $CH_2{=}C(CH_3)_2$; CAS No. 0115-11-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS			
H	1	R	1
F	4	I	1
R	0	S	1
PPG*		K	4

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Isobutylene, CAS No. 0115-11-57	Ca 100	OSHA PEL None Established ACGIH TLV, 1988-89 None Established NIOSH REL None Established Toxicity Data* Rat, Inhalation, LC_{50}: 620 g/m³ (4 Hrs) Mouse, Inhalation, LC_{50}: 415 g/m³ (2 Hrs)
*Monitor NIOSH, *RTECS* (UD0890000), for additional data.		

SECTION 3. PHYSICAL DATA

Boiling Point: -19.6°F (-6.9°C)
Melting Point: -220°F (-140°C)
Vapor Density (Air = 1): 1.9
Specific Gravity (H_2O = 1): Ca 0.6

Molecular Weight: 56 Grams/Mole
Solubility in Water (%): Insoluble*
% Volatile by Volume: 100

Appearance and Odor: A colorless, extremely flammable gas; odor not listed.

*Isobutylene is very soluble in alcohol, ether, and sulfuric acid.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: 869°F (465°C)	LEL: 1.8% v/v	UEL: 9.6% v/v

Extinguishing Media: Isobutylene gas is an extremely flammable gas that has a substantial explosive air-gas range. For isobutylene fires, the recommended fire-fighting technique is to stop the flow of gas instead of extinguishing the fire. If the flames are extinguished and the isobutylene gas continues to escape or leak, an explosive air-gas mixture can form quickly and ignite without warning. A resulting explosion could cause greater damage than that which would be caused by allowing the fire to burn itself out. If the fire must be extinguished to allow safe access to shutoff valves, recommended extinguishing agents include CO_2 and dry chemical. **Unusual Fire or Explosion Hazards:** In many cases, the preferred strategy is to allow the flames to continue to burn and to cool the surroundings with water spray to prevent ignition of nearby combustibles. Isobutylene gas is heavier than air and can collect in low-lying, confined spaces. Potentially explosive air-gas mixtures are especially likely to build up in such an area, so enter it with extreme caution whether or not it is presently involved in a fire. Possible sources of ignition must not be brought into any area suspected of containing substantial concentrations of isobutylene gas. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Sax (Genium ref. 6) reports a flash point of -105°F (-76°C) for isobutylene.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Isobutylene is stable in closed, pressurized containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Isobutylene can react dangerously with strong oxidizing materials. **Conditions to Avoid:** Prevent exposing isobutylene to any source of ignition such as an open flame, sparks, lighted tobacco products, or steam lines. **Hazardous Products of Decomposition:** Isobutylene fires can produce toxic gases such as carbon monoxide (CO) or lower-molecular-weight hydrocarbons. **Comments:** The extreme flammability of isobutylene means that any reactions involving this material, including nonhazardous ones, must be performed carefully in order to prevent fires and/or explosions.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Isobutylene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Isobutylene is a simple asphyxiant. As such it will not cause significant physiological responses, but it can displace the minimum required atmospheric oxygen level. Significant displacement by isobutylene results in an oxygen-deficient atmosphere with no

SECTION 6. HEALTH HAZARD INFORMATION, cont.

lene gas is almost twice as dense as air itself (see sect. 3). **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** None reported. **Primary Entry:** Inhalation. **Acute Effects:** Initial symptoms of the effects of simple asphyxiant gases are rapid respiration and air hunger, diminished mental alertness, and impaired muscular coordination. Continuing lack of oxygen causes faulty judgment, depression of all sensations, rapid fatigue, and emotional instability. As the asphyxia continues, nausea; vomiting; prostration; loss of consciousness; and, finally, convulsions; deep coma; and death can occur. **Chronic Effects:** None reported.

FIRST AID: Inhalation. Would-be rescuers need to be concerned about their own safety when entering confined, poorly ventilated, oxygen-deficient areas. Self-contained breathing equipment must be readily available for rescuers. Station standby workers outside the immediate area so that they can summon additional help if it is needed. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Comments:** The extreme flammability of isobutylene gas warrants special attention even during rescue operations. Rescue personnel must not smoke. All emergency lamps and floodlights that must be lowered into enclosed areas for rescue operations must be explosion proof. Obtain this equipment before any emergency occurs and make it accessible to emergency-response personnel. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any isobutylene gas leak as an emergency.* If the leaking gas has not yet ignited, use water spray to direct flammable gas-air mixtures away from sources of ignition. Extinguish all sources of ignition as quickly as possible; however, if the leaking gas is burning, do not attempt to extinguish the flames until the source of the isobutylene gas is located and sealed. Otherwise, flammable isobutylene gas-air mixtures can explode without warning and cause widespread damage that might not have occurred if the original fire had been allowed to burn itself out. If it is necessary to extinguish isobutylene flames in order to gain access to a shutoff valve, use dry chemical or carbon dioxide as extinguishing agents. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z): Not Listed

EPA Designations (40 CFR 302.4): Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres, which lack warning properties; to work in them safely requires that an SCBA be worn. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the lower explosive limit listed in section 4. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. **Comments:** Practice good personal hygiene; always wash thoroughly *after* using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale isobutylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store isobutylene in closed, pressurized containers in a cool, dry, well-ventilated area away from sources of ignition, combustible materials, and strong oxidizers. Protect containers from physical damage. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent static sparks. **Comments:** Isobutylene is an extremely explosive and flammable gas. It must not be exposed to any possible source of ignition in work or storage areas.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Liquefied Petroleum Gas
DOT Hazard Class: Flammable Gas
ID No. UN1055
DOT Label: Flammable Gas
DOT Packaging Requirements: 49 CFR 173.304, .314, .315
DOT Packaging Exceptions: 49 CFR 173.306

IMO Shipping Name: Isobutylene
IMO Hazard Class: 2.1
IMO Label: Flammable Gas

References: 1, 6, 84-94, 116, 117, 120, 122.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: W Silverman, MD

American Burdick & Jackson
Material Safety Data Sheet

MATERIAL SAFETY DATA SHEET

PENTANE

emergency telephone no. 312/973-3600 (American Scientific Products)
chemtrec telephone no. 800/424-9300
information telephone no. 616/726-3171 (American Burdick & Jackson)

I. Identification

chemical name: Pentane — molecular weight: 72.15
chemical family: Aliphatic Hydrocarbon — formula: C_5H_{12}
synonyms: n-Pentane
DOT proper shipping name: Pentane
DOT hazard class: Flammable Liquid
DOT identification no.: UN1265 — CAS no.: 109-66-0

II. Physical and Chemical Data

boiling point, 760mm Hg.: 36.07°C — freezing point: -129.7°C — evaporation rate: (BuAc=1) ca 29
vapor pressure at 20°C: 420 mm Hg — vapor density (air = 1): 2.5 — solubility in water: @ 20°C 0.04%
% volatiles by volume: ca 100 — specific gravity (H_2O = 1): @ 20°C 0.626 — stability: Stable
hazardous polymerization: Not expected to occur.
appearance and odor: Clear, colorless liquid with a mild hydrocarbon odor.
conditions to avoid: Heat, sparks, open flame, open containers, and poor ventilation.
materials to avoid: Strong oxidizing agents.
hazardous decomposition products: Incomplete combustion can generate carbon monoxide and other toxic vapors.

III. Fire and Explosion Hazard Data

flash point (test method): -40°C (Tag closed cup) — auto ignition temperature: 296°C
flammable limits in air % by volume: lower limit: 1.5 — upper limit: 7.8
unusual fire and explosion hazards: Very volatile and extremely flammable.
extinguishing media: Carbon dioxide, dry chemical or foam.
special fire fighting procedures: Water will not be effective in extinguishing a fire and may spread it, but a water spray can be used to cool exposed containers. Wear full protective clothing and self-contained breathing apparatus. Heat will build pressure and may rupture closed storage containers.

IV. Hazardous Components

	%	TLV	CAS no.
Pentane	ca 100	600 ppm	109-66-0

V. Health Hazards

Occupational Exposure Limits

OSHA	8-hour PEL	-	1000 ppm
	Ceiling	-	not listed
	Peak	-	not listed
ACGIH	TLV-TWA	-	600 ppm
	TLV-STEL (15-min)	-	750 ppm
NIOSH	TLV-TWA	-	120 ppm
	TLV-C	-	610 ppm

Concentration Immediately Dangerous to Health

OSHA/NIOSH	5,000 ppm

Odor Threshold

NIOSH	2.2 ppm
OHS	10 ppm
NSC	not listed

Primary Routes of Entry

Pentane may exert its effects through inhalation, skin absorption, and ingestion.

Industrial Exposure: Route of Exposure/Signs and Symptoms

Inhalation:	Exposure can cause dizziness, headache, nausea, and narcosis.
Eye Contact:	Liquid and high vapor concentration can be irritating.
Skin Contact:	Prolonged or repeated skin contact can cause irritation and dermatitis through defatting of skin.
Ingestion:	Can cause gastrointestinal tract discomfort.

Effects of Overexposure

Pentane is a mild eye and mucous membrane irritant, primary skin irritant, and central nervous system depressant. Acute exposure irritates the eyes and respiratory tract. Extreme concentrations can produce drowsiness and other signs of narcosis. Chronic exposure can cause dermatitis.

Medical Condition Aggravated by Exposure

Preclude from exposure those individuals susceptible to dermatitis.

Emergency First Aid

Inhalation:	Immediately remove to fresh air. If not breathing, administer mouth-to-mouth rescue breathing. If there is no pulse administer cardiopulmonary resuscitation (CPR). Contact physician immediately.
Eye Contact:	Rinse with copious amounts of water for at least 15 minutes. Get emergency medical assistance.
Skin Contact:	Flush thoroughly for at least 15 minutes. Wash affected skin with soap and water. Remove contaminated clothing and shoes. Wash clothing before re-use, and discard contaminated shoes. Get emergency medical assistance.
Ingestion:	Call local Poison Control Center for assistance. Contact physician immediately. Aspiration Hazard - Do not induce vomiting.

VI. Safety Measures and Equipment

Ventilation:	Adequate ventilation is required to protect personnel from exposure to chemical vapors exceeding the PEL and to minimize fire hazards. The choice of ventilation equipment, either local or general, will depend on the conditions of use, quantity of material, and other operating parameters.
Respiratory:	Use approved respirator equipment. Follow NIOSH and equipment manufacturer's recommendations to determine appropriate equipment (air-purifying, air-supplied, or self-contained breathing apparatus).
Eyes:	Safety glasses are considered minimum protection. Goggles or face shield may be necessary depending on quantity of material and conditions of use.
Skin:	Protective gloves and clothing are recommended. The choice of material must be based on chemical resistance and other user requirements. Generally, neoprene or Buna-N offers acceptable chemical resistance. Individuals who are acutely and specifically sensitive to pentane may require additional protective equipment.

Storage: Pentane should be protected from temperature extremes and direct sunlight. Proper storage of pentane must be determined based on other materials stored and their hazards and potential chemical incompatibility. In general, pentane should be stored in an acceptably protected and secure flammable liquid storage room.

Other: Emergency eye wash fountains and safety showers should be available in the vicinity of any potential exposure. Ground and bond metal containers to minimize static sparks.

VII. Spill and Disposal Data

Spill Control: Protect from ignition. Wear protective clothing and use approved respirator equipment. Absorb spilled material in an absorbent recommended for solvent spills and remove to a safe location for disposal by approved methods. If released to the environment, comply with all regulatory notification requirements.

Waste Disposal: Dispose of pentane as an EPA hazardous waste. Hazardous waste number: D001(Ignitable).

Revision Date: 6/85

KEY

ca	Approximately	STEL	Short Term Exposure Level
na	Not applicable	TLV	Threshold Limit Value
C	Ceiling	TWA	Time Weighted Average
PEL	Permissable Exposure Level	BuAc	Butyl Acetate

NSC National Safety Council ("Fundamentals of Industrial Hygiene", 1983)
OHS Occupational Health Services.("Hazardline")

ATTACHMENT 4

Table 1

FIT SOIL SAMPLE RESULTS

Carter-Lee Lumber

Indianapolis, Indiana

Chemical	*FIT SAMPLE RESULTS*					*SOIL INGESTION CRITERIA*			
	Sample location					Occup. Exposure (b)		Child Resid. Exposure (c)	
ORGANICS ug/kg	SX-1	SX-2	SX-3	SX-4	SX-5	Cancer 10-6 risk	Non-cancer risk	Cancer 10-6 risk	Non-cancer risk
Acenaphthylene		140J			46J		123000000		4690000
Anthracene		390J			220J		613000000		23500000
Benzo[a]anthracene		2100			960	987		157	
Benzo[g,h,i]perylene		940			360J	987		157	
Benzo[b]fluoranthene		2600			650	987		157	
Benzo[k]fluoranthene		2100				987		157	
Benzo[a]pyrene		1600			740	987		157	
2-Butanone (MEK)			27	27			102000000		391000[illegible]
Chyrsene		1300			600	987		157	
Dibenzofuran		150J							
Diethylphthalate	48J	78J					1640000000		62600000
Di-n-Butylphthalate		4100		3400			204000000		7820000
Fluoranthrene		3000	280		1500		81800000		3130000
Fluorene		210J			90J		81800000		3130000
Ideno(1,2,3-cd)pyrene		940			340J	987		157	
2-Methylnaphthalene		120J			47J				
Naphthalene		65J			35J		8180000		313000
Phenanthrene		2400	180						
Pyrene		3100	320J	81J	1500		61300000		2350000
Trichlorothene		2.6J		2.6J	2.4J	520000		83000	
Tetrachlorothene	1.6J	2.2J	1.8J		2.6J	112000		17900	
Toluene	1.5J	1.7J			1.1J		409000000		156000[illegible]
INORGANICS mg/kg									
Aluminum	2110	3820	2240	2370	3160				
Arsenic	40	33	34	36	11	3.27	613	0.521	23.5
Cadmium	8.2	4	5.7	7			1020		39.1
Chromium (total)	307	197	304	319	33		2040000 a		78200 a
Copper	22	35	29	24	93		75600		2890
Cyanide	1.2	0.95	1.2	0.95	0.56		40900		1560
Iron	133000	87300	149000	132000	16700				
Lead	37	137	27	25	70				
Manganese	1100	800	919	1030	351		204000		7820
Mercury (inorganic)		0.17	0.067	0.061	0.24		613		23.5
Nickel	88	65	92	121			40900		1560
Silver	7.6		8.3				6130		235
Zinc	23	98	36	26	89		409000		15600

Notes: All CLP RAS TAL and TCL compounds analyzed

Blanks indicate concentration is below CLP RAS detection limit

J- estimated value

Sources of toxicity values are IRIS,HEAST and EPA, 1987 Health Advisories.

a. Non-cancer risk based on chromium III

b. Adult occupational exposure assumptions include: soil intake of 0.05 gr/dy,250 dy/yr exposure,25 yrs. exposure, 70 kg. body weight.

c. Child residential exposure assumptions include: soil intake of 0.2 gr/dy,350 dy/yr exposure,6 yrs. exposure, 15 kg. body weight.

APPENDIX E
SPECIAL ANALYTICAL SERVICES PROTOCOLS

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818, Alexandria, Virginia 22313
PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[x] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V, Carter Lee - Lumber Site

B. Regional Representative: Jan Pels

C. Telephone Number: (312) 886-2720

D. Date of Request: 8/28/92

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

Analysis of total dissolved solids (TDS) in monitoring well water samples. Results are reported as mg/l dissolved solids.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

29 aqueous samples will be collected during each sampling event. The aqueous samples will contain medium to high concentration of TDS.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

Superfund Remedial

4. Estimated date(s) of collection: ____________________.

5. Estimated date(s) and method of shipment:

Method of shipment will be daily shipments by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

Sample results will be required 14 days after sample receipt.

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

EPA Method 160.1, Filterable Residue, or "Standard Methods" Method 209B.

Samples will be kept at 4° C until sample analysis and validation of results.

Holding time is 7 days from date of sample collection.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

Use standard aliquots of 100 ml; however, do not use aliquots yielding more than 200 mg residue. If residue is greater than 200 mg, repeat the analysis using a smaller aliquot.

If the pH value is less than 4.0, raise the pH of the aliquot, with NaOH titrant, to between a pH of 4 and 8, and subtract the weight of sodium added from the weight of the residue.

Residue will be weighted to constant weight pursuant to Section 7.6 of Method 160.1 (weight loss is less than 0.5 mg or less than 4% weight loss from previous loss). Constant weights will also be obtainable on a single weight basis if the sample is dried for a minimum of 12 hours. The final weight is to be used for calculations.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.

Bench records of tare weights, final weights, additional weights to determine constant weights, volumes filtered, blanks, and duplicate samples will be provided with copies of work sheets used to calculate results. Dates and times of when the following tasks are preformed will be recorded as part of the bench record:

* determination of tare weights,
* sample filtration,
* determination of constant weights.
* determination of residue weights.

Expedited (priority 1) validation is required upon completion of the 2-week turnaround time.

10. Other (use additional sheets or attach supplementary information, as needed):

11. Name of sampling/shipping contact: David Shekoski
Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	Detection Limit	Precision Desired (+/- % or conc.)
TDS	20 mg/l	Difference in duplicate sample aliquots shall not exceed 2 mg for residues. Duplicate differences shall not exceed 10% for sample values greater than 200 mg/l

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (±% or conc)
2. Lab Duplicate	At least 1 per group of 10 or fewer samples	± (10% or 2 mg residue
3. Lab Blanks (100 ml of filtered reagent water)	At least 1 per group of 10 or fewer samples	- 20 mg/l to + 20 mg/l

* See Section III

III. Action required if Limits are Exceeded:

Take corrective action and retest samples. Contact the Jan Pels at (312) 353-2720 for problems that might result in the delay of reporting sample results.

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818, Alexandria, Virginia 22313
PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[x] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V, Carter Lee Lumber

B. Regional Representative: Jan Pels

C. Telephone Number: (312) 353-2720

D. Date of Request:

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis of soils by Cation-Exchange capacity -- Method 9081 of EPA Test Methods for Evaluating Solid Waste (SW-846), September 1986.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

   Seven low level soil samples will be collected in Phase I.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

   Superfund enforcement

4. Estimated date(s) of collection: ______________________.

5. Estimated date(s) and method of shipment:

   Method of shipment will be daily shipments by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

   Laboratory should report results within 14 days of receipt of samples.

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

   Cation-Exchange Capacity of Soils (Sodium Acetate), SW846 Method 9081.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.): The pH of the 1N Sodium Acetate (NaOAc) solution should be 8.2 ± 0.05. If required, add a few drops of NaOAc or NaOH to bring the reaction of the solution to within the proper pH range.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.

   Raw data, calculations, data sheets, duplicate results, chain of custody forms, SAS packing lists, and SAS request forms.

   The analytical results should be reported on a dry weight basis.

   Expedited (priority 1) validation is required upon completion of the 2-week turnaround time.

10. Other (use additional sheets or attach supplementary information, as needed):

11. Name of sampling/shipping contact:

David Shekoski Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	Detection Limit	Precision Desired (+/- % or conc.)
Cation Exchange Capacity	1 meq/gr	Difference in duplicate results should not exceed ± 25% for concentrations > 20 meq/gr or 5 meq/gr for concentrations < 20 meq/gr.

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (±% or conc.)
Laboratory Blank	Minimum of one per batch of 10 samples	None Specified
Laboratory Duplicate	Minimum of one per batch of 10 samples	See precision as defined in data requirements.

III. ACTION REQUIRED IF LIMITS ARE EXCEEDED:

Take corrective action and reanalyze samples - contact Jan Pels (312)-353-2720.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the Sample Management Office.

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818, Alexandria, Virginia 22313
PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[X] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V/CH2M HILL - Carter-Lee

B. Regional Representative: Jan Pels

C. Telephone Number: (312) 353-2720

D. Date of Request:

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:
   The following parameters require analysis by the conventional SOWs (SOW/OLM01.1 for organics and SOW/ILM01.0 for inorganics), but with the results provided within two weeks of sample receipt.

   Low level TCL volatile organic analysis
   TCL semivolatile organic analysis
   TCL Pesticides/PCBs
   TAL Metals analysis

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

   <u>Phase I</u>
   38 soils for VOA, SVOA, Pesticides/PCBs, and Metals analyses
   11 waters for VOA, SVOA, Pesticides/PCBs, and Metals analyses
   5 waters (trip blanks) for VOA only

Phase II
41 soils for VOA, SVOA, Pesticides/PCBs, and Metals analyses
32 waters for VOA, SVOA, Pesticides/PCBs, and Metals analyses
10 waters (trip blanks) for VOA only

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

Superfund Enforcement

4. Estimated date(s) of collection:

5. Estimated date(s) and method of shipment:

Method of shipment will be daily shipments by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

The laboratory will be required to provide results within 14 days of receipt of the samples.

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

The SOW/OLM01.1 for organics and SOW/ILM01.0 for inorganics are to be followed for these analyses.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

None

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.

As specified in the Statement of Works.

Expedited (priority 1) validation is required upon completion of the 2-week turnaround time.

10. Other (use additional sheets or attach supplementary information, as needed):

11. Name of sampling/shipping contact:

David Shekoski Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	Detection Limit	Precision Desired (+/- % or conc.)

As required by appropriate Statement of Works.

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (+/- % or conc.)

As required by the appropriate Statement of Works.

III. Action Required if Limits are Exceeded:

Contact Jan Pels/QAS at (312) 353-2720.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the Sample Management Office.

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SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[X] **Regional Transmittal** [ ]**Telephone Request**

A. EPA Region and Client: Region V/CH2M HILL

B. Regional Representative: Jan Pels

C. Telephone Number: (312) 353-2720

D. Date of Request:

E. Site Name: Carter Lee Lumber

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. **General description of analytical service requested:**

   Analysis of soil samples by Total Porosity -- Methods of Soil Analysis, Section 18-2, 1986.

2. **Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; medium, or high concentrations):**

   Ten low level soil samples will be collected in Phase II.

3. **Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):**

   Superfund enforcement

4. **Estimated date(s) of collection:**____________________________.

5. **Estimated date(s) and method of shipment:**

   Method of shipment will be daily shipments by overnight carrier.

6. **Approximate number of days results required after lab receipt of samples:**

   Laboratory should report results within 14 days of receipt of samples.

7. **Analytical protocol required (attach copy if other than a protocol currently used in this program):**

   Total Porosity, Methods of Soil Analysis, Section 18-2, 1986. (Attachment 1)

8. **Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):**

   The soils must be oven dried.

9. **Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.**

   Raw data, calculations, data sheets, duplicate results, chain of custody forms, SAS packing lists, and SAS request forms.

   Expedited (priority 1) validation is required upon completion of the 2-week turnaround time.

10. **Other (use additional sheets or attach supplementary information, as needed):**

    ____
    ____

11. **Name of sampling/shipping contact:** David Shekoski
    Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	Detection Limit	Precision Desired (+/- % or conc.)
Porosity	1 Mg/m^{-3}	$\pm$ 20%

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (+/- % or conc.)
Laboratory Duplicate	Minimum of one per batch of ten samples	$\pm$ 20%
Laboratory Control Sample	Minimum of one per batch of ten samples	75 - 125%

III. ACTION REQUIRED IF LIMITS ARE EXCEEDED:

Take corrective action and reanalyze samples - contact Jan Pels (312) 353-2720.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the Sample Management Office.

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PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[X] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V, Carter Lee Lumber

B. Regional Representative: Jan Pels

C. Telephone Number: (312) 353-2720

D. Date of Request:

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis for hardness in monitoring well samples. Results will be reported in mg/L as $CaCO_3$.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

   During Phase II twenty nine aqueous samples will be collected containing low concentrations of hardness.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

   Superfund - Enforcement

4. Estimated date(s) of collection: ___________________.

5. Estimated date(s) and method of shipment:

   Method of shipment will be daily shipment by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

   Laboratory should report results within 14 days of receipt

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

   EPA method 130.1, Hardness, Total as $CaCo_3$. This is an EDTA colorimetric procedure.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

   Samples should be preserved with HNO_3 to a pH of <2 and stored at 4°C until the time of analysis. Pretreatment of the samples includes neutralizing 50.0 ml of the sample with 1N ammonium hydroxide (note volume of NH4OH used). Any remaining sample should be stored in the same manner until the validation and the acceptance of the sample result.

   Sample holding time is 14 days from date of collection.

   Use inhibitors as necessary.

   In order to avoid large titration volumes, sample volumes should be adjusted as to not contain more than 25 mg $CaCO_3$.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.

   Bench records that clearly and legibly show the order of; EDTA titrant standardization, lab blanks, samples, lab control standards, and lab duplicates. In order to be able to reproduce the calculated hardness results, these bench records should also show sample volumes, titrant volumes, and the normality of the titrant.

   Expedited (priority 1) validation is required upon completion of the 2-week turnaround time.

10. Other (use additional sheets or attach supplementary information, as needed):

---

11. Name of sampling/shipping contact: David Shekoski
Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	Detection Limit	Precision Desired (+/- % or conc.)
Hardness	3 mg/l as $CaCo_3$	Difference in duplicate results should not exceed ± 10 % for concentrations > 10 mg.1 or 2 mg/l for concentrations less than 10 mg/l

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (±% or conc)
Lab Blank	At least 1 per group of 10 or fewer samples	≤ 2.0 mg/l
Lab Duplicate	At least 1 per group of 10 or fewer samples	± (10% or 2.0 mg.1)
Matrix Spike	1 per group of 20 or fewer samples	75-125%

* See Section III

III. Action Required if Limits are Exceeded:

Take corrective action and reanalyze samples - Contact Jan Pels (312) 353-2720.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the Sample Management Office.

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PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[x] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V, Carter Lee Lumber

B. Regional Representative: Jan Pels

C. Telephone Number: (312) 353-2720
D. Date of Request: 9/1/92

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis of chloride in monitoring well water samples. Results are reported in mg/l chloride.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

   During Phase II, twenty nine aqueous samples will be collected containing low concentrations of chloride.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

   Superfund - Enforcement

4. Estimated date(s) of collection: ______________________.

5. Estimated date(s) and method of shipment:

Method of shipment will be daily shipments by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

   Laboratory should report results within 14 days of receipt of samples.

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

   1. EPA Method 325.1 (Colorimetric, Automated Ferricyanide, AA-I) 1983 ed., or

   2. EPA Method 325.2 (Colorimetric, Automated Ferricyanide, AA-II) 1983 ed., or

   3. SW-846 Method 9252 (Titrimetric, mercuric nitrate) 1986 ed.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

   Samples should be stored at 4oC until the time of analysis. Any remaining sample should be stored in the same manner until the validation and the acceptance of the sample result.

   Sample holding time is 28 days from date of collection.

   <u>Colorimetric Procedures:</u>

   1. Use a standard curve between 0 and 200 mg/l or less.

   2. The calibration curve should include 5 points or more (including a zero concentration standard).

   3. Samples with absorbance or peak heights greater than the highest standard must be diluted and reanalyzed.

   <u>Titrimetric procedure:</u>

   1. Standardize the mercuric nitrate titrant as described in the method.

   2. Avoid diluting the samples, instead titrate with a weaker, standardized, mercuric nitrate titrant solution.

   3. Chromate, free sulfite, and free iron are not expected

to be in the water samples. Follow the procedures described in step 7.6.1.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). *If not completed, format of results will be left to program discretion.*

   The test procedure used will be clearly identified. Bench records tabulating order of calibration standards, verification and control standards, samples, matrix spikes, titrant blanks, etc. with resulting peak height, titrant volumes, concentrations, or absorbance read-outs will be provided with copies of work sheets used to calculate results. A photocopy of instrument readouts (i.e., strip charts, printer tapes, etc.), must be included for all analysis. All records of analysis and calculation must be legible and sufficient to recalculate all sample concentrations and QA audit results.

   Expedited (priority 1) validation is required upon completion of the 2-week turnaround time.

10. Other (use additional sheets or attach supplementary information, as needed):

11. Name of sampling/shipping contact:

    David Shekoski Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	Detection Limit	Precision Desired (± % or conc.)
Chloride	3 - 5 mg/l	Difference in duplicate sample results are to be < 3 mg/l for concentrations <50 mg.l and are to be <10% for concentrations exceeding 50 mg/l. The significant figures to report depends on sensitivity of colorimetric curve or the number of significant figures in titrant volume.

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (± % or conc.)
Matrix Spike**	1 per group of 20 or fewer samples	85-115% Recovery
Lab Duplicate	1 per group of 10 or fewer samples	± (10% or 5 mg/l)
Lab Blank	1 per group of 10 or fewer samples	< 5 mg/l
Calibration Verification Std.	1 per group of 10 or fewer samples	90-110% Recovery

* See Section III
** Matrix spike concentrations will be greater than 30% of the sample concentration, but spiked sample shall not exceed the working range of the standard curve or titration.

III. Action Required if Limits are Exceeded:

Take corrective action and reanalyze samples - Contact Jan Pels (312) 353-2720

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the Sample Management Office.

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P.O. Box 818, Alexandria, Virginia 22313
PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[X] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V, Carter Lee Lumber

B. Regional Representative: Jan Pels

C. Telephone Number: (312) 353-2720

D. Date of Request:

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis of soils by Toxicity Characteristic Leaching Procedure (TCLP) -- Method 1311 of Federal Register June 29, 1990 for the eight regulated metals. TCLP sample extracts must be prepared within 28 days of the date of sample collection for Hg and 180 days for all other metals. Use a minimum sample aliquot of TCLP extract to determine compliance with TCLP regulatory levels.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

   Ten low concentration soil samples will be collected during the Phase II sampling event.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

Superfund enforcement.

4. Estimated date(s) of collection: ____________________.

5. Estimated date(s) and method of shipment:

   Method of shipment will be daily shipment by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

   Samples must be extracted within 28 days of collection for Hg and within 180 days for all other metals; TCLP extracts must be analyzed within 28 days of extraction for Hg. Data package due 14 days of receipt of samples.

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

   Method 1311 of Federal Register - June 29, 1990 for extraction. CLP SOW 7/88 or ILM01 for analysis of extracts with modifications of Attachment I and Table 1.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

   See Attachment I and Table 1. Soils will be collected in 1-liter wide-mouth glass jars for metals. Samplers are instructed to add only soil. It interstitial water is present on arrival the laboratory, please remix water with soil prior to initiation of Method 1311. Standardize the acetic acid solutions (Section 5.7.2), and the 1N HCl (Section 5.3) by titrating with standard 0.1N NaOH before use. Must be within $\pm$ 5% of required value.

   Analysis of diluted TCLP extract will be done using SOW 7/88 or ILM01 and QC requirements of Attachment II. CASE NARRATIVE MUST DISCUSS ANY SAMPLE PROBLEMS.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.

   Attachment I and Method 1311 provide information for extraction. Use SOW 7/88 or ILM01 for providing Table 1 constituents. Separate Form I's are to be provided for

Table 1 constituents and for Table 1 constituents corrected will also include extraction information of Items "a" through "e" and Item "g" of Attachment I.

Expedited (priority 1) validation is required upon completion of the 2-week turnaround time.

10. Other (use additional sheets or attach supplementary information, as needed):

Data rejection and non payment will be recommended if the laboratory does not follow the methods referenced in this SAS. Lab must submit all original field documentation (COCs, tags, SAS PLs, etc.) and originals for data to the Region in the time frame referenced in Section 6 of this SAS (analogous to a RAS-CSF).

11. Name of sampling/shipping contact: David Shekoski

Phone: (414) 272-2426

I. DATA REQUIREMENTS

Desired Parameter	Detection Limit	Duplicate Precision (±% or Conc.)
See Table 1 All ICP measurements of SOW 7/88 or ILM01 are to be included but remaining TALs need not be reported.	See Table 1	Use ± 25% difference(advisory for TALS)

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (±% or conc)
TCLP Extraction		
Preparation Blank for Extract Fluid #1 (see 7.1.4.4 of Method 1311)	Each set of solid samples	<5% of Regulatory levels of Table 1. Discuss in case narrative if larger than CRDLs of SOW.
Prep. Blk. for Extract Fluid #2, if necessary	Same	Same
Analysis of TLCP Extracts		
Preparation blank for TCLP Extract Determinations	Per appropriate SOW and set-up with each TCLP extract batch	CRDL of appropriate SOW for Table 1 constituents.
MS/MSD (See Table 1)	See Table 1 (required for inorganics) 1 for each set of 8 sample extracts.	Advisory - used to correct TCLP values recovery. See Note 1 of Table 1. RPD $\leq$ 20% (MS/MSD)
All other QC audits per SOW 7/88 or ILM01	Per SOW 7/88 or ILM01	Per SOW 7/88 or per ILM01

III. Action Required if Limits are Exceeded:

Take corrective action and reanalyze samples - Contact Jan Pels (312) 353-2720. Reanalysis of TCLP extracts may be necessary per requirements of Note 1 to Table 1.

Please return this request to the Sample Management Office (SMO) as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the SMO.

ATTACHMENT I

TCLP Extraction will be done by Federal Register of June 29, 1990 (attached) including bottle extraction for metals. Samples will be wet soils or sediments; therefore, the filtration procedure (Section 7.1.1.7 of attached procedure) may produce interstitial water. Also any water collecting on top of sediment or soil is not to be discarded, but mixed with sample prior to filtration or % solid determination (Section 7.1.1). TCLP Extracts <u>may</u> be a combination of liquid filtrate and solid TCLP extracts (see Sections 7.2.13.2 and 7.3.14) but will depend on the physical nature of the soils collected. Particle size reduction is not expected to be necessary for these soils. Sample preparation logs will be needed to record all required information of Method 1311 including (but not limited to):

a. Weight(s) of extracted samples (100g minimum aliquot size is required for 100% solids content) and volume of any filtrate (Sections 7.2.2 and 7.2.5).
b. Preliminary evaluations of percent solids.
c. pH data for selection of Extraction Fluid #1 or (Section 7.1.4.2).
d. Dates of each preparation step, with associated weights and measured volumes.
e. pH value of final TCLP extract (Section 7.2.14)
f. Holding times (Section 7.4) are to be met and are to be counted from the date of collection.
g. Record HCl normality (Section 5.3) and acetic acid normality (Section 5.7.2) (SAS par. 8) and measured pH of Extraction fluids(Section 5.7.1 and 5.7.2). Record dates of each of required measurements.
h. Standardization of Hydrochloric acid and acetic acid for Extraction Fluid #1 and Extraction Fluid #2.
    1. The 1 <u>N</u> HCl can be and will be standardized to 1.0 <u>N</u> HCl ± 5%.
    2. The pH of Extraction Fluid #1 will be 4.93 ± 0.05. No Standardization of acetic acid can be done - See Section 5.7.1 of Method in Federal Register 6-29-90.
    3. The pH of Extraction Fluid #2 will be 2.88 ± 0.05. Standardization of acetic acid is not mandatory but will be done for informational purposes (Optional) and will be compared to theoretical value of 5.7 ml. glacial acetic acid diluted to 1 liter. Titration of acetic acid normality can not be used for contract compliance purposes if correct pH value is obtained (2.88).
i. TCLP combined extract aliquots will be acidified for subsequent metals analysis (Section 7.2.14).

ITEMS "a" - "e" AND ITEM "g" MUST BE A PART OF FORM I REPORT.

Analysis of TCLP extracts will be done to determine compliance with Regulatory Levels using minimum sample aliquot volumes necessary for this purpose.

DETERMINATION (ml)	SAMPLE ALIQUOT (mls)	FINAL VOLUME TAKEN FOR SOW ANALYSIS AFTER DILUTION OF SAMPLE ALIQUOT
Metals (ICP)	10	100
Metals (GFAA)	10	100
Hg (CVAA)	5	100

Sample aliquot sizes are to be minimized, as above, to alleviate interferences from acetic acid/acetate buffer, to provide CRQLs that are 10-20% of Regulatory Levels, and to expand the working concentration range of the test procedures.

All constituents of Table 1 are required to be determined and reported for TCLP extracts. Remaining TALs of 7/88 or ILM01 are not required , except that all ICP emission spectroscopy measurements required by SOW 7/88 or ILM01 are to be made and included in raw data. A matrix spike (MS)/matrix spike duplicate (MSD) for all constituents in Table 1 will be prepared and determined using one of the TCLP soil extracts. The same extract need not be used for all analyses (ICP, GFAA, or CVA).

MS/MSD results are advisory and used for calculation purposes.

TABLE 1
TCLP CONSTITUENTS TO BE DETERMINED BY METHOD 1311,
TCLP REGULATORY LEVELS, SAMPLE ALIQUOT VOLUMES TO BE USED,
AND MS/MSD LEVELS AND CRQLS TO BE USED
FINAL DILUTED SAMPLE ALIQUOTS (100 ml)*

CONTAMINANT METALS (SOW 7/88 or ILM01)	REGULATORY LEVEL (ug/L)	SAMPLE ALIQUOT VOLUME ml	MS/MSD LEVEL IN FINAL ALIQUOT (ug/L)	CRQL IN FINAL ALIQUOT DILUTION (ug/L)
As (GFAA)	5,000	10	500	50
Ba (ICP)	100,000	10	10,000	1,000
Cd (ICP)	1,000	10	100	10
Cr (ICP)	5,000	10	500	50
Pb (ICP or GFAA)	5,000	10	500	50
Hg (CVAA)	200	5	10	0.5
Se (GFAA)	1,000	10	100	10
Ag (ICP)	5,000	10	500	50

*NOTE: TCLP Extraction of June 29, 1990 requires correction of constituent values for matrix spike recoveries. See Section 8.2 of Method 1311 of Federal Register June 29, 1990.

The average MS/MSD recovery developed for 1 of the soil extracts will be applied to all of the soil extracts. It is not expected that the samples will provide TCLP values that will exceed Regulatory Levels; however, there is a finite chance that this will occur.

If any on TCLP analyte in an extract exceeds Regulatory Levels, the extracts reanalysis is unnecessary using a Regulatory Matrix Spike concentration (see Section 8.2 of Method 1311).

If the concentration of the analyte after correction for the matrix spike recovery is > 10% of but less than the regulatory level, the TCLP extract must be reextracted using a smaller aliquot and spiked at the regulatory level such that the native analyte is at approximately the regulatory level.

If sample concentrations exceed the calibration range, sample must be diluted to fall within the calibration range.

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PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[X] **Regional Transmittal** [ ]**Telephone Request**

A. EPA Region and Client: Region V/CH2M HILL

B. Regional Representative: Jan Pels

C. Telephone Number: (312) 353-2720

D. Date of Request:

E. Site Name: Carter Lee Lumber

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. **General description of analytical service requested:**

   Analysis of 10 soil samples for grain size, Atterberg limits, soil moisture, and unit weight (bulk density) by the methods listed in Section 7.

2. **Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; medium, or high concentrations):**

   During Phase II, 10 low concentration soil samples will be collected for the parameters listed in Section 1.

3. **Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):**

   Superfund - Enforcement

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4. **Estimated date(s) of collection:**

5. **Estimated date(s) and method of shipment:**

   Daily by overnight carrier

6. **Approximate number of days results required after lab receipt of samples:**

   Laboratory should report results within 14 days of receipt of samples.

7. **Analytical protocol required (attach copy if other than a protocol currently used in this program):**

   Grain Size- Analysis by ASTM D 422-63,(Attachment 5) with required "Dry Preparation of Soils ...", ASTM D 421 (Attachment 4), and Sieve Accuracy Testing, Chapter 3 from "Procedures in Sediment Petrology" (Attachment 3).

   Atterberg Limits- ASTM D 4318-84 (Attachment 6). The laboratory will select the preparation procedure (A,B,C, or D) based on the characteristics of the submitted soils samples.

   Soil Moisture- ASTM D 2216-80 (Attachment 7)

   Unit Weight (bulk density)- The core method from Section 13-2, Methods for Soil Analysis. Chapter 13 is attached. (Attachment 8)

8. **Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):**

   Grain Size-See Attachment 2

9. **Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.**

   Raw data, calculations, data sheets, duplicate results, chain of custody forms, SAS packing lists, and SAS request forms.

   Grain Size- Narrative description of the process used and descriptions of problems encountered. Analyst's logbook pages, as well as deliverables required in ASTM D 422-63, Section 1B should also be included.

Atterberg Limits- Laboratory will provide descriptions of preparation procedure selected and of any problems encountered.

Expedited (priority 1) validation is required upon completion of the 2-week turnaround time.

10. **Other (use additional sheets or attach supplementary information, as needed):**

Grain Size- See Attachment 2

11. **Name of sampling/shipping contact:** David Shekoski

Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	**Detection Limit**	**Precision Desired (+/- % or conc.)**

Grain Size- Must meet report requirements and data specifications as stated in ASTM D 422-63, Section 18, page 93.

All compounds	None specified	+/- 30%

II. QUALITY CONTROL REQUIREMENTS

Audits Required	**Frequency of Audits**	**Limits* (+/- % or conc.)**
None Specified		

III. ACTION REQUIRED IF LIMITS ARE EXCEEDED:

Take corrective action and reanalyze samples - contact Jan Pels (312) 353-2720.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the Sample Management Office.

APPENDIX F
FIELD EQUIPMENT SOPS

ATTACHMENT 7

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock[1]

This standard is issued under the fixed designation D 2216; 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.

ε1 Note—The title was corrected editorially in June 1991.

1. Scope

1.1 This test method covers the laboratory determination of the water (moisture) content of soil, rock, and similar materials by mass. For simplicity, the word "material" hereinafter also refers to either soil or rock, whichever is most applicable.

1.2 The water content of a material is defined by this standard as the ratio, expressed as a percentage, of the mass of "pore" or "free" water in a given mass of material to the mass of the solid material.

1.3 The term "solid particles" as used in geotechnical engineering is typically assumed to mean naturally occurring mineral particles of soil and rock that are not readily soluble in water. Therefore, the water content of materials containing extraneous matter (such as cement, and the like) may require special treatment or a qualified definition of water content. In addition, some organic materials may be decomposed by oven drying at the standard drying temperature for this method (110°C). Materials containing gypsum (calcium sulfate dihydrate or other compounds having significant amounts of hydrated water) may present a special problem as this material slowly dehydrates at the standard drying temperature (110°C) and at very low relative humidities, forming a compound (calcium sulfate hemihydrate) which is not normally present in natural materials except in some desert soils. In order to reduce the degree of dehydration of gypsum in those materials containing gypsum, or to reduce decomposition in highly organic soils, it may be desirable to dry these materials at 60°C or in a desiccator at room temperature. Thus, when a drying temperature is used which is different from the standard drying temperature as defined by this test method, the resulting water content may be different from standard water content determined at the standard drying temperature.

Note 1—Test Method D 2974 provides an alternate procedure for determining water content of peat materials.

1.4 Materials containing water with substantial amounts of soluble solids (such as salt in the case of marine sediments) when tested by this method will give a mass of solids which includes the previously soluble solids. These materials require special treatment to remove or account for the presence of precipitated solids in the dry mass of the specimen, or a qualified definition of water content must be used.

1.5 This test method requires several hours for proper drying of the water content specimen. Test Method D 4643 provides for drying of the test specimen in a microwave oven which is a shorter process.

1.6 This standard requires the drying of material in an oven at high temperatures. If the material being dried is contaminated with certain chemicals, health and safety hazards can exist. Therefore, this standard should not be used in determining the water content of contaminated soils unless adequate health and safety precautions are taken.

1.7 *This standard does not purport to address all of the safety problems 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock and Contained Fluids[2]
D 2974 Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils[2]
D 4220 Practice for Preserving and Transporting Soil Samples[2]
D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[2]
D 4643 Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method[2]
D 4753 Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Soil and Rock Testing[2]
E 145 Specification for Gravity—Convection and Forced—Ventilation Ovens[3]

3. Terminology

3.1 Refer to Terminology D 653 for standard definitions of terms.

3.2 *Description of Term Specific to This Standard:*

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity and Density Characteristics of Soils.

Current edition approved Nov. 30, 1990. Published January 1991. Originally published as D 2216 – 63 T. Last previous edition D 2216 – 80.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

3.2.1 *water content* (of a material)—the ratio of the mass of water contained in the pore spaces of soil or rock material, to the solid mass of particles in that material, expressed as a percentage.

4. Summary of Method

4.1 A test specimen is dried in an oven to a constant mass. The loss of mass due to drying is considered to be water. The water content is calculated using the mass of water and the mass of the dry specimen.

5. Significance and Use

5.1 For many materials, the water content is one of the most significant index properties used in establishing a correlation between soil behavior and its properties.

5.2 The water content of a material is used in expressing the phase relationships of air, water, and solids in a given volume of material.

5.3 In fine-grained (cohesive) soils, the consistency of a given soil type depends on its water content. The water content of a soil, along with its liquid and plastic limits as determined by Test Method D 4318, is used to express its relative consistency or liquidity index.

6. Apparatus

6.1 *Drying Oven*, thermostatically-controlled, preferably of the forced-draft type, meeting the requirements of Specification E 145 and capable of maintaining a uniform temperature of 110 ± 5°C throughout the drying chamber.

6.2 *Balances*—All balances must meet the requirements of Specification D 4753 and this Section. A Class GP1 balance of 0.01g readability is required for specimens having a mass of up to 200 g (excluding mass of specimen container) and a Class GP2 balance of 0.1g readability is required for specimens having a mass over 200 g.

6.3 *Specimen Containers*—Suitable containers made of material resistant to corrosion and change in mass upon repeated heating, cooling, exposure to materials of varying pH, and cleaning. Containers with close-fitting lids shall be used for testing specimens having a mass of less than about 200 g; while for specimens having a mass greater than about 200 g, containers without lids may be used. One container is needed for each water content determination.

NOTE 2—The purpose of close-fitting lids is to prevent loss of moisture from specimens before initial mass determination and to prevent absorption of moisture from the atmosphere following drying and before final mass determination.

6.4 *Desiccator*—A desiccator cabinet or large desiccator jar of suitable size containing silica gel or anhydrous calcium phosphate. It is preferable to use a desiccant which changes color to indicate it needs reconstitution. See Section 10.5.

NOTE 3—Anhydrous calcium sulfate is sold under the trade name Drierite.

6.5 *Container Handling Apparatus*, gloves, tongs, or suitable holder for moving and handling hot containers after drying.

6.6 *Miscellaneous*, knives, spatulas, scoops, quartering cloth, sample splitters, etc, as required.

7. Samples

7.1 Samples shall be preserved and transported in accordance with Practice 4220 Groups B, C, or D soils. Keep the samples that are stored prior to testing in noncorrodible airtight containers at a temperature between approximately 3 and 30°C and in an area that prevents direct contact with sunlight. Disturbed samples in jars or other containers shall be stored in such a way as to prevent or minimize moisture condensation on the insides of the containers.

7.2 The water content determination should be done as soon as practicable after sampling, especially if potentially corrodible containers (such as thin-walled steel tubes, paint cans, etc.) or plastic sample bags are used.

8. Test Specimen

8.1 For water contents being determined in conjunction with another ASTM method, the specimen mass requirement stated in that method shall be used if one is provided. If no minimum specimen mass is provided in that method then the values given before shall apply.

8.2 The minimum mass of moist material selected to be representative of the total sample, if the total sample is not tested by this method, shall be in accordance with the following:

Maximum particle size (100 % passing)	Standard Sieve Size	Recommended minimum mass of moist test specimen for water content reported to ±0.1 %	Recommended minimum mass of moist test specimen for water content reported to ±1 %
2 mm or less	No. 10	20 g	20 g[a]
4.75 mm	No. 4	100 g	20 g[a]
9.5 mm	3/8-in.	500 g	50 g
19.0 mm	3/4-in.	2.5 kg	250 g
37.5 mm	1 1/2 in.	10 kg	1 kg
75.0 mm	3-in.	50 kg	5 kg

NOTE—[a]To be representative not less than 20 g shall be used.

8.2.1 If the total sample is used it does not have to meet the minimum mass requirements provided in the table above. The report shall indicate that the entire sample was used.

8.3 Using a test specimen smaller than the minimum indicated in 8.2 requires discretion, though it may be adequate for the purposes of the test. Any specimen used not meeting these requirements shall be noted in the report of results.

8.4 When working with a small (less than 200g) specimen containing a relatively large gravel particle, it is appropriate not to include this particle in the test specimen. However, any discarded material shall be described and noted in the report of the results.

9. Test Specimen Selection

9.1 When the test specimen is a portion of a larger amount of material, the specimen must be selected to be representative of the water condition of the entire amount of material. The manner in which the test specimen is selected depends on the purpose and application of the test, type of material being tested, the water condition, and the type of sample (from another test, bag, block, and the likes.)

9.2 For disturbed samples such as trimmings, bag samples, and the like, obtain the test specimen by one of the following methods (listed in order of preference):

9.2.1 If the material is such that it can be manipulated and handled without significant moisture loss, the material should be mixed and then reduced to the required size by quartering or splitting.

9.2.2 If the material is such that it cannot be thoroughly mixed and/or split, form a stockpile of the material, mixing as much as possible. Take at least five portions of material at random locations using a sampling tube, shovel, scoop, trowel, or similar device appropriate to the maximum particle size present in the material. Combine all the portions for the test specimen.

9.2.3 If the material or conditions are such that a stockpile cannot be formed, take as many portions of the material as possible at random locations that will best represent the moisture condition. Combine all the portions for the test specimen.

9.3 Intact samples such as block, tube, split barrel, and the like, obtain the test specimen by one of the following methods depending on the purpose and potential use of the sample.

9.3.1 Carefully trim at least 3 mm of material from the outer surface of the sample to see if material is layered and to remove material that is drier or wetter than the main portion of the sample. Then carefully trim at least 5 mm, or a thickness equal to the maximum particle size present, from the entire exposed surface or from the interval being tested.

9.3.2 Slice the sample in half. If material is layered see Section 9.3.3. Then carefully trim at least 5 mm, or a thickness equal to the maximum particle size present, from the exposed surface of one half, or from the interval being tested. Avoid any material on the edges that may be wetter or drier than the main portion of the sample.

NOTE 4—Migration of moisture in some cohesionless soils may require that the full section be sampled.

9.3.3 If a layered material (or more than one material type is encountered), select an average specimen, or individual specimens, or both. Specimens must be properly identified as to location, or what they represent, and appropriate remarks entered on data sheets.

10. Procedure

10.1 Determine and record the mass of the clean and dry specimen container (and its lid, if used).

10.2 Select representative test specimens in accordance with Section 9.

10.3 Place the moist test specimen in the container and, if used, set the lid securely in position. Determine the mass of the container and moist material using a balance (See 6.2) selected on the basis of the specimen mass. Record this value.

NOTE 5—To prevent mixing of specimens and yielding of incorrect results, all containers, and lids if used, should be numbered and the container numbers shall be recorded on the laboratory data sheets. The lid numbers should match the container numbers to eliminate confusion.

NOTE 6—To assist in the oven-drying of large test specimens, they should be placed in containers having a large surface area (such as pans) and the material broken up into smaller aggregations.

10.4 Remove the lid (if used) and place the container with moist material in the drying oven. Dry the material to a constant mass. Maintain the drying oven at 110 ± 5°C unless otherwise specified (see 1.3). The time required to obtain constant mass will vary depending on the type of material, size of specimen, oven type and capacity, and other factors. The influence of these factors generally can be established by good judgment, and experience with the materials being tested and the apparatus being used.

NOTE 7—In most cases, drying a test specimen overnight (about 12 to 16 h) is sufficient. In cases where there is doubt concerning the adequacy of drying, drying should be continued until the change in mass after two successive periods (greater than 1 h) of drying is an insignificant amount (less than about 0.1 %). Specimens of sand may often be dried to constant mass in a period of about 4 h, when a forced-draft oven is used.

NOTE 8—Since some dry materials may absorb moisture from moist specimens, dried specimens should be removed before placing moist specimens in the same oven. However, this would not be applicable if the previously dried specimens will remain in the drying oven for an additional time period of about 16 h.

10.5 After the material has dried to constant mass remove the container from the oven (and replace the lid if used). Allow the material and container to cool to room temperature or until the container can be handled comfortably with bare hands and the operation of the balance will not be affected by convection currents and/or its being heated. Determine the mass of the container and oven-dried material using the same balance as used in 10.3. Record this value. Tight fitting lids shall be used if it appears that the specimen is absorbing moisture from the air prior to determination of its dry mass.

NOTE 9—Cooling in a desiccator is acceptable in place of tight fitting lids since it greatly reduces absorption of moisture from the atmosphere during cooling especially for containers without tight fitting lids.

11. Calculation

11.1 Calculate the water content of the material as follows:

$$w = [(M_{cws} - M_{cs})/(M_{cs} - M_c)] \times 100 = \frac{M_w}{M_s} \times 100$$

where:

w = water content, %,
M_{cws} = mass of container and wet specimen, g,
M_{cs} = mass of container and oven dry specimen, g,
M_c = mass of container, g,
M_w = mass of water ($M_w = M_{cws} - M_{cds}$), g, and
M_s = mass of solid particles ($M_s = M_{cds} - M_c$), g.

12. Report

12.1 The report (data sheet) shall include the following:

12.1.1 Identification of the sample (material) being tested, such as boring number, sample number, test number, container number etc.

12.1.2 Water content of the specimen to the nearest 1 % or 0.1 %, as appropriate based on the minimum sample used. If this method is used in concert with another method, the water content of the specimen should be reported to the value required by the test method for which the water content is being determined.

12.1.3 Indicate if test specimen had a mass less than the minimum indicated in 8.2.

Designation: D 4318 – 84

ATTACHMENT 6

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS[1]

This standard is issued under the fixed designation D 4318; 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.

1. Scope

1.1 This test method covers the determination of the liquid limit, plastic limit, and the plasticity index of soils as defined in Section 3.

1.1.1 Two procedures for preparing test specimens and two procedures for performing the liquid limit are provided as follows:

A Multipoint test using a wet preparation procedure, described in Sections 10.1, 11, and 12.
B Multipoint test using a dry preparation procedure, described in Sections 10.2, 11, and 12.
C One-point test using a wet preparation procedure, described in Sections 13, 14, and 15.
D One-point test using a dry preparation procedure, described in Sections 13, 14, and 15.

The procedure to be used shall be specified by the requesting authority. If no procedure is specified, Procedure A shall be used.

NOTE 1—Prior to the adoption of this test method, a curved grooving tool was specified as part of the apparatus for performing the liquid limit test. The curved tool is not considered to be as accurate as the flat tool described in 6.2 since it does not control the depth of the soil in the liquid limit cup. However, there are some data which indicate that typically the liquid limit is slightly increased when the flat tool is used instead of the curved tool.

1.1.2 The plastic limit test procedure is described in Sections 16, 17, and 18. The plastic limit test is performed on material prepared for the liquid limit test. In effect, there are two procedures for preparing test specimens for the plastic limit test.

1.1.3 The procedure for calculating the plasticity index is given in Section 19.

1.2 The liquid limit and plastic limit of soils (along with the shrinkage limit) are often collectively referred to as the Atterberg limits in recognition of their formation by Swedish soil scientist, A. Atterberg. These limits distinguish the boundaries of the several consistency states of plastic soils.

1.3 As used in this test method, soil is any natural aggregation of mineral or organic materials, mixtures of such materials, or artificial mixtures of aggregates and natural mineral and organic particles.

1.4 The multipoint liquid limit procedure is somewhat more time consuming than the one-point procedure when both are performed by experienced operators. However, the one-point procedure requires the operator to judge when the test specimen is approximately at its liquid limit. In cases where this is not done reliably, the multipoint procedure is as fast as the one-point procedure and provides additional precision due to the information obtained from additional trials. It is particularly recommended that the multipoint procedure be used by inexperienced operators.

1.5 The correlations on which the calculations of the one-point procedure are based may not be valid for certain soils, such as organic soils or soils from a marine environment. The liquid

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity and Density Characteristics of Soils.

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limit of these soils should therefore be determined by the multipoint procedure (Procedure A).

1.6 The liquid and plastic limits of many soils that have been allowed to dry before testing may be considerably different from values obtained on undried samples. If the liquid and plastic limits of soils are used to correlate or estimate the engineering behavior of soils in their natural moist state, samples should not be permitted to dry before testing unless data on dried samples are specifically desired.

1.7 The composition and concentration of soluble salts in a soil affect the values of the liquid and plastic limits as well as the water content values of soils (see Method D 2216). Special consideration should therefore be given to soils from a marine environment or other sources where high soluble salt concentrations may be present. The degree to which the salts present in these soils are diluted or concentrated must be given consideration if meaningful results are to be obtained.

1.8 Since the tests described herein are performed only on that portion of a soil which passes the 425-μm (No. 40) sieve, the relative contribution of this portion of the soil to the properties of the sample as a whole must be considered when using these tests to evaluate the properties of a soil.

1.9 The values stated in acceptable metric units are to be regarded as the standard. The values given in parentheses are for information only.

1.10 *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.*

2. Applicable Documents

2.1 *ASTM Standards:*

C 702 Methods for Reducing Field Samples of Aggregate to Testing Size[2]

D 75 Practice for Sampling Aggregates[3]

D 420 Recommended Practice for Investigating and Sampling Soil and Rock for Engineering Purposes[4]

D 653 Terms and Symbols Relating to Soil and Rock[4]

D 1241 Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses[4]

D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures[4]

D 2240 Test Method for Rubber Property—Durometer Hardness[5]

D 2487 Test Method for Classification of Soils for Engineering Purposes[4]

D 2488 Recommended Practice for Description of Soils (Visual-Manual Procedure)[4]

D 3282 Recommended Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes[4]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[6]

E 319 Methods of Testing Single-Arm Balances[6]

E 898 Method of Testing Top-Loading, Direct-Reading Laboratory Scales and Balances[6]

3. Definitions

3.1 *Atterberg limits*—originally, seven "limits of consistency" of fine-grained soils were defined by Albert Atterberg. In current engineering usage, the term usually refers only to the liquid limit, plastic limit, and in some references, the shrinkage limit.

3.2 *consistency*—the relative ease with which a soil can be deformed.

3.3 *liquid limit (LL)*—the water content, in percent, of a soil at the arbitrarily defined boundary between the liquid and plastic states. This water content is defined as the water content at which a pat of soil placed in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove for a distance of 13 mm (½ in.) when subjected to 25 shocks from the cup being dropped 10 mm in a standard liquid limit apparatus operated at a rate of 2 shocks per second.

[2] *Annual Book of ASTM Standards*, Vol 04.02.
[3] *Annual Book of ASTM Standards*, Vols 04.02, 04.03, and 04.08.
[4] *Annual Book of ASTM Standards*, Vol 04.08.
[5] *Annual Book of ASTM Standards*, Vol 09.01.
[6] *Annual Book of ASTM Standards*, Vol 14.02.

preserved. The device may be operated either by a hand crank or by an electric motor.

6.1.1 *Base*—The base shall be hard rubber having a D Durometer hardness of 80 to 90, and a resilience such that an 8-mm (5⁄16-in.) diameter polished steel ball, when dropped from a height of 25 cm (9.84 in.) will have an average rebound of at least 80 % but no more than 90 %. The tests shall be conducted on the finished base with feet attached.

6.1.2 *Feet*—The base shall be supported by rubber feet designed to provide isolation of the base from the work surface and having an A Durometer hardness no greater than 60 as measured on the finished feet attached to the base.

6.1.3 *Cup*—The cup shall be brass and have a weight, including cup hanger, of 185 to 215 g.

6.1.4 *Cam*—The cam shall raise the cup smoothly and continuously to its maximum height, over a distance of at least 180° of cam rotation. The preferred cam motion is a uniformly accelerated lift curve. The design of the cam and follower combination shall be such that there is no upward or downward velocity of the cup when the cam follower leaves the cam.

NOTE 3—The cam and follower design in Fig. 1 is for uniformly accelerated (parabolic) motion after contact and assures that the cup has no velocity at drop off. Other cam designs also provide this feature and may be used. However, if the cam-follower lift pattern is not known, zero velocity at drop off can be assured by carefully filing or machining the cam and follower so that the cup height remains constant over the last 20 to 45° of cam rotation.

6.1.5 *Carriage*—The cup carriage shall be constructed in a way that allows convenient but secure adjustment of the height of drop of the cup to 10 mm (0.394 in.). The cup hanger shall be attached to the carriage by means of a pin which allows removal of the cup and cup hanger for cleaning and inspection.

6.1.6 *Optional Motor Drive*—As an alternative to the hand crank shown in Fig. 1, the device may be equipped with a motor to turn the cam. Such a motor must turn the cam at 2 ±0.1 revolutions per second, and must be isolated from the rest of the device by rubber mounts or in some other way that prevents vibration from the motor being transmitted to the rest of the apparatus. It must be equipped with an ON-OFF switch and a means of conveniently positioning the cam for height of drop adjustments. The results obtained using a motor-driven device must not differ from those obtained using a manually operated device.

6.2 *Flat Grooving Tool*—A grooving tool having dimensions shown in Fig. 2. The tool shall be made of plastic or noncorroding metal. The design of the tool may vary as long as the essential dimensions are maintained. The tool may, but need not, incorporate the gage for adjusting the height of drop of the liquid limit device.

6.3 *Gage*—A metal gage block for adjusting the height of drop of the cup, having the dimensions shown in Fig. 3. The design of the tool may vary provided the gage will rest securely on the base without being susceptible to rocking, and the edge which contacts the cup during adjustment is straight, at least 10 mm (3⁄8 in.) wide, and without bevel or radius.

6.4 *Containers*—Small corrosion-resistant containers with snug-fitting lids for water content specimens. Aluminum or stainless steel cans 2.5 cm (1 in.) high by 5 cm (2 in.) in diameter are appropriate.

6.5 *Balance*—A balance readable to at least 0.01 g and having an accuracy of 0.03 g within three standard deviations within the range of use. Within any 15-g range, a difference between readings shall be accurate within 0.01 g (Notes 4 and 5).

NOTE 4—See Methods E 898 and E 319 for an explanation of terms relating to balance performance.

NOTE 5—For frequent use, a top-loading type balance with automatic load indication, readable to 0.01 g, and having an index of precision (standard deviation) of 0.003 or better is most suitable for this method. However, nonautomatic indicating equal-arm analytical balances and some small equal arm top pan balances having readabilities and sensitivities of 0.002 g or better provide the required accuracy when used with a weight set of ASTM Class 4 (National Bureau of Standards Class P) or better. Ordinary commercial and classroom type balances such as beam balances are not suitable for this method.

6.6 *Storage Container*—A container in which to store the prepared soil specimen that will not contaminate the specimen in any way, and which prevents moisture loss. A porcelain, glass, or plastic dish about 11.4 cm (4½ in.) in diameter and a plastic bag large enough to enclose the dish and be folded over is adequate.

6.7 *Ground Glass Plate*—A ground glass plate at least 30 cm (12 in.) square by 1 cm (3⁄8 in.) thick for mixing soil and rolling plastic limit threads.

6.8 *Spatula*—A spatula or pill knife having a

NOTE 2—The undrained shear strength of soil at the liquid limit is considered to be 2 ±0.2 kPa (0.28 psi).

3.4 *plastic limit (PL)*—the water content, in percent, of a soil at the boundary between the plastic and brittle states. The water content at this boundary is the water content at which a soil can no longer be deformed by rolling into 3.2 mm (⅛ in.) in diameter threads without crumbling.

3.5 *plastic soil*—a soil which has a range of water content over which it exhibits plasticity and which will retain its shape on drying.

3.6 *plasticity index (PI)*—the range of water content over which a soil behaves plastically. Numerically, it is the difference between the liquid limit and the plastic limit.

3.7 *liquidity index*—the ratio, expressed as a percentage, of (*1*) the natural water content of a soil minus its plastic limit, to (*2*) its plasticity index.

3.8 *activity number (A)*—the ratio of (*1*) the plasticity index of a soil to (*2*) the percent by weight of particles having an equivalent diameter smaller than 0.002 mm.

4. Summary of Method

4.1 The sample is processed to remove any material retained on a 425-μm (No. 40) sieve. The liquid limit is determined by performing trials in which a portion of the sample is spread in a brass cup, divided in two by a grooving tool, and then allowed to flow together from the shocks caused by repeatedly dropping the cup in a standard mechanical device. The multipoint liquid limit, Procedures A and B, requires three or more trials over a range of water contents to be performed and the data from the trials plotted or calculated to make a relationship from which the liquid limit is determined. The one-point liquid limit, Procedures C and D, uses the data from two trials at one water content multiplied by a correction factor to determine the liquid limit.

4.2 The plastic limit is determined by alternately pressing together and rolling into a 3.2 mm (⅛ in.) diameter thread a small portion of plastic soil until its water content is reduced to a point at which the thread crumbles and is no longer able to be pressed together and rerolled. The water content of the soil at this stage is reported as the plastic limit.

4.3 The plasticity index is calculated as the difference between the liquid limit and the plastic limit.

5. Significance and Use

5.1 This test method is used as an integral part of several engineering classification systems to characterize the fine-grained fractions of soils (see Test Method D 2487 and Recommended Practice D 3282) and to specify the fine-grained fraction of construction materials (see Specification D 1241). The liquid limit, plastic limit, and plasticity index of soils are also used extensively, either individually or together with other soil properties to correlate with engineering behavior such as compressibility, permeability, compactibility, shrink-swell, and shear strength.

5.2 The liquid and plastic limits of a soil can be used with the natural water content of the soil to express its relative consistency or liquidity index and can be used with the percentage finer than 2-μm size to determine its activity number.

5.3 The one-point liquid limit procedure is frequently used for routine classification purposes. When greater precision is required, as when used for the acceptance of a material or for correlation with other test data, the multipoint procedure should be used.

5.4 These methods are sometimes used to evaluate the weathering characteristics of clay-shale materials. When subjected to repeated wetting and drying cycles, the liquid limits of these materials tend to increase. The amount of increase is considered to be a measure of a shale's susceptibility to weathering.

5.5 The liquid limit of a soil containing substantial amounts of organic matter decreases dramatically when the soil is oven-dried before testing. Comparison of the liquid limit of a sample before and after oven-drying can therefore be used as a qualitative measure of organic matter content of a soil.

6. Apparatus

6.1 *Liquid Limit Device*—A mechanical device consisting of a brass cup suspended from a carriage designed to control its drop onto a hard rubber base. A drawing showing the essential features of the device and the critical dimensions is given in Fig. 1. The design of the device may vary provided that the essential functions are blade about 2 cm (¾ in.) wide by about 10 cm (4 in.) long. In addition, a spatula having a blade about 2.5 cm (1 in.) wide and 15 cm (6 in.) long has been found useful for initial mixing of samples.

6.9 *Sieve*—A 20.3 cm (8 in.) diameter, 425-µm (No. 40) sieve conforming to the requirements of Specification E 11 and having a rim at least 5 cm (2 in.) above the mesh. A 2-mm (No. 10) sieve meeting the same requirements may also be needed.

6.10 *Wash Bottle*, or similar container for adding controlled amounts of water to soil and washing fines from coarse particles.

6.11 *Drying Oven*—A thermostatically controlled oven, preferably of the forced-draft type, capable of continuously maintaining a temperature of 110 ±5°C throughout the drying chamber. The oven shall be equipped with a thermometer of suitable range and accuracy for monitoring oven temperature.

6.12 *Washing Pan*—A round, flat-bottomed pan at least 7.6 cm (3 in.) deep, slightly larger at the bottom than a 20.3-cm (8-in.) diameter sieve.

6.13 *Rod* (optional)—A metal or plastic rod or tube 3.2 mm (⅛ in.) in diameter and about 10 cm (4 in.) long for judging the size of plastic limit threads.

7. Materials

7.1 A supply of distilled or demineralized water.

8. Sampling

8.1 Samples may be taken from any location that satisfies testing needs. However, Methods C 702, and Practice D 75, and Recommended Practice D 420 should be used as guides for selecting and preserving samples from various types of sampling operations. Samples which will be prepared using the wet preparation procedure, 10.1, must be kept at their natural water content prior to preparation.

8.2 Where sampling operations have preserved the natural stratification of a sample, the various strata must be kept separated and tests performed on the particular stratum of interest with as little contamination as possible from other strata. Where a mixture of materials will be used in construction, combine the various components in such proportions that the resultant sample represents the actual construction case.

8.3 Where data from this test method are to be used for correlation with other laboratory or field test data, use the same material as used for these tests where possible.

8.4 Obtain a representative portion from the total sample sufficient to provide 150 to 200 g of material passing the 425-µm (No. 40) sieve. Free flowing samples may be reduced by the methods of quartering or splitting. Cohesive samples shall be mixed thoroughly in a pan with a spatula, or scoop and a representative portion scooped from the total mass by making one or more sweeps with a scoop through the mixed mass.

9. Calibration of Apparatus

9.1 *Inspection of Wear:*

9.1.1 *Liquid Limit Device*—Determine that the liquid limit device is clean and in good working order. The following specific points should be checked:

9.1.1.1 *Wear of Base*—The spot on the base where the cup makes contact should be worn no greater than 10 mm (⅜ in.) in diameter. If the wear spot is greater than this, the base can be machined to remove the worn spot provided the resurfacing does not make the base thinner than specified in 6.1 and the other dimensional relationships are maintained.

9.1.1.2 *Wear of Cup*—The cup must be replaced when the grooving tool has worn a depression in the cup 0.1 mm (0.004 in.) deep or when the edge of the cup has been reduced to half its original thickness. Verify that the cup is firmly attached to the cup hanger.

9.1.1.3 *Wear of Cup Hanger*—Verify that the cup hanger pivot does not bind and is not worn to an extent that allows more than 3-mm (⅛-in.) side-to-side movement of the lowest point on the rim.

9.1.1.4 *Wear of Cam*—The cam shall not be worn to an extent that the cup drops before the cup hanger (cam follower) loses contact with the cam.

9.1.2 *Grooving Tools*—Inspect grooving tools for wear on a frequent and regular basis. The rapidity of wear depends on the material from which the tool is made and the types of soils being tested. Sandy soils cause rapid wear of grooving tools; therefore, when testing these materials, tools should be inspected more frequently than for other soils. Any tool with a tip width greater than 2.1 mm must not be used. The depth of the tip of the grooving tool must be 7.9 to 8.1 mm.

NOTE 6—The width of the tip of grooving tools is conveniently checked using a pocket-sized measuring magnifier equipped with a millimetre scale. Magnifiers of this type are available from most laboratory supply companies. The depth of the tip of grooving tools can be checked using the depth measuring feature of vernier calipers.

9.2 *Adjustment of Height of Drop*—Adjust the height of drop of the cup so that the point on the cup that comes in contact with the base rises to a height of 10 ±0.2 mm. See Fig. 4 for proper location of the gage relative to the cup during adjustment.

NOTE 7—A convenient procedure for adjusting the height of drop is as follows: place a piece of masking tape across the outside bottom of the cup parallel with the axis of the cup hanger pivot. The edge of the tape away from the cup hanger should bisect the spot on the cup that contacts the base. For new cups, placing a piece of carbon paper on the base and allowing the cup to drop several times will mark the contact spot. Attach the cup to the device and turn the crank until the cup is raised to its maximum height. Slide the height gage under the cup from the front, and observe whether the gage contacts the cup or the tape. See Fig. 4. If the tape and cup are both contacted, the height of drop is approximately correct. If not, adjust the cup until simultaneous contact is made. Check adjustment by turning the crank at 2 revolutions per second while holding the gage in position against the tape and cup. If a ringing or clicking sound is heard without the cup rising from the gage, the adjustment is correct. If no ringing is heard or if the cup rises from the gage, readjust the height of drop. If the cup rocks on the gage during this checking operation, the cam follower pivot is excessively worn and the worn parts should be replaced. Always remove tape after completion of adjustment operation.

MULTIPOINT LIQUID LIMIT—PROCEDURES A AND B

10. Preparation of Test Specimens

10.1 *Wet Preparation*—Except where the dry method of specimen preparation is specified (10.2), prepare specimens for test as described in the following sections.

10.1.1 *Samples Passing the 425-µm (No. 40) Sieve*—When by visual and manual procedures it is determined that the sample has little or no material retained on a 425-µm (No. 40) sieve, prepare a specimen of 150 to 200 g by mixing thoroughly with distilled or demineralized water on the glass plate using the spatula. If desired, soak soil in a storage dish with small amount of water to soften the soil before the start of mixing. Adjust the water content of the soil to bring it to a consistency that would require 25 to 35 blows of the liquid limit device to close the groove (Note 8). If, during mixing, a small percentage of material is encountered that would be retained on a 425-µm (No. 40) sieve, remove these particles by hand, if possible. If it is impractical to remove the coarser material by hand, remove small percentages (less than about 15 %) of coarser material by working the specimen through a 425-µm (No. 40) sieve using a piece of rubber sheeting, rubber stopper, or other convenient device provided the operation does not distort the sieve or degrade material that would be retained if the washing method described in 10.1.2 were used. If larger percentages of coarse material are encountered during mixing, or it is considered impractical to remove the coarser material by the methods just described, wash the sample as described in 10.1.2. When the coarse particles found during mixing are concretions, shells, or other fragile particles, do not crush these particles to make them pass a 425-µm (No. 40) sieve, but remove by hand or by washing. Place the mixed soil in the storage dish, cover to prevent loss of moisture, and allow to stand for at least 16 h (overnight). After the standing period and immediately before starting the test, thoroughly remix the soil.

NOTE 8—The time taken to adequately mix a soil will vary greatly, depending on the plasticity and initial water content. Initial mixing times of more than 30 — in may be needed for stiff, fat clays.

10.1.2 *Samples Containing Material Retained on a 425-µm (No. 40) Sieve:*

10.1.2.1 Select a sufficient quantity of soil at natural water content to provide 150 to 200 g of material passing the 425-µm (No. 40) sieve. Place in a pan or dish and add sufficient water to cover the soil. Allow to soak until all lumps have softened and the fines no longer adhere to the surfaces of the corase particles (Note 9).

NOTE 9—In some cases, the cations of salts present in tap water will exchange with the natural cations in the soil and significantly alter the test results should tap water be used in the soaking and washing operations. Unless it is known that such cations are not present in the tap water, distilled or demineralized water should be used. As a general rule, water containing more than 100 mg/L of dissolved solids should not be used for washing operations.

10.1.2.2 When the sample contains a large percentage of material retained on the 425-µm

(No. 40) sieve, perform the following washing operation in increments, washing no more than 0.5 kg (1 lb) of material at one time. Place the 425-µm (No. 40) sieve in the bottom of the clean pan. Pour the soil water mixture onto the sieve. If gravel or coarse sand particles are present, rinse as many of these as possible with small quantities of water from a wash bottle, and discard. Alternatively, pour the soil water mixture over a 2-mm (No. 10) sieve nested atop the 425-µm (No. 40) sieve, rinse the fine material through and remove the 2-mm (No. 10) sieve. After washing and removing as much of the coarser material as possible, add sufficient water to the pan to bring the level to about 13 mm (½ in.) above the surface of the 425-µm (No. 40) sieve. Agitate the slurry by stirring with the fingers while raising and lowering the sieve in the pan and swirling the suspension so that fine material is washed from the coarser particles. Disaggregate fine soil lumps that have not slaked by gently rubbing them over the sieve with the fingertips. Complete the washing operation by raising the sieve above the water surface and rinsing the material retained with a small amount of clean water. Discard material retained on the 425-µm (No. 40) sieve.

10.1.2.3 Reduce the water content of the material passing the 425-µm (No. 40) sieve until it approaches the liquid limit. Reduction of water content may be accomplished by one or a combination of the following methods: (*a*) exposing the air currents at ordinary room temperature, (*b*) exposing to warm air currents from a source such as an electric hair dryer, (*c*) filtering in a Buckner funnel or using filter candles, (*d*) decanting clear water from surface of suspension, or (*e*) draining in a colander or plaster of paris dish lined with high retentivity, high wet-strength filter paper.[7] If a plaster of paris dish is used, take care that the dish never becomes sufficiently saturated that it fails to actively absorb water into its surface. Thoroughly dry dishes between uses. During evaporation and cooling, stir the sample often enough to prevent overdrying of the fringes and soil pinnacles on the surface of the mixture. For soil samples containing soluble salts, use a method of water reduction such as *a* or *b* that will not eliminate the soluble salts from the test specimen.

10.1.2.4 Thoroughly mix the material passing the 425-µm (No. 40) sieve on the glass plate using the spatula. Adjust the water content of the mixture, if necessary, by adding small increments of distilled or demineralized water or by allowing the mixture to dry at room temperature while mixing on the glass plate. The soil should be at a water content that will result in closure of the groove in 25 to 35 blows. Return the mixed soil to the mixing dish, cover to prevent loss of moisture, and allow to stand for at least 16 h. After the standing period, and immediately before starting the test, remix the soil thoroughly.

10.2 *Dry Preparation:*

10.2.1 Select sufficient soil to provide 150 to 200 g of material passing the 425-µm (No. 40) sieve after processing. Dry the sample at room temperature or in an oven at a temperature not exceeding 60°C until the soil clods will pulverize readily. Disaggregation is expedited if the sample is not allowed to completely dry. However, the soil should have a dry appearance when pulverized. Pulverize the sample in a mortar with a rubber tipped pestal or in some other way that does not cause breakdown of individual grains. When the coarse particles found during pulverization are concretions, shells, or other fragile particles, do not crush these particles to make them pass a 425-µm (No. 40) sieve, but remove by hand or other suitable means, such as washing.

10.2.2 Separate the sample on a 425-µm (No. 40) sieve, shaking the sieve by hand to assure thorough separation of the finer fraction. Return the material retained on the 425-µm (No. 40) sieve to the pulverizing apparatus and repeat the pulverizing and sieving operations as many times as necessary to assure that all finer material has been disaggregated and material retained on the 425-µm (No. 40) sieve consists only of individual sand or gravel grains.

10.2.3 Place material remaining on the 425-µm (No. 40) sieve after the final pulverizing operations in a dish and soak in a small amount of water. Stir the soil water mixture and pour over the 425-µm (No. 40) sieve, catching the water and any suspended fines in the washing pan. Pour this suspension into a dish containing the dry soil previously sieved through the 425-µm (No. 40) sieve. Discard material retained on the 425-µm (No. 40) sieve.

10.2.4 Adjust the water content as necessary by drying as described in 10.1.2.3 or by mixing on the glass plate, using the spatula while adding increments of distilled or demineralized water,

[7] S and S 595 filter paper, available in 32-cm circles, has proven satisfactory.

until the soil is at a water content that will result in closure of the groove in 25 to 35 blows.

10.2.5 Put soil in the storage dish, cover to prevent loss of moisture and allow to stand for at least 16 h. After the standing period, and immediately before starting the test, thoroughly remix the soil (Note 8).

11. Procedure

11.1 Place a portion of the prepared soil in the cup of the liquid limit device at the point where the cup rests on the base, squeeze it down, and spread it into the cup to a depth of about 10 mm at its deepest point, tapering to form an approximately horizontal surface. Take care to eliminate air bubbles from the soil pat but form the pat with as few strokes as possible. Heap the unused soil on the glass plate and cover with the inverted storage dish or a wet towel.

11.2 Form a groove in the soil pat by drawing the tool, beveled edge forward, through the soil on a line joining the highest point to the lowest point on the rim of the cup. When cutting the groove, hold the grooving tool against the surface of the cup and draw in an arc, maintaining the tool perpendicular to the surface of the cup throughout its movement. See Fig. 5. In soils where a groove cannot be made in one stroke without tearing the soil, cut the groove with several strokes of the grooving tool. Alternatively, cut the groove to slightly less than required dimensions with a spatula and use the grooving tool to bring the groove to final dimensions. Exercise extreme care to prevent sliding the soil pat relative to the surface of the cup.

11.3 Verify that no crumbs of soil are present on the base or the underside of the cup. Lift and drop the cup by turning the crank at a rate of 1.9 to 2.1 drops per second until the two halves of the soil pat come in contact at the bottom of the groove along a distance of 13 mm (½ in.). See Fig. 6.

NOTE 10—Use the end of the grooving tool, Fig. 2, or a scale to verify that the groove has closed 13 mm (½ in.).

11.4 Verify that an air bubble has not caused premature closing of the groove by observing that both sides of the groove have flowed together with approximately the same shape. If a bubble has caused premature closing of the groove, reform the soil in the cup, adding a small amount of soil to make up for that lost in the grooving operation and repeat 11.1 to 11.3. If the soil slides on the surface of the cup, repeat 11.1 through 11.3 at a higher water content. If, after several trials at successively higher water contents, the soil pat continues to slide in the cup or if the number of blows required to close the groove is always less than 25, record that the liquid limit could not be determined, and report the soil as nonplastic without performing the plastic limit test.

11.5 Record the number of drops, N, required to close the groove. Remove a slice of soil approximately the width of the spatula, extending from edge to edge of the soil cake at right angles to the groove and including that portion of the groove in which the soil flowed together, place in a weighed container, and cover.

11.6 Return the soil remaining in the cup to the glass plate. Wash and dry the cup and grooving tool and reattach the cup to the carriage in preparation for the next trial.

11.7 Remix the entire soil specimen on the glass plate adding distilled water to increase the water content of the soil and decrease the number of blows required to close the groove. Repeat 11.1 through 11.6 for at least two additional trials producing successively lower numbers of blows to close the groove. One of the trials shall be for a closure requiring 25 to 35 blows, one for closure between 20 and 30 blows, and one trial for a closure requiring 15 to 25 blows.

11.8 Determine the water content, W_N, of the soil specimen from each trial in accordance with Method D 2216. Make all weighings on the same balance. Initial weighings should be performed immediately after completion of the test. If the test is to be interrupted for more than about 15 min, the specimens already obtained should be weighed at the time of the interruption.

12. Calculations

12.1 Plot the relationship between the water content, W_N, and the corresponding number of drops, N, of the cup on a semilogarithmic graph with the water content as ordinates on the arithmetical scale, and the number of drops as abscissas on the logarithmic scale. Draw the best straight line through the three or more plotted points.

12.2 Take the water content corresponding to the intersection of the line with the 25-drop abscissa as the liquid limit of the soil. Computational methods may be substituted for the graphical method for fitting a straight line to the data and determining the liquid limit.

ONE-POINT LIQUID LIMIT—PROCEDURES C AND D

13. Preparation of Test Specimens

13.1 Prepare the specimen in the same manner as described in Section 10, except that at mixing, adjust the water content to a consistency requiring 20 to 30 drops of the liquid limit cup to close the groove.

14. Procedure

14.1 Proceed as described in 11.1 through 11.5 except that the number of blows required to close the groove shall be 20 to 30. If less than 20 or more than 30 blows are required, adjust the water content of the soil and repeat the procedure.

14.2 *Immediately* after removing a water content specimen as described in 11.5, reform the soil in the cup, adding a small amount of soil to make up for that lost in the grooving and water content sampling operations. Repeat 11.2 through 11.5, and, if the second closing of the groove requires the same number of drops or no more than two drops difference, secure another water content specimen. Otherwise, remix the entire specimen and repeat.

NOTE 11—Excessive drying or inadequate mixing will cause the number of blows to vary.

14.3 Determine water contents of specimens as described in 11.8.

15. Calculations

15.1 Determine the liquid limit for each water content specimen using one of the following equations:

$$LL = W_N\left(\frac{N}{25}\right)^{0.121} \quad \text{or}$$

$$LL = K(W_N)$$

where:

N = the number of blows causing closure of the groove at water content,
W_N = water content, and
K = a factor given in Table 1.

The liquid limit is the average of the two trial liquid limit values.

15.2 If the difference between the two trial liquid limit values is greater than one percentage point, repeat the test.

PLASTIC LIMIT

16. Preparation of Test Specimen

16.1 Select a 20-g portion of soil from the material prepared for the liquid limit test, either after the second mixing before the test, or from the soil remaining after completion of the test. Reduce the water content of the soil to a consistency at which it can be rolled without sticking to the hands by spreading and mixing continuously on the glass plate. The drying process may be accelerated by exposing the soil to the air current from an electric fan, or by blotting with paper that does not add any fiber to the soil, such as hard surface paper toweling or high wet strength filter paper.

17. Procedure

17.1 From the 20-g mass, select a portion of 1.5 to 2.0 g. Form the test specimen into an ellipsoidal mass. Roll this mass between the palm or fingers and the ground-glass plate with just sufficient pressure to roll the mass into a thread of uniform diameter throughout its length (Note 12). The thread shall be further deformed on each stroke so that its diameter is continuously reduced and its length extended until the diameter reaches 3.2 ±0.5 mm (0.125 ±.020 in.), taking no more than 2 min (Note 13). The amount of hand or finger pressure required will vary greatly, according to the soil. Fragile soils of low plasticity are best rolled under the outer edge of the palm or at the base of the thumb.

NOTE 12—A normal rate of rolling for most soils should be 80 to 90 strokes per minute, counting a stroke as one complete motion of the hand forward and back to the starting position. This rate of rolling may have to be decreased for very fragile soils.

NOTE 13—A 3.2-mm (⅛-in.) diameter rod or tube is useful for frequent comparison with the soil thread to ascertain when the thread has reached the proper diameter, especially for inexperienced operators.

17.1.1 When the diameter of the thread becomes 3.2 mm, break the thread into several pieces. Squeeze the pieces together, knead between the thumb and first finger of each hand, reform into an ellipsoidal mass, and reroll. Continue this alternate rolling to a thread 3.2 mm in diameter, gathering together, kneading and rerolling, until the thread crumbles under the pressure required for rolling and the soil can no longer be rolled into a 3.2-mm diameter thread (See Fig. 7). It has no significance if the thread breaks into threads of shorter length. Roll each of these shorter threads to 3.2 mm in diameter. The only requirement for continuing the test is that they are able to be reformed into an ellipsoidal mass and rolled out again. The operator shall at no time attempt to produce failure at exactly 3.2 mm diameter by allowing the thread to reach 3.2 mm, then reducing the rate of rolling or the hand pressure, or both, while continuing the rolling without further deformation until the thread falls apart. It is permissible, however, to reduce the total amount of deformation for feebly plastic soils by making the initial diameter of the ellipsoidal mass nearer to the required 3.2-mm final diameter. If crumbling occurs when the thread has a diameter greater than 3.2 mm, this shall be considered a satisfactory end point, provided the soil has been previously rolled into a thread 3.2 mm in diameter. Crumbling of the thread will manifest itself differently with the various types of soil. Some soils fall apart in numerous small aggregations of particles, others may form an outside tubular layer that starts splitting at both ends. The splitting progresses toward the middle, and finally, the thread falls apart in many small platy particles. Fat clay soils require much pressure to deform the thread, particularly as they approach the plastic limit. With these soils, the thread breaks into a series of barrel-shaped segments about 3.2 to 9.5 mm (1/8 to 3/8 in.) in length.

17.2 Gather the portions of the crumbled thread together and place in a weighed container. Immediately cover the container.

17.3 Select another 1.5 to 2.0 g portion of soil from the original 20-g specimen and repeat the operations described in 17.1 and 17.2 until the container has at least 6 g of soil.

17.4 Repeat 17.1 through 17.3 to make another container holding at least 6 g of soil. Determine the water content, in percent, of the soil contained in the containers in accordance with Method D 2216. Make all weighings on the same balance.

NOTE 14—The intent of performing two plastic limit trials is to verify the consistency of the test results. It is acceptable practice to perform only one plastic limit trial when the consistency in the test results can be confirmed by other means.

18. Calculations

18.1 Compute the average of the two water contents. If the difference between the two water contents is greater than two percentage points, repeat the test. The plastic limit is the average of the two water contents.

PLASTICITY INDEX

19. Calculations

19.1 Calculate the plasticity index as follows:

$$PI = LL - PL$$

where:

LL = the liquid limit,
PL = the plastic limit.

Both LL and PL are whole numbers. If either the liquid limit or plastic limit could not be determined, or if the plastic limit is equal to or greater than the liquid limit, report the soil as nonplastic, NP.

20. Report

20.1 Report the following information:

20.1.1 Sample identifying information,

20.1.2 Any special specimen selection process used, such as removal of sand lenses from undisturbed sample,

20.1.3 Report sample as airdried if the sample was airdried before or during preparation,

20.1.4 Liquid limit, plastic limit, and plasticity index to the nearest whole number and omitting the percent designation. If the liquid limit or plastic limit tests could not be performed, or if the plastic limit is equal to or greater than the liquid limit; report the soil as nonplastic, NP,

20.1.5 An estimate of the percentage of sample retained on the 425-µm (No. 40) sieve, and

20.1.6 Procedure by which liquid limit was performed, if it differs from the multipoint method.

21. Precision and Bias

21.1 No interlaboratory testing program has as yet been conducted using this test method to determine multilaboratory precision.

21.2 The within laboratory precision of the results of tests performed by different operators at one laboratory on two soils using Procedure A for the liquid limit is shown in Table 2.

TABLE 1 Factors for Obtaining Liquid Limit from Water Content and Number of Drops Causing Closure of Groove

N (Number of Drops)	K (Factor for Liquid Limit)
20	0.974
21	0.979
22	0.985
23	0.990
24	0.995
25	1.000
26	1.005
27	1.009
28	1.014
29	1.018
30	1.022

TABLE 2 Within Laboratory Precision for Liquid Limit

	Average Value, $\bar{x}$	Standard Deviation, s
Soil A:		
PL	21.9	1.07
LL	27.9	1.07
Soil B:		
PL	20.1	1.21
LL	32.6	0.98

DIMENSIONS

LETTER	A[Δ]	B[Δ]	C[Δ]	E[Δ]	F	G	H	J[Δ]	K[Δ]	L[Δ]	M[Δ]
MM	54 ± 0.5	2 ± 0.1	27 ± 0.5	56 ± 2.0	32	10	16	60 ± 1.0	50 ± 2.0	150 ± 2.0	125 ± 2.0
LETTER	N	P	R	T	U[Δ]	V	W	Z			
MM	24	28	24	45	47 ± 1.0	3.8	13	6.5			

Δ ESSENTIAL DIMENSIONS

CAM ANGLE DEGREES	CAM RADIUS
0	0.742 R
30	0.753 R
60	0.764 R
90	0.773 R
120	0.784 R
150	0.796 R
180	0.818 R
210	0.854 R
240	0.901 R
270	0.945 R
300	0.974 R
330	0.995 R
360	1.000 R

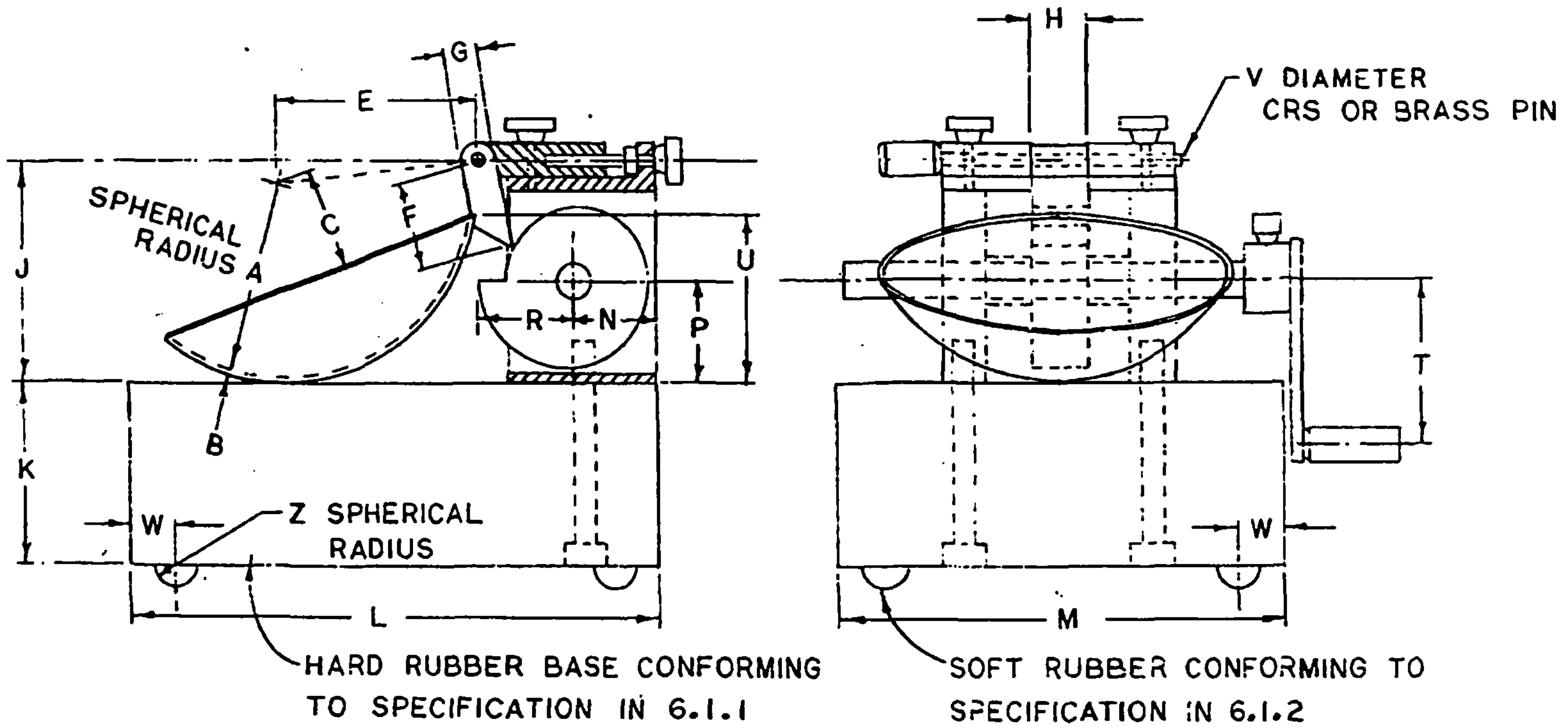


FIG. 1 Hand-Operated Liquid Limit Device

DIMENSIONS

LETTER	A△	B△	C△	D△	E△	F△
MM	2 ±0.1	11 ±0.2	40 ±0.5	8 ±0.1	50 ±0.5	2 ±0.1
LETTER	G	H	J	K△	L△	N
MM	10 MINIMUM	13	60	10 ±0.05	60 DEG ±1 DEG	20

△ *ESSENTIAL DIMENSIONS*

□ *BACK AT LEAST 15 MM FROM TIP*

NOTE: DIMENSION A SHOULD BE 1.9–2.0 AND DIMENSION D SHOULD BE 8.0–8.1 WHEN NEW TO ALLOW FOR ADEQUATE SERVICE LIFE

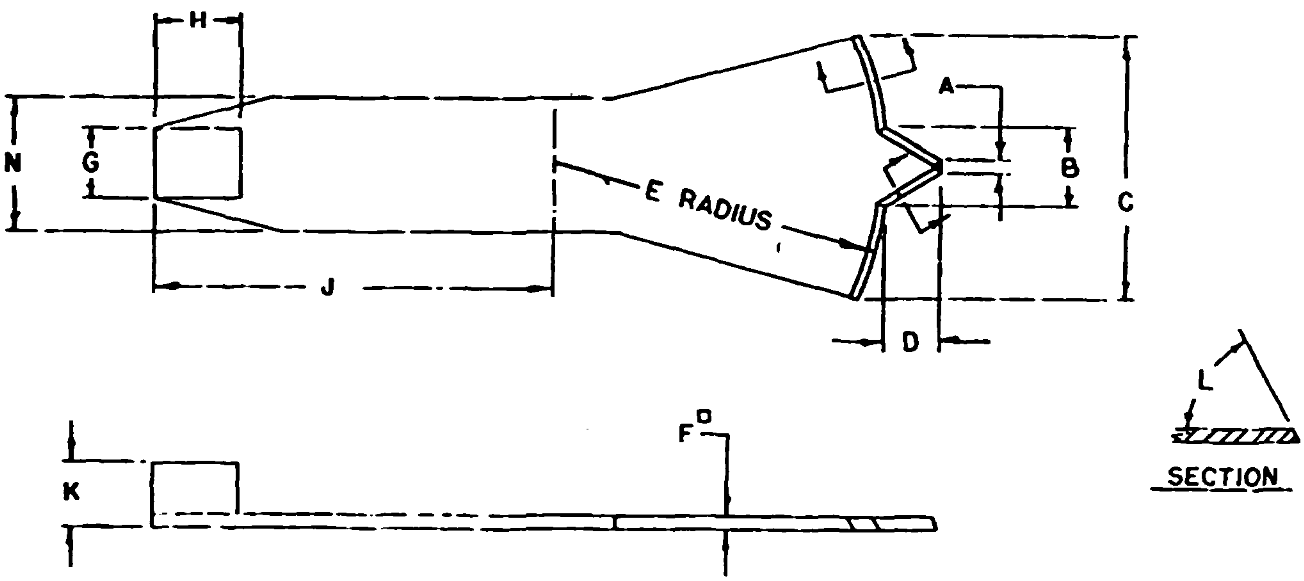
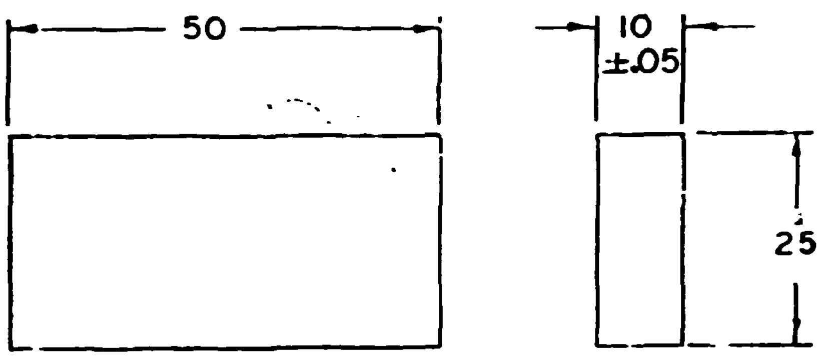


FIG. 2 Grooving Tool (Optional Height-of-Drop Gage Attached)



DIMENSIONS IN MILLIMETRES

FIG. 3 Height of Drop Gage

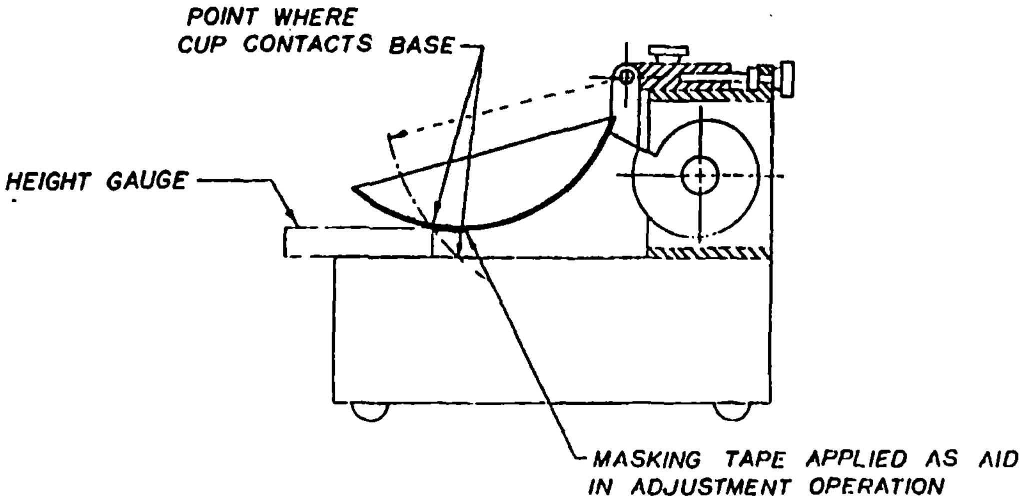


FIG. 4 Calibration for Height of Drop

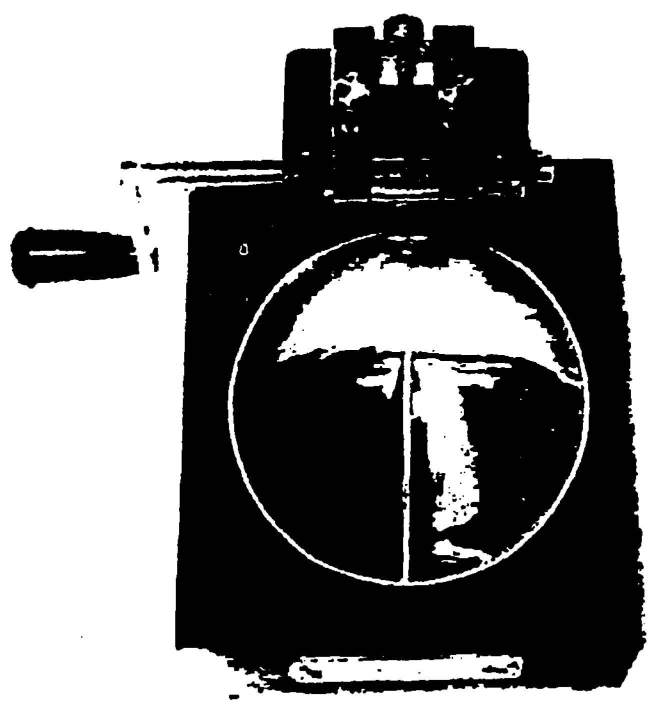


FIG. 5 Grooved Soil Pat in Liquid Limit Device

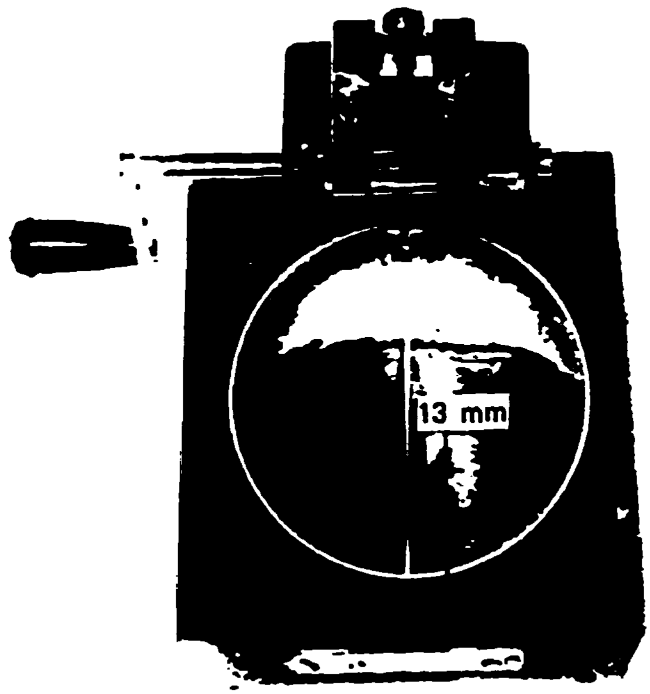


FIG. 6 Soil Pat After Groove Has Closed

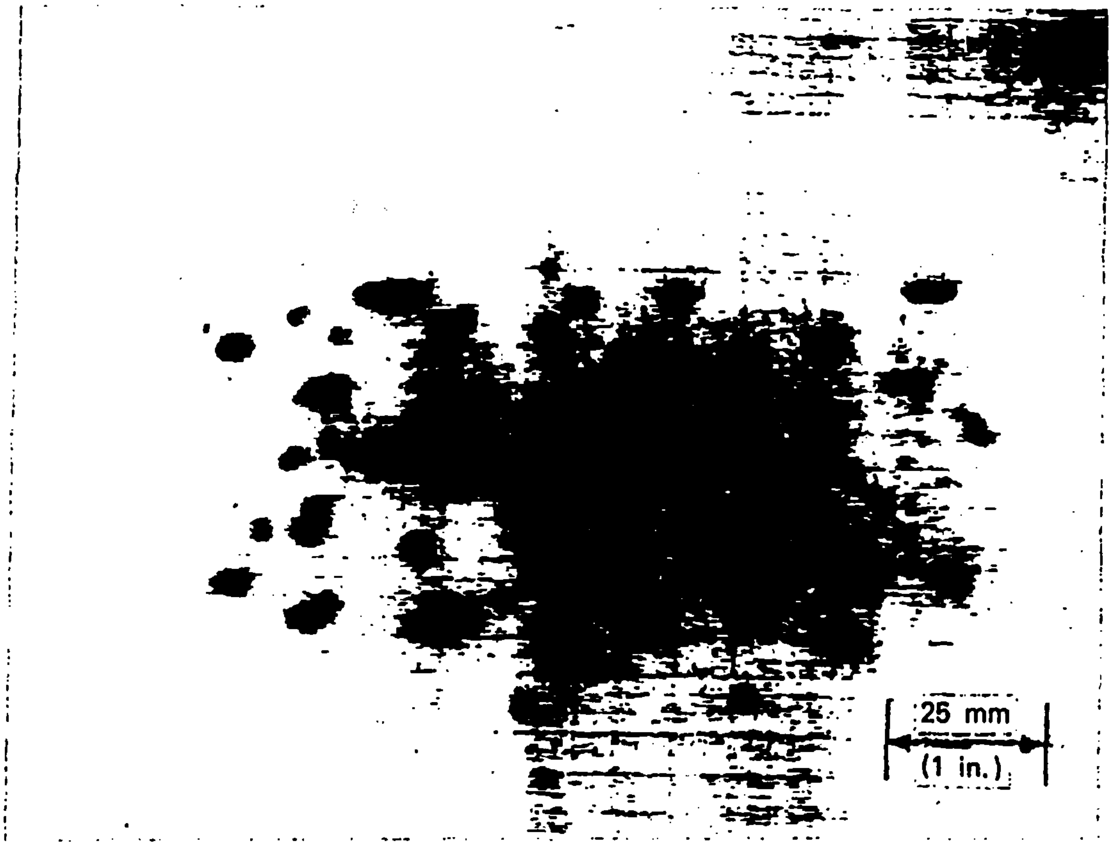


FIG. 7 Lean Clay Soil at the Plastic Limit

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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.

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Designation: D 421 – 85

ATTACHMENT 4

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for DRY PREPARATION OF SOIL SAMPLES FOR PARTICLE-SIZE ANALYSIS AND DETERMINATION OF SOIL CONSTANTS[1]

This standard is issued under the fixed designation D 421; 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.

1. Scope

1.1 This practice covers the dry preparation of soil samples as received from the field for particle-size analysis and the determination of the soil constants.

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.*

2. Applicable Documents

2.1 *ASTM Standards:*

D2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants[2]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

3. Significance and Use

3.1 This practice can be used to prepare samples for particle-size and plasticity tests where it is desired to determine test values on air-dried samples, or where it is known that air drying does not have an effect on test results relative to samples prepared in accordance with Practice D 2217.

4. Apparatus

4.1 *Balance*, sensitive to 0.1 g.

4.2 *Mortar and Rubber-Covered Pestle*, suitable for breaking up the aggregations of soil particles.

4.3 *Sieves*—A series of sieves, of square mesh woven wire cloth, conforming to Specification E 11. The sieves required are as follows:

No. 4 (4.75-mm)
No. 10 (2.00-mm)
No. 40 (425-μm)

4.4 *Sampler*—A riffle sampler or sample splitter, for quartering the samples.

5. Sampling

5.1 Expose the soil sample as received from the field to the air at room temperature until dried thoroughly. Break up the aggregations thoroughly in the mortar with a rubber-covered pestle. Select a representative sample of the amount required to perform the desired tests by the method of quartering or by the use of a sampler. The amounts of material required to perform the individual tests are as follows:

5.1.1 *Particle-Size Analysis*—For the particle-size analysis, material passing a No. 10 (2.00-mm) sieve is required in amounts equal to 115 g of sandy soils and 65 g of either silt or clay soils.

5.1.2 *Tests for Soil Constants*—For the tests for soil constants, material passing the No. 40

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity, and Density Characteristics of Soils.

Current edition approved July 26, 1985. Published September 1985. Originally published as D 421 – 35 T. Last previous edition D 421 – 58 (1978)[ε1].

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

(425-µm) sieve is required in total amount of 220 g, allocated as follows:

Test	Grams
Liquid limit	100
Plastic limit	15
Centrifuge moisture equivalent	10
Volumetric shrinkage	30
Check tests	65

6. Preparation of Test Sample

6.1 Select that portion of the air-dried sample selected for purpose of tests and record the mass as the mass of the total test sample uncorrected for hygroscopic moisture. Separate the test sample by sieving with a No. 10 (2.00-mm) sieve. Grind that fraction retained on the No. 10 sieve in a mortar with a rubber-covered pestle until the aggregations of soil particles are broken up into the separate grains. Then separate the ground soil into two fractions by sieving with a No. 10 sieve.

6.2 Wash that fraction retained after the second sieving free of all fine material, dry, and weigh. Record this mass as the mass of coarse material. Sieve the coarse material, after being washed and dried, on the No. 4 (4.75-mm) sieve and record the mass retained on the No. 4 sieve.

7. Test Sample for Particle-Size Analysis

7.1 Thoroughly mix together the fractions passing the No. 10 (2.00-mm) sieve in both sieving operations, and by the method of quartering or the use of a sampler, select a portion weighing approximately 115 g for sandy soils and approximately 65 g for silt and clay soil for particle-size analysis.

8. Test Sample for Soil Constants

8.1 Separate the remaining portion of the material passing the No. 10 (2.00-mm) sieve into two parts by means of a No. 40 (425-µm) sieve. Discard the fraction retained on the No. 40 sieve. Use the fraction passing the No. 40 sieve for the determination of the soil constants.

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Standard Test Method for Particle-Size Analysis of Soils[1]

This standard is issued under the fixed designation D 422; 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.

ε1 NOTE—Section 19 was added editorially in September 1990.

1. Scope

1.1 This test method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 µm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 µm is determined by a sedimentation process, using a hydrometer to secure the necessary data (Notes 1 and 2).

NOTE 1—Separation may be made on the No. 4 (4.75-mm), No. 40 (425-µm), or No. 200 (75-µm) sieve instead of the No. 10. For whatever sieve used, the size shall be indicated in the report.

NOTE 2—Two types of dispersion devices are provided: (*1*) a high-speed mechanical stirrer, and (*2*) air dispersion. Extensive investigations indicate that air-dispersion devices produce a more positive dispersion of plastic soils below the 20-µm size and appreciably less degradation on all sizes when used with sandy soils. Because of the definite advantages favoring air dispersion, its use is recommended. The results from the two types of devices differ in magnitude, depending upon soil type, leading to marked differences in particle size distribution, especially for sizes finer than 20 µm.

2. Referenced Documents

2.1 *ASTM Standards:*

D 421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants[2]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

E 100 Specification for ASTM Hydrometers[4]

3. Apparatus

3.1 *Balances*—A balance sensitive to 0.01 g for weighing the material passing a No. 10 (2.00-mm) sieve, and a balance sensitive to 0.1 % of the mass of the sample to be weighed for weighing the material retained on a No. 10 sieve.

3.2 *Stirring Apparatus*—Either apparatus A or B may be used.

3.2.1 Apparatus A shall consist of a mechanically operated stirring device in which a suitably mounted electric motor turns a vertical shaft at a speed of not less than 10 000 rpm without load. The shaft shall be equipped with a replaceable stirring paddle made of metal, plastic, or hard rubber, as shown in Fig. 1. The shaft shall be of such length that the stirring paddle will operate not less than ¾ in. (19.0 mm) nor more than 1½ in. (38.1 mm) above the bottom of the dispersion cup. A special dispersion cup conforming to either of the designs shown in Fig. 2 shall be provided to hold the sample while it is being dispersed.

3.2.2 Apparatus B shall consist of an air-jet dispersion cup[5] (Note 3) conforming to the general details shown in Fig. 3 (Notes 4 and 5).

NOTE 3—The amount of air required by an air-jet dispersion cup is of the order of 2 ft³/min; some small air compressors are not capable of supplying sufficient air to operate a cup.

NOTE 4—Another air-type dispersion device, known as a dispersion tube, developed by Chu and Davidson at Iowa State College, has been shown to give results equivalent to those secured by the air-jet dispersion cups. When it is used, soaking of the sample can be done in the sedimentation cylinder, thus eliminating the need for transferring the slurry. When the air-dispersion tube is used, it shall be so indicated in the report.

NOTE 5—Water may condense in air lines when not in use. This water must be removed, either by using a water trap on the air line, or by blowing the water out of the line before using any of the air for dispersion purposes.

3.3 *Hydrometer*—An ASTM hydrometer, graduated to read in either specific gravity of the suspension or grams per litre of suspension, and conforming to the requirements for hydrometers 151H or 152H in Specifications E 100. Dimensions of both hydrometers are the same, the scale being the only item of difference.

3.4 *Sedimentation Cylinder*—A glass cylinder essentially 18 in. (457 mm) in height and 2½ in. (63.5 mm) in diameter, and marked for a volume of 1000 mL. The inside diameter shall be such that the 1000-mL mark is 36 ± 2 cm from the bottom on the inside.

3.5 *Thermometer*—A thermometer accurate to 1°F (0.5°C).

3.6 *Sieves*—A series of sieves, of square-mesh woven-wire cloth, conforming to the requirements of Specification E 11. A full set of sieves includes the following (Note 6):

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity, and Density Characteristics of Soils.

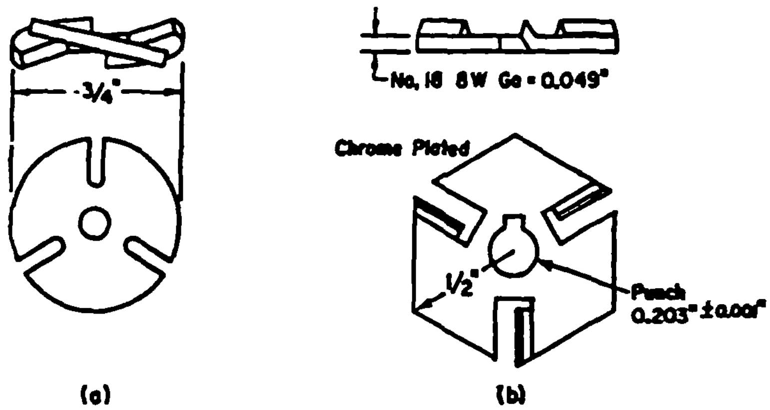
Current edition approved Nov. 21, 1963. Originally published 1935. Replaces D 422 – 62.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] *Annual Book of ASTM Standards*, Vol 14.03.

[5] Detailed working drawings for this cup are available at a nominal cost from the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103. Order Adjunct No. 12-404220-00.



Metric Equivalents

in.	0.001	0.049	0.203	½	¾
mm	0.03	1.24	5.16	12.7	19.0

FIG. 1 Detail of Stirring Paddles

3-in. (75-mm) | No. 10 (2.00-mm)
2-in. (50-mm) | No. 20 (850-µm)
1½-in. (37.5-mm) | No. 40 (425-µm)
1-in. (25.0-mm) | No. 60 (250-µm)
¾-in. (19.0-mm) | No. 140 (106-µm)
⅜-in. (9.5-mm) | No. 200 (75-µm)
No. 4 (4.75-mm)

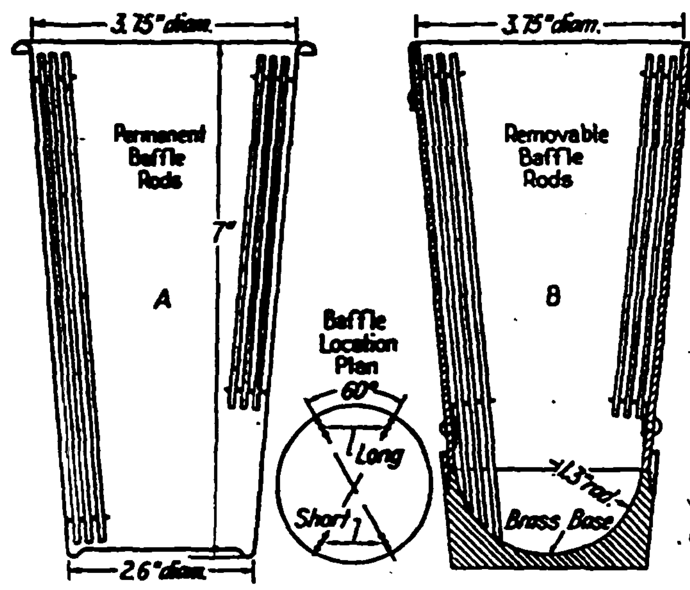
NOTE 6—A set of sieves giving uniform spacing of points for the graph, as required in Section 17, may be used if desired. This set consists of the following sieves:

3-in. (75-mm) | No. 16 (1.18-mm)
1½-in. (37.5-mm) | No. 30 (600-µm)
¾-in. (19.0-mm) | No. 50 (300-µm)
⅜-in. (9.5-mm) | No. 100 (150-µm)
No. 4 (4.75-mm) | No. 200 (75-µm)
No. 8 (2.36-mm)

3.7 *Water Bath or Constant-Temperature Room*—A water bath or constant-temperature room for maintaining the soil suspension at a constant temperature during the hydrometer analysis. A satisfactory water tank is an insulated tank that maintains the temperature of the suspension at a convenient constant temperature at or near 68°F (20°C). Such a device is illustrated in Fig. 4. In cases where the work is performed in a room at an automatically controlled constant temperature, the water bath is not necessary.

3.8 *Beaker*—A beaker of 250-mL capacity.

3.9 *Timing Device*—A watch or clock with a second hand.



Metric Equivalents

in.	1.3	2.6	3.75
mm	33	66	95.2

FIG. 2 Dispersion Cups of Apparatus

4. Dispersing Agent

4.1 A solution of sodium hexametaphosphate (sometimes called sodium metaphosphate) shall be used in distilled or demineralized water, at the rate of 40 g of sodium hexametaphosphate/litre of solution (Note 7).

NOTE 7—Solutions of this salt, if acidic, slowly revert or hydrolyze back to the orthophosphate form with a resultant decrease in dispersive action. Solutions should be prepared frequently (at least once a month) or adjusted to pH of 8 or 9 by means of sodium carbonate. Bottles containing solutions should have the date of preparation marked on them.

4.2 All water used shall be either distilled or demineralized water. The water for a hydrometer test shall be brought to the temperature that is expected to prevail during the hydrometer test. For example, if the sedimentation cylinder is to be placed in the water bath, the distilled or demineralized water to be used shall be brought to the temperature of the controlled water bath; or, if the sedimentation cylinder is used in a room with controlled temperature, the water for the test shall be at the temperature of the room. The basic temperature for the hydrometer test is 68°F (20°C). Small variations of temperature do not introduce differences that are of practical significance and do not prevent the use of corrections derived as prescribed.

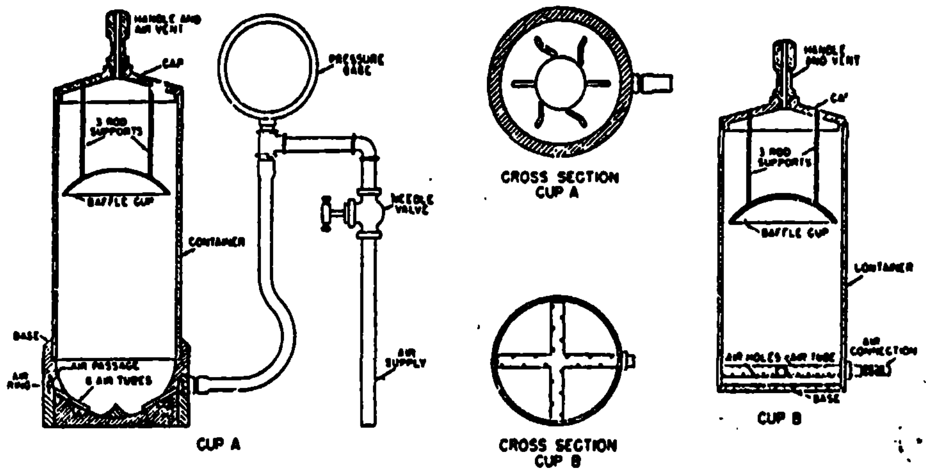


FIG. 3 Air-Jet Dispersion Cups of Apparatus B

5. Test Sample

5.1 Prepare the test sample for mechanical analysis as outlined in Practice D 421. During the preparation procedure the sample is divided into two portions. One portion contains only particles retained on the No. 10 (2.00-mm) sieve while the other portion contains only particles passing the No. 10 sieve. The mass of air-dried soil selected for purpose of tests, as prescribed in Practice D 421, shall be sufficient to yield quantities for mechanical analysis as follows:

5.1.1 The size of the portion retained on the No. 10 sieve shall depend on the maximum size of particle, according to the following schedule:

Nominal Diameter of Largest Particles, in. (mm)	Approximate Minimum Mass of Portion, g
⅜ (9.5)	500
¾ (19.0)	1000
1 (25.4)	2000
1½ (38.1)	3000
2 (50.8)	4000
3 (76.2)	5000

5.1.2 The size of the portion passing the No. 10 sieve shall be approximately 115 g for sandy soils and approximately 65 g for silt and clay soils.

5.2 Provision is made in Section 5 of Practice D 421 for weighing of the air-dry soil selected for purpose of tests, the separation of the soil on the No. 10 sieve by dry-sieving and washing, and the weighing of the washed and dried fraction retained on the No. 10 sieve. From these two masses the percentages retained and passing the No. 10 sieve can be calculated in accordance with 12.1.

NOTE 8—A check on the mass values and the thoroughness of pulverization of the clods may be secured by weighing the portion passing the No. 10 sieve and adding this value to the mass of the washed and oven-dried portion retained on the No. 10 sieve.

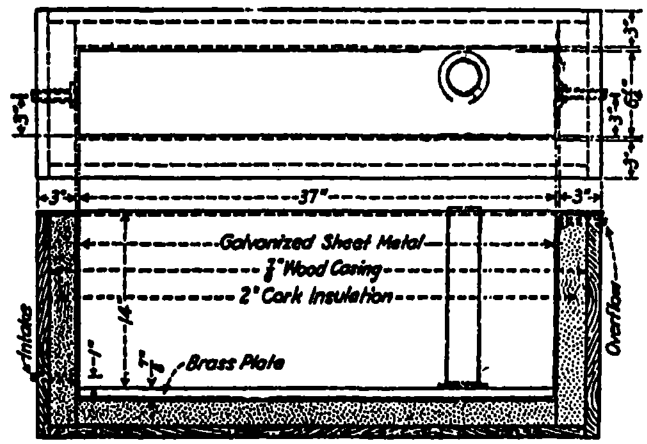
SIEVE ANALYSIS OF PORTION RETAINED ON NO. 10 (2.00-mm) SIEVE

6. Procedure

6.1 Separate the portion retained on the No. 10 (2.00-mm) sieve into a series of fractions using the 3-in. (75-mm), 2-in. (50-mm), 1½-in. (37.5-mm), 1-in. (25.0-mm), ¾-in. (19.0-mm), ⅜-in. (9.5-mm), No. 4 (4.75-mm), and No. 10 sieves, or as many as may be needed depending on the sample, or upon the specifications for the material under test.

6.2 Conduct the sieving operation by means of a lateral and vertical motion of the sieve, accompanied by a jarring action in order to keep the sample moving continuously over the surface of the sieve. In no case turn or manipulate fragments in the sample through the sieve by hand. Continue sieving until not more than 1 mass % of the residue on a sieve passes that sieve during 1 min of sieving. When mechanical sieving is used, test the thoroughness of sieving by using the hand method of sieving as described above.

6.3 Determine the mass of each fraction on a balance conforming to the requirements of 3.1. At the end of weighing, the sum of the masses retained on all the sieves used should equal closely the original mass of the quantity sieved.



Metric Equivalents

in.	⅞	1	3	6¼	14	37
mm	22.2	25.4	76.2	158.2	356	940

FIG. 4 Insulated Water Bath

HYDROMETER AND SIEVE ANALYSIS OF PORTION PASSING THE NO. 10 (2.00-mm) SIEVE

7. Determination of Composite Correction for Hydrometer Reading

7.1 Equations for percentages of soil remaining in suspension, as given in 14.3, are based on the use of distilled or demineralized water. A dispersing agent is used in the water, however, and the specific gravity of the resulting liquid is appreciably greater than that of distilled or demineralized water.

7.1.1 Both soil hydrometers are calibrated at 68°F (20°C), and variations in temperature from this standard temperature produce inaccuracies in the actual hydrometer readings. The amount of the inaccuracy increases as the variation from the standard temperature increases.

7.1.2 Hydrometers are graduated by the manufacturer to be read at the bottom of the meniscus formed by the liquid on the stem. Since it is not possible to secure readings of soil suspensions at the bottom of the meniscus, readings must be taken at the top and a correction applied.

7.1.3 The net amount of the corrections for the three items enumerated is designated as the composite correction, and may be determined experimentally.

7.2 For convenience, a graph or table of composite corrections for a series of 1° temperature differences for the range of expected test temperatures may be prepared and used as needed. Measurement of the composite corrections may be made at two temperatures spanning the range of expected test temperatures, and corrections for the intermediate temperatures calculated assuming a straight-line relationship between the two observed values.

7.3 Prepare 1000 mL of liquid composed of distilled or demineralized water and dispersing agent in the same proportion as will prevail in the sedimentation (hydrometer) test. Place the liquid in a sedimentation cyclinder and the cylinder in the constant-temperature water bath, set for one of the two temperatures to be used. When the temperature of the liquid becomes constant, insert the hydrometer, and, after a short interval to permit the hydrometer to come to the temperature of the liquid, read the hydrometer at the top of the meniscus formed on the stem. For hydrometer 151H the composite correction is the difference between this reading and one; for hydrometer 152H it is the difference between the reading and zero. Bring the liquid and the hydrometer to the other temperature to be used, and secure the composite correction as before.

8. Hygroscopic Moisture

8.1 When the sample is weighed for the hydrometer test, weigh out an auxiliary portion of from 10 to 15 g in a small metal or glass container, dry the sample to a constant mass in an oven at 230 ± 9°F (110 ± 5°C), and weigh again. Record the masses.

9. Dispersion of Soil Sample

9.1 When the soil is mostly of the clay and silt sizes, weigh out a sample of air-dry soil of approximately 50 g. When the soil is mostly sand the sample should be approximately 100 g.

9.2 Place the sample in the 250-mL beaker and cover with 125 mL of sodium hexametaphosphate solution (40 g/L). Stir until the soil is thoroughly wetted. Allow to soak for at least 16 h.

9.3 At the end of the soaking period, disperse the sample further, using either stirring apparatus A or B. If stirring apparatus A is used, transfer the soil - water slurry from the beaker into the special dispersion cup shown in Fig. 2, washing any residue from the beaker into the cup with distilled or demineralized water (Note 9). Add distilled or demineralized water, if necessary, so that the cup is more than half full. Stir for a period of 1 min.

NOTE 9—A large size syringe is a convenient device for handling the water in the washing operation. Other devices include the wash-water bottle and a hose with nozzle connected to a pressurized distilled water tank.

9.4 If stirring apparatus B (Fig. 3) is used, remove the cover cap and connect the cup to a compressed air supply by means of a rubber hose. A air gage must be on the line between the cup and the control valve. Open the control valve so that the gage indicates 1 psi (7 kPa) pressure (Note 10). Transfer the soil - water slurry from the beaker to the air-jet dispersion cup by washing with distilled or demineralized water. Add distilled or demineralized water, if necessary, so that the total volume in the cup is 250 mL, but no more.

NOTE 10—The initial air pressure of 1 psi is required to prevent the soil - water mixture from entering the air-jet chamber when the mixture is transferred to the dispersion cup.

9.5 Place the cover cap on the cup and open the air control valve until the gage pressure is 20 psi (140 kPa). Disperse the soil according to the following schedule:

Plasticity Index	Dispersion Period, min
Under 5	5
6 to 20	10
Over 20	15

Soils containing large percentages of mica need be dispersed for only 1 min. After the dispersion period, reduce the gage pressure to 1 psi preparatory to transfer of soil - water slurry to the sedimentation cylinder.

10. Hydrometer Test

10.1 Immediately after dispersion, transfer the soil - water slurry to the glass sedimentation cylinder, and add distilled or demineralized water until the total volume is 1000 mL.

10.2 Using the palm of the hand over the open end of the cylinder (or a rubber stopper in the open end), turn the cylinder upside down and back for a period of 1 min to complete the agitation of the slurry (Note 11). At the end of 1 min set the cylinder in a convenient location and take hydrometer readings at the following intervals of time (measured from the beginning of sedimentation), or as many as may be needed, depending on the sample or the specification for the material under test: 2, 5, 15, 30, 60, 250, and 1440 min. If the controlled water bath is used, the sedimentation cylinder should be placed in the bath between the 2- and 5-min readings.

NOTE 11—The number of turns during this minute should be approximately 60, counting the turn upside down and back as two turns.

Any soil remaining in the bottom of the cylinder during the first few turns should be loosened by vigorous shaking of the cylinder while it is in the inverted position.

10.3 When it is desired to take a hydrometer reading, carefully insert the hydrometer about 20 to 25 s before the reading is due to approximately the depth it will have when the reading is taken. As soon as the reading is taken, carefully remove the hydrometer and place it with a spinning motion in a graduate of clean distilled or demineralized water.

NOTE 12—It is important to remove the hydrometer immediately after each reading. Readings shall be taken at the top of the meniscus formed by the suspension around the stem, since it is not possible to secure readings at the bottom of the meniscus.

10.4 After each reading, take the temperature of the suspension by inserting the thermometer into the suspension.

11. Sieve Analysis

11.1 After taking the final hydrometer reading, transfer the suspension to a No. 200 (75-µm) sieve and wash with tap water until the wash water is clear. Transfer the material on the No. 200 sieve to a suitable container, dry in an oven at 230 ± 9°F (110 ± 5°C) and make a sieve analysis of the portion retained, using as many sieves as desired, or required for the material, or upon the specification of the material under test.

CALCULATIONS AND REPORT

12. Sieve Analysis Values for the Portion Coarser than the No. 10 (2.00-mm) Sieve

12.1 Calculate the percentage passing the No. 10 sieve by dividing the mass passing the No. 10 sieve by the mass of soil originally split on the No. 10 sieve, and multiplying the result by 100. To obtain the mass passing the No. 10 sieve, subtract the mass retained on the No. 10 sieve from the original mass.

12.2 To secure the total mass of soil passing the No. 4 (4.75-mm) sieve, add to the mass of the material passing the No. 10 sieve the mass of the fraction passing the No. 4 sieve and retained on the No. 10 sieve. To secure the total mass of soil passing the ⅜-in. (9.5-mm) sieve, add to the total mass of soil passing the No. 4 sieve, the mass of the fraction passing the ⅜-in. sieve and retained on the No. 4 sieve. For the remaining sieves, continue the calculations in the same manner.

12.3 To determine the total percentage passing for each sieve, divide the total mass passing (see 12.2) by the total mass of sample and multiply the result by 100.

13. Hygroscopic Moisture Correction Factor

13.1 The hydroscopic moisture correction factor is the ratio between the mass of the oven-dried sample and the air-dry mass before drying. It is a number less than one, except when there is no hygroscopic moisture.

14. Percentages of Soil in Suspension

14.1 Calculate the oven-dry mass of soil used in the hydrometer analysis by multiplying the air-dry mass by the hygroscopic moisture correction factor.

14.2 Calculate the mass of a total sample represented by the mass of soil used in the hydrometer test, by dividing the oven-dry mass used by the percentage passing the No. 10 (2.00-mm) sieve, and multiplying the result by 100. This value is the weight W in the equation for percentage remaining in suspension.

TABLE 1 Values of Correction Factor, a, for Different Specific Gravities of Soil Particles[A]

Specific Gravity	Correction Factor[A]
2.95	0.94
2.90	0.95
2.85	0.96
2.80	0.97
2.75	0.98
2.70	0.99
2.65	1.00
2.60	1.01
2.55	1.02
2.50	1.03
2.45	1.05

[A] For use in equation for percentage of soil remaining in suspension when using Hydrometer 152H.

14.3 The percentage of soil remaining in suspension at the level at which the hydrometer is measuring the density of the suspension may be calculated as follows (Note 13): For hydrometer 151H:

$$P = [(100\,000/W) \times G/(G - G_1)](R - G_1)$$

NOTE 13—The bracketed portion of the equation for hydrometer 151H is constant for a series of readings and may be calculated first and then multiplied by the portion in the parentheses.

For hydrometer 152H:

$$P = (Ra/W) \times 100$$

where:

a = correction faction to be applied to the reading of hydrometer 152H. (Values shown on the scale are computed using a specific gravity of 2.65. Correction factors are given in Table 1),

P = percentage of soil remaining in suspension at the level at which the hydrometer measures the density of the suspension,

R = hydrometer reading with composite correction applied (Section 7),

W = oven-dry mass of soil in a total test sample represented by mass of soil dispersed (see 14.2), g,

G = specific gravity of the soil particles, and

G_1 = specific gravity of the liquid in which soil particles are suspended. Use numerical value of one in both instances in the equation. In the first instance any possible variation produces no significant effect, and in the second instance, the composite correction for R is based on a value of one for G_1.

15. Diameter of Soil Particles

15.1 The diameter of a particle corresponding to the percentage indicated by a given hydrometer reading shall be calculated according to Stokes' law (Note 14), on the basis that a particle of this diameter was at the surface of the suspension at the beginning of sedimentation and had settled to the level at which the hydrometer is measuring the density of the suspension. According to Stokes' law:

$$D = \sqrt{[30n/980(G - G_1)] \times L/T}$$

where:

D = diameter of particle, mm,

n = coefficient of viscosity of the suspending medium (in this case water) in poises (varies with changes in temperature of the suspending medium),
L = distance from the surface of the suspension to the level at which the density of the suspension is being measured, cm. (For a given hydrometer and sedimentation cylinder, values vary according to the hydrometer readings. This distance is known as effective depth (Table 2)),
T = interval of time from beginning of sedimentation to the taking of the reading, min,
G = specific gravity of soil particles, and
G_1 = specific gravity (relative density) of suspending medium (value may be used as 1.000 for all practical purposes).

NOTE 14—Since Stokes' law considers the terminal velocity of a single sphere falling in an infinity of liquid, the sizes calculated represent the diameter of spheres that would fall at the same rate as the soil particles.

15.2 For convenience in calculations the above equation may be written as follows:

$$D = K\sqrt{L/T}$$

where:
K = constant depending on the temperature of the suspension and the specific gravity of the soil particles. Values of K for a range of temperatures and specific gravities are given in Table 3. The value of K does not change for a series of readings constituting a test, while values of L and T do vary.

15.3 Values of D may be computed with sufficient accuracy, using an ordinary 10-in. slide rule.

NOTE 15—The value of L is divided by T using the A- and B-scales, the square root being indicated on the D-scale. Without ascertaining the value of the square root it may be multiplied by K, using either the C- or CI-scale.

16. Sieve Analysis Values for Portion Finer than No. 10 (2.00-mm) Sieve

16.1 Calculation of percentages passing the various sieves used in sieving the portion of the sample from the hydrometer test involves several steps. The first step is to calculate the mass of the fraction that would have been retained on the No. 10 sieve had it not been removed. This mass is equal to the total percentage retained on the No. 10 sieve (100 minus total percentage passing) times the mass of the total sample represented by the mass of soil used (as calculated in 14.2), and the result divided by 100.

16.2 Calculate next the total mass passing the No. 200 sieve. Add together the fractional masses retained on all the sieves, including the No. 10 sieve, and subtract this sum from the mass of the total sample (as calculated in 14.2).

16.3 Calculate next the total masses passing each of the other sieves, in a manner similar to that given in 12.2.

16.4 Calculate last the total percentages passing by dividing the total mass passing (as calculated in 16.3) by the total mass of sample (as calculated in 14.2), and multiply the result by 100.

17. Graph

17.1 When the hydrometer analysis is performed, a graph of the test results shall be made, plotting the diameters of the particles on a logarithmic scale as the abscissa and the percentages smaller than the corresponding diameters to an

TABLE 2 Values of Effective Depth Based on Hydrometer and Sedimentation Cylinder of Specified Sizes[A]

Hydrometer 151H		Hydrometer 152H			
Actual Hydrometer Reading	Effective Depth, L, cm	Actual Hydrometer Reading	Effective Depth, L, cm	Actual Hydrometer Reading	Effective Depth, L, cm
1.000	16.3	0	16.3	31	11.2
1.001	16.0	1	16.1	32	11.1
1.002	15.8	2	16.0	33	10.9
1.003	15.5	3	15.8	34	10.7
1.004	15.2	4	15.6	35	10.6
1.005	15.0	5	15.5		
1.006	14.7	6	15.3	36	10.4
1.007	14.4	7	15.2	37	10.2
1.008	14.2	8	15.0	38	10.1
1.009	13.9	9	14.8	39	9.9
1.010	13.7	10	14.7	40	9.7
1.011	13.4	11	14.5	41	9.6
1.012	13.1	12	14.3	42	9.4
1.013	12.9	13	14.2	43	9.2
1.014	12.6	14	14.0	44	9.1
1.015	12.3	15	13.8	45	8.9
1.016	12.1	16	13.7	46	8.8
1.017	11.8	17	13.5	47	8.6
1.018	11.5	18	13.3	48	8.4
1.019	11.3	19	13.2	49	8.3
1.020	11.0	20	13.0	50	8.1
1.021	10.7	21	12.9	51	7.9
1.022	10.5	22	12.7	52	7.8
1.023	10.2	23	12.5	53	7.6
1.024	10.0	24	12.4	54	7.4
1.025	9.7	25	12.2	55	7.3
1.026	9.4	26	12.0	56	7.1
1.027	9.2	27	11.9	57	7.0
1.028	8.9	28	11.7	58	6.8
1.029	8.6	29	11.5	59	6.6
1.030	8.4	30	11.4	60	6.5
1.031	8.1				
1.032	7.8				
1.033	7.6				
1.034	7.3				
1.035	7.0				
1.036	6.8				
1.037	6.5				
1.038	6.2				

[A] Values of effective depth are calculated from the equation:

$$L = L_1 + \frac{1}{2}[L_2 - (V_B/A)]$$

where:
L = effective depth, cm,
L_1 = distance along the stem of the hydrometer from the top of the bulb to the mark for a hydrometer reading, cm,
L_2 = overall length of the hydrometer bulb, cm,
V_B = volume of hydrometer bulb, cm^3, and
A = cross-sectional area of sedimentation cylinder, cm^2

Values used in calculating the values in Table 2 are as follows:
For both hydrometers, 151H and 152H:
L_2 = 14.0 cm
V_B = 67.0 cm^3
A = 27.8 cm^2
For hydrometer 151H:
L_1 = 10.5 cm for a reading of 1.000
= 2.3 cm for a reading of 1.031
For hydrometer 152H:
L_1 = 10.5 cm for a reading of 0 g/litre
= 2.3 cm for a reading of 50 g/litre

TABLE 3 Values of K for Use in Equation for Computing Diameter of Particle in Hydrometer Analysis

Temperature, °C	Specific Gravity of Soil Particles								
	2.45	2.50	2.55	2.60	2.65	2.70	2.75	2.80	2.85
16	0.01510	0.01505	0.01481	0.01457	0.01435	0.01414	0.01394	0.01374	0.01356
17	0.01511	0.01486	0.01462	0.01439	0.01417	0.01396	0.01376	0.01356	0.01338
18	0.01492	0.01467	0.01443	0.01421	0.01399	0.01378	0.01359	0.01339	0.01321
19	0.01474	0.01449	0.01425	0.01403	0.01382	0.01361	0.01342	0.1323	0.01305
20	0.01456	0.01431	0.01408	0.01386	0.01365	0.01344	0.01325	0.01307	0.01289
21	0.01438	0.01414	0.01391	0.01369	0.01348	0.01328	0.01309	0.01291	0.01273
22	0.01421	0.01397	0.01374	0.01353	0.01332	0.01312	0.01294	0.01276	0.01258
23	0.01404	0.01381	0.01358	0.01337	0.01317	0.01297	0.01279	0.01261	0.01243
24	0.01388	0.01365	0.01342	0.01321	0.01301	0.01282	0.01264	0.01246	0.01229
25	0.01372	0.01349	0.01327	0.01306	0.01286	0.01267	0.01249	0.01232	0.01215
26	0.01357	0.01334	0.01312	0.01291	0.01272	0.01253	0.01235	0.01218	0.01201
27	0.01342	0.01319	0.01297	0.01277	0.01258	0.01239	0.01221	0.01204	0.01188
28	0.01327	0.01304	0.01283	0.01264	0.01244	0.01255	0.01208	0.01191	0.01175
29	0.01312	0.01290	0.01269	0.01249	0.01230	0.01212	0.01195	0.01178	0.01162
30	0.01298	0.01276	0.01256	0.01236	0.01217	0.01199	0.01182	0.01165	0.01149

arithmetic scale as the ordinate. When the hydrometer analysis is not made on a portion of the soil, the preparation of the graph is optional, since values may be secured directly from tabulated data.

18. Report

18.1 The report shall include the following:

18.1.1 Maximum size of particles,

18.1.2 Percentage passing (or retained on) each sieve, which may be tabulated or presented by plotting on a graph (Note 16),

18.1.3 Description of sand and gravel particles:

18.1.3.1 Shape—rounded or angular,

18.1.3.2 Hardness—hard and durable, soft, or weathered and friable,

18.1.4 Specific gravity, if unusually high or low,

18.1.5 Any difficulty in dispersing the fraction passing the No. 10 (2.00-mm) sieve, indicating any change in type and amount of dispersing agent, and

18.1.6 The dispersion device used and the length of the dispersion period.

NOTE 16—This tabulation of graph represents the gradation of the sample tested. If particles larger than those contained in the sample were removed before testing, the report shall so state giving the amount and maximum size.

18.2 For materials tested for compliance with definite specifications, the fractions called for in such specifications shall be reported. The fractions smaller than the No. 10 sieve shall be read from the graph.

18.3 For materials for which compliance with definite specifications is not indicated and when the soil is composed almost entirely of particles passing the No. 4 (4.75-mm) sieve, the results read from the graph may be reported as follows:

(*1*)	Gravel, passing 3-in. and retained on No. 4 sieve	.... %
(*2*)	Sand, passing No. 4 sieve and retained on No. 200 sieve	.... %
	(*a*) Course sand, passing No. 4 sieve and retained on No. 10 sieve	.... %
	(*b*) Medium sand, passing No. 10 sieve and retained on No. 40 sieve	.... %
	(*c*) Fine sand, passing No. 40 sieve and retained on No. 200 sieve	.... %
(*3*)	Silt size, 0.074 to 0.005 mm	.... %
(*4*)	Clay size, smaller than 0.005 mm	.... %
	Colloids, smaller than 0.001 mm	.... %

18.4 For materials for which compliance with definite specifications is not indicated and when the soil contains material retained on the No. 4 sieve sufficient to require a sieve analysis on that portion, the results may be reported as follows (Note 17):

SIEVE ANALYSIS

Sieve Size	Percentage Passing
3-in.	....
2-in.	....
1½-in.	....
1-in.	....
¾-in.	....
⅜-in.	....
No. 4 (4.75-mm)	....
No. 10 (2.00-mm)	....
No. 40 (425-μm)	....
No. 200 (75-μm)	....
HYDROMETER ANALYSIS	
0.074 mm	....
0.005 mm	....
0.001 mm	....

NOTE 17—No. 8 (2.36-mm) and No. 50 (300-μm) sieves may be substituted for No. 10 and No. 40 sieves.

19. Keywords

19.1 grain-size; hydrometer analysis; hygroscopic moisture; particle-size; sieve analysis

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818, Alexandria, Virginia 22313
PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[x] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V, Carter Lee Lumber

B. Regional Representative: Denise Boone

C. Telephone Number: (312) 886-1488

D. Date of Request:

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis for total organic carbon (TOC) in monitoring well samples. All aqueous samples will be filtered. Results are reported as mg/l C.

   Analysis for TOC in soil (air-dried, all screened through 100 or 140 mesh). Applicable concentration 0.1%-2.0% or more. Detailed information must be provided with Case Narrative for test procedures, instrumentation/apparatus, and QC used. See Attachment 1.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

   Seven soil samples containing low levels of TOC will be collected in Phase I. Twenty nine aqueous samples containing low levels of TOC will be collected in Phase II.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

Superfund enforcement

4. Estimated date(s) of collection: ______________________.

5. Estimated date(s) and method of shipment:

Method of shipment will be daily shipments by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

Laboratory should report results within 14 days of receipt of samples.

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

Waters: EPA Method 415.1, the combustion method.

Soils: See Attachment 1

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

Waters: Samples will be preserved with 1 ml/l H_2SO_4 to pH< 2. Samples should be stored at 4oC until the time of analysis. Any remaining sample should be stored in the same manner until the validation and the acceptance of the sample result. The holding time is not to exceed 28 days from sample collection. The calibration curve must include at least 5 standards. (One of the standards must be zero concentration).

Soils: See Attachment 1.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.

Waters: Test procedures and specific instrument conditions should be clearly identified. Bench records tabulating order of calibration standards, lab blanks, samples, lab control standards, spikes, duplicates, etc., will be provided along with copies of work-sheets used to calculate results. Specify the organic compound used to prepare standards and spikes. A photocopy of the instrument readout, (i.e. stripcharts, printer tapes, etc.) must be included. All records of analysis must be legible and sufficient to recalculate all sample concentrations and QA audit results.

Soils: See Attachment 1.

10. Other (use additional sheets or attach supplementary information, as needed):

11. Name of sampling/shipping contact:

David Shekoski Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	Detection Limit	Precision Desired (+/- % or conc.)
Total Organic Carbon	2 mg/l	Difference in duplicate results should not exceed ± 10 % for concentrations > 20 mg.l or 2 mg/l for concentrations less than 20 mg/l
Organic Carbon % in soil	0.10% Report actual det.lim. if smaller.	± 20% on duplicate sample results

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (±% or conc)
Matrix Spike** SOILS: Positive Control (To be determined by lab)	At least 1 per group of 20 or fewer samples 1 in 10 samples	85-115% Recovery 85-115% Recovery
Lab Blank (1 liter of tapwater at pH < 2) SOILS: Prep Blank	At least 1 per group of 10 or fewer samples 1 in 10 samples, or at least twice.	≤ 2.0 mg/l ≤ 0.1%
Lab Duplicate SOILS: Duplicate Samples	At least 1 per group of 10 or fewer samples 1 in 5 samples	± (10% or 2.0 mg.1) ≤ 20% RPD in differences of dup. sample results, or <0.2% differences at samll concentrations
Calibration Verification Std. SOILS: Instrument Calibration checks and Calibration Blanks (if appropriate)	1 per group of 10 or fewer samples 1 in 10 or fewer samples	90-110% 90-110% Recovery for calibration check, and <0.1% total Carbon for assumed routine sample weight.

* See Section III

** Matrix spike concentrations will be greater than 30% of the sample concentration, but spiked sample shall not exceed the working range of the standard curve or titration.

III. Action required if Limits are Exceeded:

Take corrective action and reanalyze samples - Contact Denise Boone (312)-886-1488.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the Sample Management Office.

METHOD FOR DETERMINATION OF TOC IN SOIL
(As supplied by U.S. EPA Quality Assurance Office)

Determination of organic carbon (percent) in soil, using subaliquots of air-dried soil, passed through a 100 mesh to 140 mesh screen. All of the subaliquot must pass the screen. Applicable organic carbon concentration range of interest is 0.1 to 2 percent (or larger) in soil, (dry weight basis). Laboratory may report lower concentration values.

Test procedures used for determining soil shall be the 1) dry combustion (resistance furnace), 2) dry combustion (induction furnace), 3) dry combustion (automated methods), or 4) wet combustion (combustion train) methods of analysis specified by Table 29-1 of "Methods of Soil Analyses," Part 2--Chemical and Microbiological properties, 2nd ed., 1982, American Society of Agronomy, and Soil Science Society of America, Madison, Wisconsin.

Any automated dry combustion test procedure used must provide results consistent with the other three methodologies and must be consistent with the requirements of Chapter 29, Sections 29-1, 29-2, and 29-3, "Methods of Soil Analysis" (MSA) Part II, 2nd ed., as appropriate. Soils can be calcerous or noncalcerous soils, with varying amounts of organic carbon. Soils determined may be subsurface as well as surface soils. If peat or muck soils are ever encountered, the laboratory will provide with the case narrative, limitations of any sample results and any solutions to problems encountered. This is also true for any other problem sample types encountered.

The laboratory, providing organic carbon analysis data, will provide information with the case narrative concerning methodology, instrumentation, and specific QA practices used for the set of soils tested. Requested information is detailed in the following material.

ANALYTICAL METHODS--ORGANIC CARBON IN SOIL

SAMPLE PREPARATION

Representative subaliquot of air-dried soil (see percent solids SAS) screened through 100 or 140 mesh as appropriate. All of the subaliquot must pass this screen.

TEST FOR PRESENCE OF INORGANIC CARBON, MSA, PART II, SECTION 29-3.3.1

Place finely ground soil on a spot plate, and moisten with a few drops of water. Add 4 N HCl dropwise to the wetted sample and observe any effervescence. Allow sufficient time for dolomite to react (~5 min.). If inorganic carbon is absent proceed with Total Carbon in items No. 7c, or 7d below. If inorganic carbon is present, or the test is not definitive, proceed with items No. 7e, or 7f prior to Total Carbon measurements of Item No. 7c or 7d.

TOTAL CARBON (DRY COMBUSTION), MSA, PART II, SECTION 29-2.2.2

Use this as a guide for instrumental specifications. Instrument must test solid sample directly. Illustrative examples of this methodology are:

- Total Carbon (Dry Combustion--Medium Temperature Resistance Furnace), MSA, Part II, Section 29-2.2.3.
- Total Carbon (Dry Combustion--High Temperature Induction Furnace), MSA Part II, Section 29-2.2.4.
- Total Carbon (Dry Combustion--Other Instrumental Methods), MSA, Part II, Section 29-2.2.5. Any other instrumentation such as this must be justified and provide results as precise and accurate as the results from Sections 29-2.2.3 and 29-2.2.4.

TOTAL CARBON (WET DIGESTION), MSA, PART II, SECTION 29-2.3.2

Soil digested in 60:40 mixture of sulfuric acid and phosphoric acid (containing K_2CrO_7). CO_2 evolved is absorbed and weighed, or absorbed in standard base and titrated.

- Specific examples are found in MSA, Part II, Figure 29-2, and Section 29-2.3.3.

PRETREATMENT PRIOR TO DRY COMBUSTION, MSA, PART II, SECTION 29-3.3.3

Inorganic carbon is removed by treating sample in a combustion boat, with 5 percent sulfurous acid (H_2SO_3). After several hours, remove the excess H_2SO_3 by leaving overnight in an evacuated dessicator. Read citation for further details.

PRETREATMENT PRIOR TO WET DIGESTION, MSA, PART II, SECTION 29-3.3.2

Inorganic carbon is removed by sulfuric acid--ferrous sulfate reagent in apparatus used for total carbon (Wet Digestion) prior to Total Carbon measurement. See citation for further details.

Use only the methods specified above or obtain approval of CPMS, CRL prior to use of other method. Test procedure description, and description of specific measurement principles including equivalency to each of the 10 items in Figure 29-1 of MSA, Part II and sample pretreatment of Section 29-3, MSA, Part II.

Laboratory performing Total Carbon determinations must use and have a recognized procedure for removal of any inorganic carbon in sample.

A variety of apparatus, instrumentation, sample preparation systems and read-outs can be used. It is the responsibility of the laboratory to provide appropriate QC audits and QC data with each set of samples tested.

If instrumentation requires calibration, provide calibration curve, including zero concentration standard and preparation blanks. Provide positive control (a test sample prepared independently from calibration standards) that provides a measure of accuracy of system. This should be done for all systems including gravimetric read-outs.

ANALYTICAL RESULTS REQUIRED

As part of Case Narrative, attach description of test procedure and instrumentation used for measurement of Total C and removal of any Inorganic C. Test procedure description must include sufficient information that the nature of specific analytical result deliverables can be determined including QC audits. In Case Narrative, discuss any problem type samples (including peat or muck soils), limitations on any sample results, and solution taken to resolve any problems. A sample preparation log will be provided, as appropriate.

Bench records tabulating any order of any sample weights and tare weights of absorbed CO_2, instrument calibrations, blanks, QA audits, etc., must be provided along with copies of any worksheets used to calculate results. Include copies of any instrument read-outs. All must be legible. Report results as percent organic Carbon on a dry weight basis (103-105°).

GLT826/10

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818, Alexandria, Virginia 22313
PHONE: (703) 557-2490

SAS Number
[ ]

SPECIAL ANALYTICAL SERVICES
Regional Request

[x] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V, Carter Lee Lumber

B. Regional Representative: Denise Boone

C. Telephone Number: (312) 886-1488

D. Date of Request:

Please provide below a description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis of chloride in monitoring well water samples. Results are reported in mg/l chloride.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

   During Phase II, twenty nine aqueous samples will be collected containing low concentrations of chloride.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

   Superfund - Enforcement

4. Estimated date(s) of collection: ______________________.

5. Estimated date(s) and method of shipment:

   Method of shipment will be daily shipments by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

   Laboratory should report results within 14 days of receipt of samples.

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

   1. EPA Method 325.1 (Colorimetric, Automated Ferricyanide, AA-I) 1983 ed., or

   2. EPA Method 325.2 (Colorimetric, Automated Ferricyanide, AA-II) 1983 ed.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

   Samples should be stored at 4oC until the time of analysis. Any remaining sample should be stored in the same manner until the validation and the acceptance of the sample result.

   Sample holding time is 28 days from date of collection.

   Use a standard curve between 0 and 200 mg/l or less.

   The calibration curve should include 5 points or more (including a zero concentration standard).

   Samples with absorbance or peak heights greater than the highest standard must be diluted and reanalyzed.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.

   The test procedure used will be clearly identified. Bench records tabulating order of calibration standards, verification and control standards, samples, matrix spikes, titrant blanks, etc. with resulting peak height, concentration, or absorbance read-outs will be provided with copies of work sheets used to calculate results. A photocopy of instrument readouts, (i.e., strip charts, printer tapes, etc.) must be included for all analysis. All records of analysis and calculation must be legible and sufficient to recalculate all sample concentrations and QA audit results.

10. Other (use additional sheets or attach supplementary information, as needed):

11. Name of sampling/shipping contact:

David Shekoski Phone: (414) 272-2426

I. DATA REQUIREMENTS

Parameter	Detection Limit	Precision Desired (± % or conc.)
Chloride	2 mg/l	Difference in duplicate sample results are to be < 2 mg/l for concentrations <50 mg.1 and are to be <10% for concentrations exceeding 50 mg/l. The significant figures to report depends on sensitivity of colorimetric curve or the number of significant figures in titrant volume.

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[X] Regional Transmittal [ ]Telephone Request

A. EPA Region and Site Name: Region V, Carter Lee Lumber

B. Regional Representative: Denise Boone

C. Telephone Number: (312) 886-1488

D. Date of Request:

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1. General description of analytical service requested:

   Analysis of soils by Toxicity Characteristic Leaching Procedure (TCLP) -- Method 1311 of Federal Register June 29, 1990 for the eight regulated metals. TCLP sample extracts must be prepared within 28 days of the date of sample collection for Hg and 180 days for all other metals. Use a minimum sample aliquot of TCLP extract to determine compliance with TCLP regulatory levels.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or Soil and sediments; and whether low, medium, or high concentrations):

   Ten low concentration soil samples will be collected during the Phase II sampling event.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, ETC.):

Superfund enforcement.

4. Estimated date(s) of collection: ____________________.

5. Estimated date(s) and method of shipment:

   Method of shipment will be daily shipment by overnight carrier.

6. Approximate number of days results required after lab receipt of samples:

   ~~Samples must be extracted within 28 days of collection for Hg and within 180 days for all other metals; TCLP extracts must be analyzed within 28 days of extraction for Hg.~~ Data package due within 14 days of receipt of samples.

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

   Method 1311 of Federal Register - June 29, 1990 for extraction. CLP SOW 7/88 or ILM01 for analysis of extracts with modifications of Attachment I and Table 1.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

   See Attachment I and Table 1. Soils will be collected in 1-liter wide-mouth glass jars for metals. Samplers are instructed to add only soil. It interstitial water is present on arrival the laboratory, please remix water with soil prior to initiation of Method 1311. Standardize the acetic acid solutions (Section 5.7.2), and the 1N HCl (Section 5.3) by titrating with standard 0.1N NaOH before use. Must be within ± 5% of required value.

   Analysis of diluted TCLP extract ~~will be done~~ using SOW 7/88 or ILM01 and QC requirements of ~~Attachment II~~. CASE NARRATIVE MUST DISCUSS ANY SAMPLE PROBLEMS. 2 Section II

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of Custody documentation, etc.). If not completed, format of results will be left to program discretion.

   Attachment I and Method 1311 provide information for extraction. Use SOW 7/88 or ILM01 for providing Table 1 constituents. Separate Form I's are to be provided for

Table 1 constituents and for Table 1 constituents corrected will also include extraction information of Items "a" through "e" and Item "g" of Attachment I.

10. Other (use additional sheets or attach supplementary information, as needed):

    Data rejection and non payment will be recommended if the laboratory does not follow the methods referenced in this SAS. Lab must submit all original field documentation (COCs, tags, SAS PLs, etc.) and originals for data to the Region in the time frame referenced in Section 6 of this SAS (analogous to a RAS-CSF).

11. Name of sampling/shipping contact: David Shekoski

    Phone: (414) 272-2426

I. DATA REQUIREMENTS

Desired Parameter	**Detection Limit**	**Duplicate Precision** (**±% or Conc.**)
See Table 1 All ICP measurements of SOW 7/88 or ILM01 are to be included but remaining TALs need not be reported.	**See Table 1**	**Use** ± 25% difference(advisory for TALS)

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (± % or conc.)
Matrix Spike**	1 per group of 20 or fewer samples	85-115% Recovery
Lab Duplicate	1 per group of 10 or fewer samples	± (10% or 5 mg/l)
Lab Blank	1 per group of 10 or fewer samples	< 5 mg/l
Calibration Verification Std.	1 per group of 10 or fewer samples	90-110% Recovery

* See Section III

** Matrix spike concentrations will be greater than 30% of the sample concentration, but spiked sample shall not exceed the working range of the standard curve or titration.

III. Action Required if Limits are Exceeded:

Take corrective action and reanalyze samples - Contact Denise Boone (312)-886-1488.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the Sample Management Office.

II. QUALITY CONTROL REQUIREMENTS

Audits Required	Frequency of Audits	Limits* (±% or conc)
TCLP Extraction		
Preparation Blank for Extract Fluid #1 (see 7.1.4.4 of Method 1311)	Each set of solid samples	<5% of Regulatory levels of Table 1. Discuss in case narrative if larger than CRDLs of SOW.
Prep. Blk. for Extract Fluid #2, if necessary	Same	Same
Analysis of TLCP Extracts		
Preparation blank for TCLP Extract Determinations	Per appropriate SOW and set-up with each TCLP extract batch	CRDL of appropriate SOW for Table 1 constituents.
MS/MSD (See Table 1)	See Table 1 (required for inorganics) 1 for each set of 8 sample extracts.	Advisory - used to correct TCLP values recovery. See Note 1 of Table 1. RPD ≤ 20% (MS/MSD)
All other QC audits per SOW 7/88 or ILM01	Per SOW 7/88 or ILM01	Per SOW 7/88 or per ILM01

III. Action Required if Limits are Exceeded:

Take corrective action and reanalyze samples - Contact Denise Boone (312) 886-1488. Reanalysis of TCLP extracts may be necessary per requirements of Note 1 to Table 1.

Please return this request to the Sample Management Office (SMO) as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please call the SMO.

ATTACHMENT I

TCLP Extraction will be done by Federal Register of June 29, 1990 (attached) including bottle extraction for metals. Samples will Dry ~~be wet~~ soils ~~or sediments~~; therefore, the filtration procedure is not expe (Section 7.1.1.7 of attached procedure) ~~may~~ produce interstitial water. ~~Also~~ any water collecting on top of sediment or soil is not to be discarded, but mixed with sample prior to filtration or % solid determination (Section 7.1.1). TCLP Extracts <u>may</u> be a combination of liquid filtrate and solid TCLP extracts (see Sections 7.2.13.2 and 7.3.14) but will depend on the physical nature of the soils collected. Particle size reduction is not expected to be necessary for these soils. Sample preparation logs will be needed to record all required information of Method 1311 including (but not limited to):

a. Weight(s) of extracted samples (100g minimum aliquot size is required for 100% solids content) and volume of any filtrate (Sections 7.2.2 and 7.2.5).
b. Preliminary evaluations of percent solids.
c. pH data for selection of Extraction Fluid #1 or (Section 7.1.4.2).
d. Dates of each preparation step, with associated weights and measured volumes.
e. pH value of final TCLP extract (Section 7.2.14)
f. Holding times (Section 7.4) are to be met and are to be counted from the date of collection.
g. Record HCl normality (Section 5.3) and acetic acid normality (Section 5.7.2) (SAS par. 8) and measured pH of Extraction fluids(Section 5.7.1 and 5.7.2). Record dates of each of required measurements.
h. Standardization of Hydrochloric acid and acetic acid for Extraction Fluid #1 and Extraction Fluid #2.
    1. The 1 <u>N</u> HCl can be and will be standardized to 1.0 <u>N</u> HCl ± 5%.
    2. The pH of Extraction Fluid #1 will be 4.93 ± 0.05. No Standardization of acetic acid can be done - See Section 5.7.1 of Method in Federal Register 6-29-90.
    3. The pH of Extraction Fluid #2 will be 2.88 ± 0.05. Standardization of acetic acid is not mandatory but will be done for informational purposes (Optional) and will be compared to theoretical value of 5.7 ml. glacial acetic acid diluted to 1 liter. Titration of acetic acid normality can not be used for contract compliance purposes if correct pH value is obtained (2.88).
i. TCLP combined extract aliquots will be acidified for subsequent metals analysis (Section 7.2.14).

ITEMS "a" - "e" AND ITEM "g" MUST BE A PART OF FORM I REPORT.

Analysis of TCLP extracts will be done to determine compliance with Regulatory Levels using minimum sample aliquot volumes necessary for this purpose.

DETERMINATION (ml)	**SAMPLE ALIQUOT (mls)**	**FINAL VOLUME TAKEN FOR SOW ANALYSIS AFTER DILUTION OF SAMPLE ALIQUOT**
Metals (ICP)	10	100
Metals (GFAA)	10	100
Hg (CVAA)	5	100

Sample aliquot sizes are to be minimized, as above, to alleviate interferences from acetic acid/acetate buffer, to provide CRQLs that are 10-20% of Regulatory Levels, and to expand the working concentration range of the test procedures.

All constituents of Table 1 are required to be determined and reported for TCLP extracts. Remaining TALs of 7/88 or ILM01 are not required , except that all ICP emission spectroscopy measurements required by SOW 7/88 or ILM01 are to be made and included in raw data. A matrix spike (MS)/matrix spike duplicate (MSD) for all constituents in Table 1 will be prepared and determined using one of the TCLP soil extracts. The same extract need not be used for all analyses (ICP, GFAA, or CVA).

MS/MSD results are advisory and used for calculation purposes.

TABLE 1
TCLP CONSTITUENTS TO BE DETERMINED BY METHOD 1311,
TCLP REGULATORY LEVELS, SAMPLE ALIQUOT VOLUMES TO BE USED,
AND MS/MSD LEVELS AND CRQLS TO BE USED
FINAL DILUTED SAMPLE ALIQUOTS (100 ml)*

CONTAMINANT METALS (SOW 7/88 or ILM01)	REGULATORY LEVEL (ug/L)	SAMPLE ALIQUOT VOLUME ml	MS/MSD LEVEL IN FINAL ALIQUOT (ug/L)	CRQL IN FINAL ALIQUOT DILUTION (ug/L)
As (GFAA)	5,000	10	500	50
Ba (ICP)	100,000	10	10,000	1,000
Cd (ICP)	1,000	10	100	10
Cr (ICP)	5,000	10	500	50
Pb (ICP or GFAA)	5,000	10	500	50
Hg (CVAA)	200	5	10	0.5
Se (GFAA)	1,000	10	100	10
Ag (ICP)	5,000	10	500	50

*NOTE: TCLP Extraction of June 29, 1990 requires correction of constituent values for matrix spike recoveries. See Section 8.2 of Method 1311 of Federal Register June 29, 1990.

The average MS/MSD recovery developed for 1 of the soil extracts will be applied to all of the soil extracts. It is not expected that the samples will provide TCLP values that will exceed Regulatory Levels; however, there is a finite chance that this will occur.

If any on TCLP analyte in an extract exceeds Regulatory Levels, the extracts reanalysis is unnecessary using a Regulatory Matrix Spike concentration (see Section 8.2 of Method 1311).

If the concentration of the analyte after correction for the matrix spike recovery is > 10% of but less than the regulatory level, the TCLP extract must be reextracted using a smaller aliquot and spiked at the regulatory level such that the native analyte is at approximately the regulatory level.

If sample concentrations exceed the calibration range, sample must be diluted to fall within the calibration range.

Appendix F
Field Measurements and Monitoring

pH

Method

Electrometric

References

Methods for Chemical Analysis of Water and Wastes, U.S. EPA, Method 150.1, 1983.

Orion SA250 pH Meter Instruction Manual, 1987, Part No. 205376-001, Orion Research Incorporated, Boston, MA.

Orion Ross pH Electrode Instruction Manual, 1988, Part No. 502700-098, Orion Research Incorporated, Boston, MA.

Sensitivity

0.01 pH unit

Range

1 to 12 pH units

Sample Holding Time

Less than 6 hours

Reagents

- pH buffer solutions for pH 4, 7, and 10
- Deionized water in squirt bottle
- 3 M KCL internal filling solution
- Storage solutions

Apparatus

- pH meter
- Combination pH and reference electrode
- Beakers, plastic or glass
- Spare battery

Calibration (most pH Meters)

1. Select either pH 4 and 7, or pH 7 and 10 buffers, whichever will bracket the expected sample concentration. Note: Mix all buffer solutions before use.

2. Place electrode in pH 7 buffer solution. Wait for the pH to stabilize and adjust CAL until pH display reads 7.0.

3. Rinse electrodes and replace pH 7 buffer with either pH 4 or 10 buffer.

4. Wait for the pH value to stabilize. Adjust SLOPE until pH display reads 4.0 for the pH 4 buffer or 10.0 for the pH 10 buffer. Note: Slope values in the 92 to 102 percent range are acceptable.

5. Rinse electrodes and replace pH 4/10 buffer with pH 7 buffer.

6. If display reading is not 7.0, repeat steps 2 through 4.

Autocalibration (Orion SA 250)

1. Select either pH 4 and 7, or pH 7 and 10 buffers, whichever will bracket the expected sample concentration. Note: Shake all buffer solutions before use.

2. Select pH mode and resolution (pH 0.1).

3. Press ISO and verify that the isopotential point is 7.0.

4. Place electrode and Automatic Temperature Compensation (ATC) probe in pH 7 buffer.

5. Press CAL. The display will alternate between 0.1 and the pH value of the buffer. Wait for the pH value to stabilize. Press ENTER. After a short pause the display will advance to 0.2.

6. Rinse electrodes and ATC probe and replace pH 7 buffer with either pH 4 or 10 buffer.

7. Wait for pH value to stabilize. Press ENTER. The letters pH will be displayed. The pH meter is calibrated and ready for use. Note: Slope values in the 92 to 102 percent range are acceptable.

8. Rinse electrode and ATC probe and place into sample. Read the pH directly.

Calibration Frequency

Daily, at the beginning and end of the day, recheck calibration with pH 7 buffer once every 10 samples and after maintenance.

Operating Procedure

1. Check all connections for tight fit.

2. Inspect electrodes (and ATC probe).

3. Check battery charge.

4. Perform calibration, at the beginning and end of the day.

5. Rinse the electrode with distilled water and then with the sample to be measured.

6. Place electrode (and ATC probe) in previously mixed sample. Immerse electrode such that junction is covered by sample.

7. When the display is stable, record sample pH.

8. Recheck calibration with pH 7 buffer solution once every ten samples.

9. After use store electrode. For short-term storage (up to 1 week) soak electrode in manufacturer's recommended storage solution. For long-term storage, the reference chamber should be filled and the filling hole securely covered.

10. Cover the sensing element and/or reference junction with its protective cap and a few drops of the manufacturer's recommended storage solution.

When calibrating the meter, use pH 4 and 7 buffers for sample with pH <7, and pH 7 and 10 buffers for samples with pH >7. Measurement of pH is temperature dependent. Therefore, temperatures of buffers and samples should be within 2°C. This is not applicable for meters equipped with an automatic temperature compensation probe.

Weak organic salts, inorganic salts, and oil and grease interfere with pH measurements. If oil and grease are visible, note on data sheet. Clean electrode as described in manufacturer's instrument manual.

Avoid rubbing or wiping electrode bulb to reduce chance of error from polarization. To ensure a quick response and free-flowing liquid junction, the sensing element and reference junction must not be allowed to dry out.

Quality Control Requirements

Accuracy will be assessed by performing two measurements on two standard buffer solutions that bracket the pH range of the samples. Recheck calibration with ph 7 buffer solution once every ten samples. Each measurement will be within ±0.05 standard unit of pH selection. Precision will be assessed by duplicate measurements and must be less than or equal to 0.1 standard unit. Duplicates will be run at the rate of one every ten samples.

Preventive Maintenance (Frequency)

1. Field equipment is inspected in the warehouse prior to delivery to the field.

2. Check batteries (daily).

3. Perform a two-point calibration (daily and after maintenance).

4. Inspect the electrode for scratches, cracks, salt crystal buildup, or membrane/junction deposits. Rinse off any salt buildup with deionized water and remove membrane/junction deposits as described in the manufacturer's operators manual (as needed).

5. Clean electrode by soaking in 0.1M HCL or $HN0_3$ for 30 minutes, followed by soaking in storage solution for at least 1 hour (as needed or when slow response is observed).

6. Drain the reference chamber and flush it with the manufacturer's filling solution (weekly).

Specific Conductivity and Temperature

References

Methods for Chemical Analysis of Water and Wastes, U.S. EPA Method 120.1, 1983.

YSI Models 33 and 33M S-C-T Meters, Instructions, November 1987, Item 021470, Yellow Springs Instrument Co., Yellow Springs, Ohio.

Sensitivity

1 μmho/cm @ 25°C.

Range

0.1 to 100,000 μmho/cm.

Sample Holding Time

Determine onsite or within 24 hours.

Reagents

Distilled water in squirt bottle and standard potassium chloride solution.

Reagent Preparation

1. Stock Potassium Chloride (KC1) Solution (1.00 N): Dissolve 74.555 g KCl in distilled water and dilute to 1,000 mL in a volumetric flask.

2. Standard Potassium Chloride Solution (0.01 N): Dilute 10.0 mL of stock 1.00 N KCl solution to 1,000 mL with distilled water using a volumetric pipet and flask.

Apparatus

Conductivity meter and electrodes. Beakers or jars, plastic, or glass; spare batteries, size D alkaline.

Calibration Procedure

1. Switch mode to OFF and unplug the probe, correct meter zero (if necessary) by turning the adjustment screw so that the meter needle coincides with the zero on the conductivity scale.

2. Switch mode to REDLINE, correct meter redline (if necessary) by turning the adjustment screw so that the meter needle coincides with the redline on the meter face. If this cannot be accomplished, replace the batteries.

3. Plug the probe into the probe jack.

4. Place the probe in the 0.01 N standard potassium chloride solution. Record temperature (°C) and conductance (micromho/cm).

5. Correct conductivity reading for temperature. This value must correspond ($\pm$10 percent) to the expected value in Table 1. If the calibration fails, then appropriate corrective action must be performed and the instrument recalibrated.

Note: The temperature probe should be calibrated against a NBS, an ATSM standard or equivalent thermometer before each sampling event.

Operation Procedure

1. Perform calibration at end and beginning of the day.

2. Switch mode to TEMPERATURE. Allow time for the probe temperature to come to equilibrium with that of the water before reading. Read the temperature on the bottom scale of the meter in degrees Celsius.

3. Switch mode to X100. If the reading is below 50 on the 0 to 500 range (5.0 on the 0 to 50 mS/m range), switch to X10. If the reading is still below 50 (5.0 mS/m), switch to the X1 scale. Read the meter scale and multiply the reading by the mode factor. The answer is expressed in microohms/cm. Measurements are not temperature compensated.

4. When measuring on the X100 and X10 scales, depress the CELL TEST button. The meter reading should fall less than 2 percent; if greater, the probe is fouled and the measurement is in error. Clean the probe and remeasure.

Operating Suggestions

- Obstructions near the probe can disturb readings.

- When the calibration test indicates low readings the probable cause is dirty electrodes. Hard water deposits, oil, and organic matter are the most likely contaminants.

- Caution: Do not touch the electrodes inside the probe. The plating material is soft and can be scraped off.

- If cleaning does not restore the probe performance, replatinizing may be required. Always rinse the probe thoroughly in tap water, then in distilled or deionized water after cleaning and before storage. It is best (not required) to store conductivity cells in deionized water.

- Most problems in obtaining good records with monitoring equipment are related to electrode fouling and to inadequate sample circulation.

Calibration Frequency

At the beginning and end of the day or after maintenance, recharge battery after each use. Factory checkout and calibration shall be yearly or when malfunctioning.

Calculations

Calculate conductivity using the formula:

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

where:

G_{25} = conductivity at 25°C, μmho/cm
T = temperature of sample, °C
G_T = conductivity of sample at temperature T, μmho/cm

Table 1
Conductivity Meter Calibration Table

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

Quality Control Requirements

The accuracy of conductivity measurements will be assessed by measurement with a 0.01 N standard KCl solution before sample analysis and at the end of the day. Accuracy of measurements will be ±5 percent of the standard. Precision will be assessed by analysis of duplicate measurements which will have a relative percent difference of ≤15 percent. Duplicates will be run at the rate of one every ten samples. The thermometer on the conductivity meter will be checked before each sampling event for accuracy against an ASTM, NBS standard or equivalent thermometer. Accuracy of the measurement shall be ±1°C.

Preventive Maintenance

- Field equipment is inspected in the warehouse prior to delivery to the field.
- The only maintenance required in battery replacement (every 200 hours or as needed).
- Recalibration (if necessary) should be done at the factory.

Field Filtering

Reference

EPA 1979, Metals 5.

Sample Handling

Filter as soon as possible after sample collection.

Reagents and Apparatus

1. 10 percent HNO_3 solution in a squirt bottle and in a liter plastic bottle
2. DI water
3. Plastic forceps
4. Filtration apparatus
5. 2.0 μm membrane filters (142 mm)
6. Glass fiber prefilters (142 mm)
7. Peristaltic pump

Reagent Preparation

1. 10 percent HNO_3 solution: Add about 900 mLs of DI water to a 1 liter Erlenmeyer flask. Using a graduated cylinder, add 100 mLs concentrated HNO_3 to the DI water while stirring.

Procedure—Filter Stand

1. Using plastic forceps, place a 0.45 μm filter on top of filter apparatus.

2. Place a prefilter on top of membrane filter.

3. Place top onto filter apparatus. Screw wing nut bolts down until even and snug. Finish tightening with plastic wrench.

4. Attach end of PVC hosing from pump to filter apparatus.

5. Run 50 to 100 mLs of HNO_3 through apparatus, rinse with 50 to 100 mLs DI water. Do not collect this filtrate.

6. Place sample bottle under outlet.

7. Turn pump on, run sample through filter, and collect filtered sample from bottom of apparatus.

8. Shut off pump.

9. Rinse twice with DI water, remove filter and dispose, proceed as above for next sample.

10. Run a DI water blank every 10 to 20 samples.

Notes

Samples with high sediment can be filtered through several membranes with increasing pore size and several prefilters. The 0.45 μm membrane filter should always be on the grid, and the coarsest filters on the top.

Procedure—Disposable Inline Filter

1. Attach tubing from pump outlet to filter inlet (note flow direction on the filter housing).

2. Place sample bottle under outlet.

3. Turn pump on, run sample through filter and collect filtered sample from outlet.

4. Shut off pump.

5. Remove filter and discard.

6. Run 50 to 100 mL 10 percent HNO_3 through pump tubing, discarding rinsate.

7. Run 50 to 100 mL DI water through pump tubing, discarding rinsate. Allow enough time to remove all water from the tubing before turning off the pump.

8. Run a DI water blank every 10 to 20 samples.

HNu Monitoring

References

HNu Model PI101 Portable Photoionization Analyzer Instruction Manual, December 1985, HNu Systems, Inc., Newton, MA.

HNu Model ISP1 101 Intrinsically Safe Portable Photoionization Analyzer Instruction Manual, January 1986, HNu Systems, Inc., Newton, MA.

Sensitivity

0 to 20 ppm at full-scale detection at span = 9.8 ppm; 10.2 ev Probe.

Range

0.1 to 2,000 ppm.

Calibration Gas

Isobutylene at 100 ppm.

Calibration

By analyzing a gas of known concentration, the HNu is easily calibrated. Isobutylene is typically used as the calibration gas with the instrument calibrated to benzene equivalents. When calibrating the HNu, always remember to deliver the calibration gas at ambient temperature and pressure, handle gas cylinders with care, and calibrate every day. Also, the calibration gas must be stable during the period of use, all gas cylinders must have proper regulators.

Calibration Procedure

1. Identify the probe by lamp label.

2. Attach the probe to the readout unit. Twist connector clockwise until locked.

3. Affirm the relative photoionization sensitivity (PS) calibration gas. [The required reading for isobutylene to read in benzene equivalents is equal to isobutylene ppm × PS (Isob.)/PS (benzene).]

4. Turn the function switch to battery check position. The indicator should read within the green arc. If indicator is below the green arc or if red L&D comes on, battery must be charged.

5. Zero the instrument by turning function switch to standby and rotate potentiometer until the meter reads zero.

6. Connect sampling hose to regulator outlet and the other end to sampling probe of HNu.

7. Crack regulator valve.

8. Adjust span potentiometer to obtain proper reading.

9. If calibration can not be achieved, clean the UV light source window using lens paper and HNu cleaning compound.

10. If still unable to calibrate, perform preventive maintenance. Return to factory if those procedures do not work.

Calibration Frequency

Daily or after maintenance. Recharge battery after each use. Factory check out and calibration shall be yearly or when malfunctioning.

Preventive Maintenance (Frequency)

The HNu is inspected and calibrated in the warehouse prior to delivery to the field to ensure the instrument is operating property.

Battery (Daily)

Check the battery charge during each period of operation. When the meter needle falls below the green zone or the low-battery indicator light illuminates recharge battery. Do not use the instrument when light is on. When not operating, leave the analyzer assembled and connected to the battery charger. In case of emergency, the analyzer may be used with a low-battery charge.

Gas Cylinders and Valves (After Installation)

All gas supply lines must be leak tested. Leakage can be determined by testing line connections and valve stems with a commercially available leak test solution. Leaks are generally stopped by tightening the fitted surfaces but may require new hardware.

Air Sampling Stream (Initially, then as Needed)

Leaks that develop in this system may result in dilution or loss of sample, causing erroneous vapor concentrations and slow response. A fan draws gas in through the probe and ion chamber. Small fluctuations in the flow rate will not affect the measurement. A major obstruction to the flow rate will prevent proper operation and lengthen response time. Refer to the manufacturer's instrument manual for specific procedures.

Quality Control Requirements

Precision of ±30 percent. Daily calibration.

OVA Monitoring

Reference

Model OVA 128 Century Organic Vapor Analyzer, Instruction. December 1985, Foxboro, New Haven, CT.

Sensitivity

0.1 ppm (methane).

Range

0 to 1,000 ppm.

Calibration Gas

Methane gas at 100 ppm.

Calibration

By analyzing a gas of known concentration, the OVA is easily calibrated. Methane in air at a concentration of 100 ppm is typically used as the calibration mixture, although the OVA can be calibrated to many other compounds. Primary calibration of an OVA is performed at the factory. When calibrating the OVA, always remember to deliver the calibration gas at ambient temperature and pressure, handle the gas cylinders with care, and calibrate every day. Also, the calibration gas must be stable during the period of use, and all gas cylinders must have proper regulators.

Calibration Procedure

1. Connect probe readout assembly to sidepack unit.

2. Check battery condition by moving INSTR Switch to BATT.

3. Turn INSTR to ON and allow 5 minutes to warm up.

4. Use calibration adjust knob to set needle to level desired for activating alarm. If alarm level is not zero, the calibration switch must be set to appropriate level.

5. Turn volume knob fully clockwise.

6. Turn the alarm level adjust knob until the audible alarm is activated.

7. Move calibration switch to 1X and adjust meter reading to zero using zero calibration adjustment.

8. Turn pump switch on.

9. Open hydrogen tank valve and hydrogen supply valve. Wait 1 minute.

10. Depress ignitor button until burner lights (not more than 6 seconds).

11. Set calibration switch to 10X.

12. Connect sampling hose to regulator outlet and the other end to sampling probe of OVA.

13. Crack the regulator valve.

14. Check to see if proper reading is achieved.

15. If reading is ±10 percent from expected value, return to factory for recalibration.

Calibration Frequency

Daily or after maintenance, recharge battery after each use. Factory check out and calibration shall be yearly or when malfunctioning.

Preventive Maintenance

The OVA is inspected and calibrated in the warehouse prior to delivery to the field to ensure the instrument is operating property.

Battery (Daily)

Check battery condition by moving the INSTR switch to the BATT position. Recharge the battery if a low charge is indicated. Do not use the instrument with a low battery charge. When not operating, leave the analyzer connected to a battery charger. Never recharge battery in a hazardous environment.

Particle Filter (As Needed)

Particle filters (primary and secondary) remove foreign matter (>10 microns) from the sample stream. These filters must be in the sample line whenever the instrument is operating. A decrease in flow rate may indicate a plugged filter.

Sampling Fixtures (As Needed)

Sampling fixtures should be periodically cleaned with an air hose and/or detergent water to eliminate foreign particulate matter.

Hydrogen Fuel, Calibration Gas, and Valves (Initially, after Changes)

Use prepurified or zero-grade hydrogen (certified total hydrocarbons as methane <0.5 ppm recommended). All fuel and calibration gas supply lines should be leak tested. Leakage can be determined by testing line connections and valve stems with a commercially available leak test solution. Leaks are usually stopped by tightening the fitted surfaces but may require new washers or hardware.

Air Sampling Pump System (Initially, As Needed)

Leaks that develop in this system may result in dilution or loss of sample, causing erroneous vapor concentrations and slow response. The OVA is equipped with a flow gauge that provides a method to check for air leaks. Refer to the manufacturer's instrument manual for specific procedures.

Contaminated Control (As Needed)

Background readings may be relatively high under normal ambient conditions. The sources of high background are normal methane background, contaminated hydrogen supply gas, and contamination in the air sample line. Background readings less than

1 ppm are generally accepted since sample measurement is additive to that background. However, the low background values are more desirable. High background is commonly corrected by running the OVA for an extended time in a clean area. Refer to the manufacturer's instrument manual for specific analysis and correction procedures.

Quality Control Requirements

Precision of ±30 percent. Daily calibration.

GLT338/029.51

APPENDIX G
SAMPLE PACKING AND SHIPPING PROCEDURES

Appendix G

Sample Documentation and Packing and Shipping Instructions

Sample Documentation Instructions

Sample Identification Matrix (Figure 1)

1. Enter site name.

2. Enter project number.

3. Enter the case number and/or SAS number.

4. Enter the CRL log number.

5. Specify the sample matrix using the two- or three-digit codes listed below:

   - SS—Surface Soil
   - GW—Groundwater

6. Enter the sample number.

7. Enter the organic traffic label number or the SAS sample number.

8. Enter the inorganic traffic label number.

9. Enter the chain-of-custody number.

10. Indicate the laboratory to be doing the analysis (abbreviations may be used as they are shown on the current laboratory list).

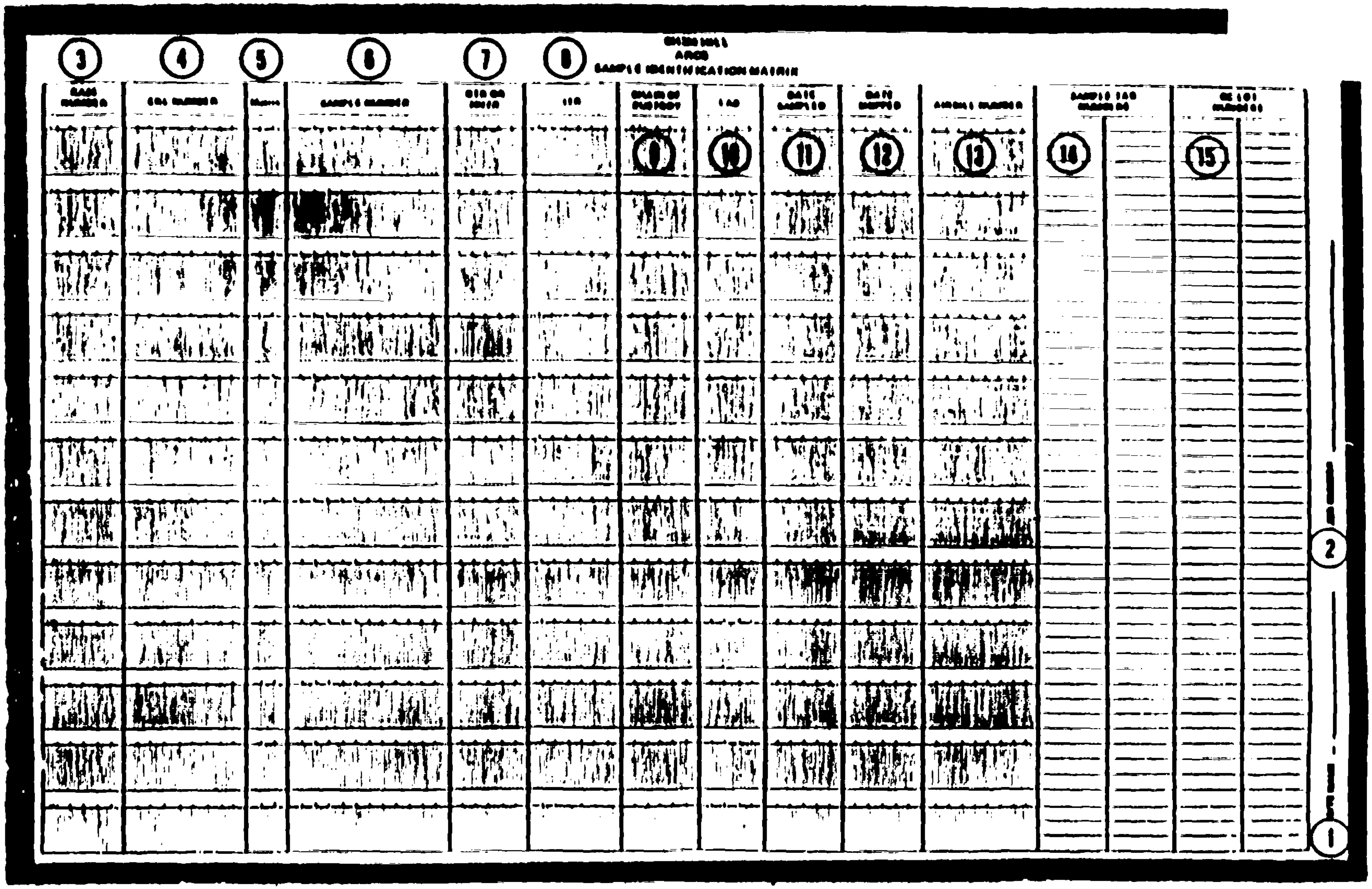
11. Enter the date the sample was taken: month, day, year (no hyphen or slash, e.g., 081292).

12. Enter the shipping date.

13. Enter the airbill number of the shipment.

14. List sample tag numbers corresponding to sample containers shipped under the traffic label number listed in either box 7 or 8.

15. List the QC lot numbers of the containers matching the tag numbers listed in Item 14.



NOTE: For purposes of illustration this form has been reproduced at 60% of original size.

FIGURE 1

Note: The date recorded on this form must be suitable for computer entry. Each entry must be flush left and must not exceed the number of digits allowed in each section. If portions of samples are to be sent to more than one laboratory for analysis, allow an entire line for each laboratory to accommodate for the additional traffic report, chain-of-custody, and airbill numbers.

Sample Tag (Figure 2)

1. Enter date of sampling.
2. Enter time of sampling (military time only).
3. Specify "grab" or "composite" sample with an "X."
4. Enter CH2M HILL sample identification code.
5. Obtain signature of sample team leader.
6. Indicate preservative used (if any) with an "X."
7. Specify all parameters for analysis by placing an "X" to the right of each one.
8. Indicate the sample number (for CLP Lab) or CRL log number (for CRL).
9. Indicate case number and/or SAS number (e.g., Case No. 1234 and/or SAS No. 5678E).
10. Leave BLANK (for laboratory use only).
11. Enter any desired analyses not listed on menu (e.g., PCBs, ammonia, sulfide, etc.) and mark box with an "X."

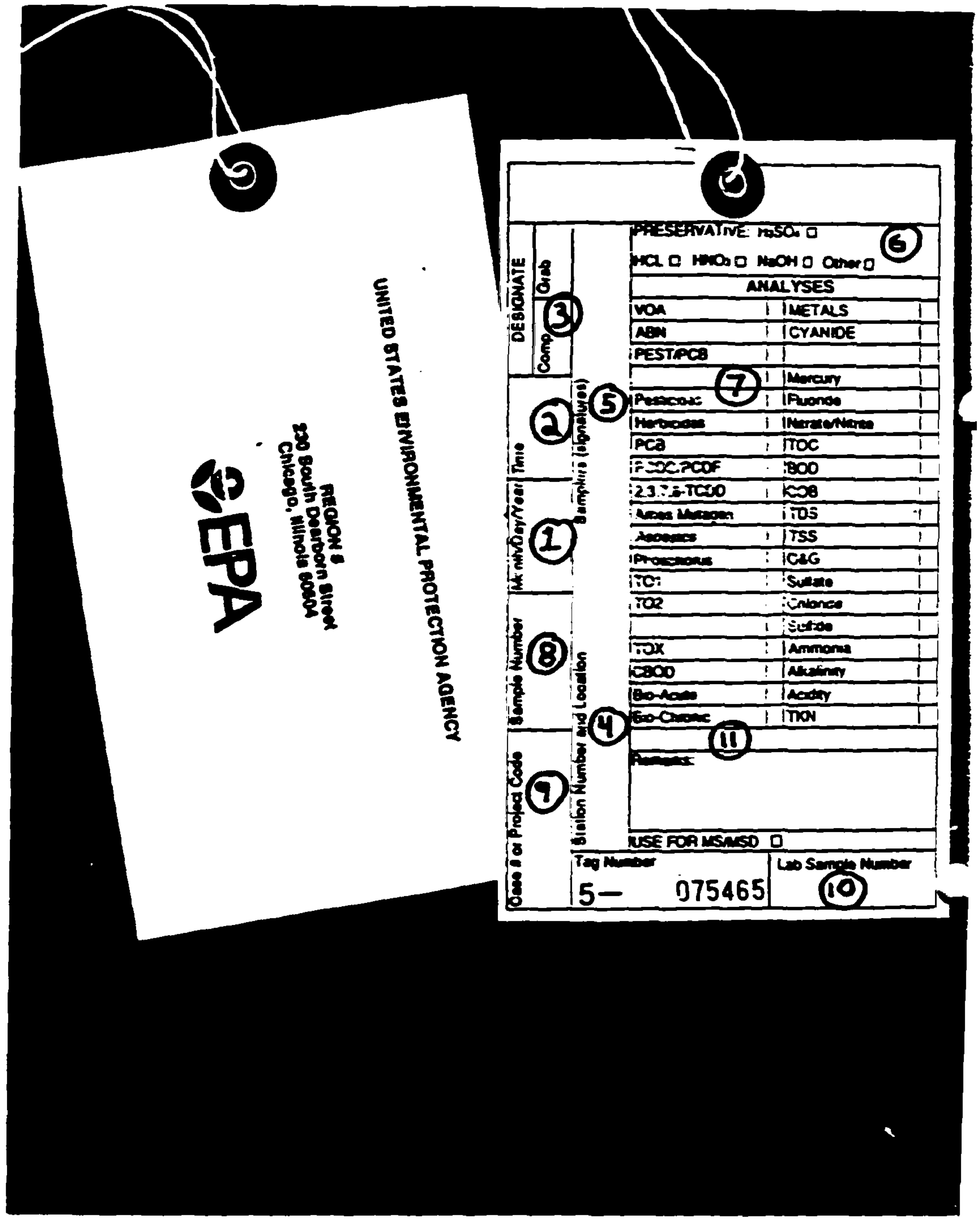
Inorganic Traffic Report (Figure 3)

1. Enter assigned laboratory case number.
2. Enter assigned laboratory SAS number, if applicable.
3. Check the code that describes the activity being performed.

4a. Enter site name.

4b. Enter city and state of site.

4c. Enter spill ID No. (obtained from the PM or Data Coordinator).



NOTE: For purposes of illustration forms are reproduced at 70% of original size.

FIGURE 2

United States Environmental Protection Agency
Contract Laboratory Program Sample Management Office
PO Box 818 Alexandria, VA 22313
703-557-2490 FTS 557-2490

EPA

Inorganic Traffic Report
(For CLP Use Only)

Case Number	SAS No. (If applicable)
1	2

1. Type of Activity (Check one) 3

ENF, NPLD, RA, SI, STSI, ER, O&M, RD, ST, Other *(Specify)*, ESI, PA, RIFS, STPA

Non-Superfund Program

Site Name 4a

City, State 4b

Site Spill ID 4c

2. Region Number 5

Sampling Co. 6

Sampler (Name) 7

3. Ship To: 8

4. Date Shipped 9

Airbill Number 10

Carrier 11

Double volume required for matrix spike/duplicate aqueous sample.

Ship medium and high concentration samples in paint cans.

See reverse for additional instructions.

5. Sample Description *(Enter in Column A)*

1. Surface Water
2. Ground Water
3. Leachate
4. Rinsate
5. Soil/Sediment
6. Oil (SAS)
7. Waste (SAS)
8. Other (SAS) *(Specify)*

CLP Sample Number *(From labels)*	(A) Sample Description *(From box 5)*	(B) Concentration L=low M=med H=high	(C) RAS Analysis 15		(D) Special Handling	(E) Station Location	(F) Date/Time of Sample Collection	(G) Corresponding Organic Sample Number	
			Total Metals	Cyanide	16	17	18		19
12	13	14							
					20				

EPA Form 9110-1 (8-88) Replaces EPA Form 2075-6, which may be used. Green - SMO Copy Pink - Region Copy White - Lab Copy for Return to SMO Yellow - Lab Copy

For purposes of illustration this form is reproduced at 80% of original size

FIGURE 3

5. Enter EPA region number (e.g., V).

6. Enter sample team leader's company/office.

7. Enter sample team leader's name.

8. Enter laboratory name and address, and laboratory contact.

9. Indicate date of shipment.

10. Indicate airbill number corresponding to sample shipment.

11. Indicate the shipment carrier (i.e., Federal Express).

12. Enter the ITR Label Number.

13. Indicate sample description with a number (e.g., 1, 2, 3, 4, 5, 6, 7, 8) from box 5 on ITR.

14. Specify sample concentration with an L, M, or H indicating contamination level.

15. Check required analyses.

16. Specify special handling to notify laboratory if sample is a blank, MS/MSD or field duplicate.

17. Enter CH2M HILL sample number.

18. Enter the date/time of sample collection.

19. Leave BLANK (for laboratory use only).

20. Write at bottom of form if shipment is **complete** or is **not complete**.

Organic Traffic Report (Figure 4)

1. Enter assigned laboratory case number.

2. Enter assigned laboratory SAS number, if applicable.

3. Check the code that describes the activity being performed.

4a. Enter site name.

4b. Enter site city and state.

United States Environmental Protection Agency
Contract Laboratory Program Sample Management Office
PO Box 818 Alexandria, VA 22313
703-557-2490 FTS 557-2490

EPA

Organic Traffic Report

(For CLP Use Only)

Case Number 1

SAS No. *(if applicable)* 2

1. Type of Activity (Check one) 3

☐ ENF ☐ NPLD ☐ RA ☐ SI ☐ STSI
☐ ER ☐ O&M ☐ RD ☐ ST ☐ Other *(Specify)*
☐ ESI ☐ PA ☐ RIFS ☐ STPA

Non-Superfund Program

Site Name 4a

City, State 4b

Site Spill ID 4c

2. Region Number 5

Sampling Co. 6

Sampler (Name) 7

3. Ship To: 8

4. Date Shipped 9

Airbill Number 10

Carrier 11

Triple volume required for matrix spike/duplicate aqueous sample.

Ship medium and high concentration samples in paint cans.

See reverse for additional instructions.

5. Sample Description *(Enter in Column A)*

1. Surface Water
2. Ground Water
3. Leachate
4. Rinsate
5. Soil/Sediment
6. Oil (SAS)
7. Waste (SAS)
8. Other (SAS) *(Specify)*

CLP Sample Number *(From labels)*	(A) Sample Description *(From box 5)*	(B) Concentration L=low M=med H=high	(C) RAS Analysis 15 VOA	BNA	Pest/PCB	(D) Special Handling	(E) Station Location	(F) Date/Time of Sample Collection	(G) Corresponding CLP Inorganic Sample Number	
12	13	14				16	17	18		19
						20				

EPA Form 9110-2 (8-89) Replaces EPA Form 2075-7, which may be used. Blue - SMO Copy Pink - Region Copy White - Lab Copy for Return to SMO Yellow - Lab Copy

For purposes of illustration this form is reproduced at 80% of original size

FIGURE 4

4c. Enter spill ID No. (obtained from the PM or Data Coordinator).

5. Enter EPA region number (e.g., V).

6. Enter sample team leader's company/office.

7. Enter sample team leader's name.

8. Enter laboratory name and address and laboratory contact.

9. Indicate date of shipment.

10. Indicate airbill number corresponding to sample shipment.

11. Indicate the shipment carrier (i.e., Federal Express).

12. Enter the OTR Label Number.

13. Specify sample description with a number (e.g., 1, 2, 3, 4, 5, 6, 7, 8) from box 5 on OTR.

14. Specify the sample concentration with an L, M, or H, indicating contamination level.

15. Check required analyses.

16. Specify special handling to notify laboratory if sample is a blank, MS/MSD or field duplicate (replicate).

17. Enter CH2M HILL sample number.

18. Enter the date/time of sample collection.

19. Leave BLANK (for laboratory use only).

20. Write at bottom of form if shipment is **complete** or is **not complete**.

SAS Packing List (Figure 5)

1. Enter assigned SAS case number.

2. Enter EPA region number (e.g., V).

3. Enter sample team leader's name.

4. Enter sample team leader's company/office and phone number.

U.S. ENVIRONMENTAL PROTECTION AGENCY
CLP Sample Management Office
P.O. Box 818 - Alexandria, Virginia 22313
Phone: 703/557-2490 - FTS/557-2490

SAS Number
1

SPECIAL ANALYTICAL SERVICE

PACKING LIST

Sampling Office: 2	Sampling Date(s): 5	Ship To: 8	For Lab Use Only
Sampling Contact: 3 (name)	Date Shipped: 6		Date Samples Rec'd:
4 (phone)	Site Name/Code: 7	Attn: 9	Received By:

	Sample Numbers	Sample Description i.e., Analysis, Matrix, Concentration	Sample Condition on Receipt at Lab
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.	10	11	12
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
			For Lab Use Only

White - SMO Copy, Yellow - Region Copy, Pink - Lab Copy for return to SMO, Gold - Lab Copy

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FIGURE 5

5. Enter date sample was taken.

6. Enter date of shipment.

7. Enter site name.

8. Enter laboratory name and address.

9. Enter name of laboratory contact.

10. List SAS sample numbers, which should include the SAS number.

11. Specify sample matrix, concentration, tag number, and analysis to be performed (e.g., low concentration soil sample for PCB analysis, tag No. 5-48246).

12. Leave BLANK (for laboratory use only).

Chain-of-Custody Record (Figure 6)

1. Enter first six digits of the CRL sample identification code.

2. Leave blank.

3. Obtain full signature of sample team leader and signed initials of active team members (including paperwork person).

4. Enter last three digits of the CRL sample identification code.

5. List sampling dates for all samples.

6. List sampling times for all samples (military time only).

7. Indicate "grab" or "composite" sample with an "X."

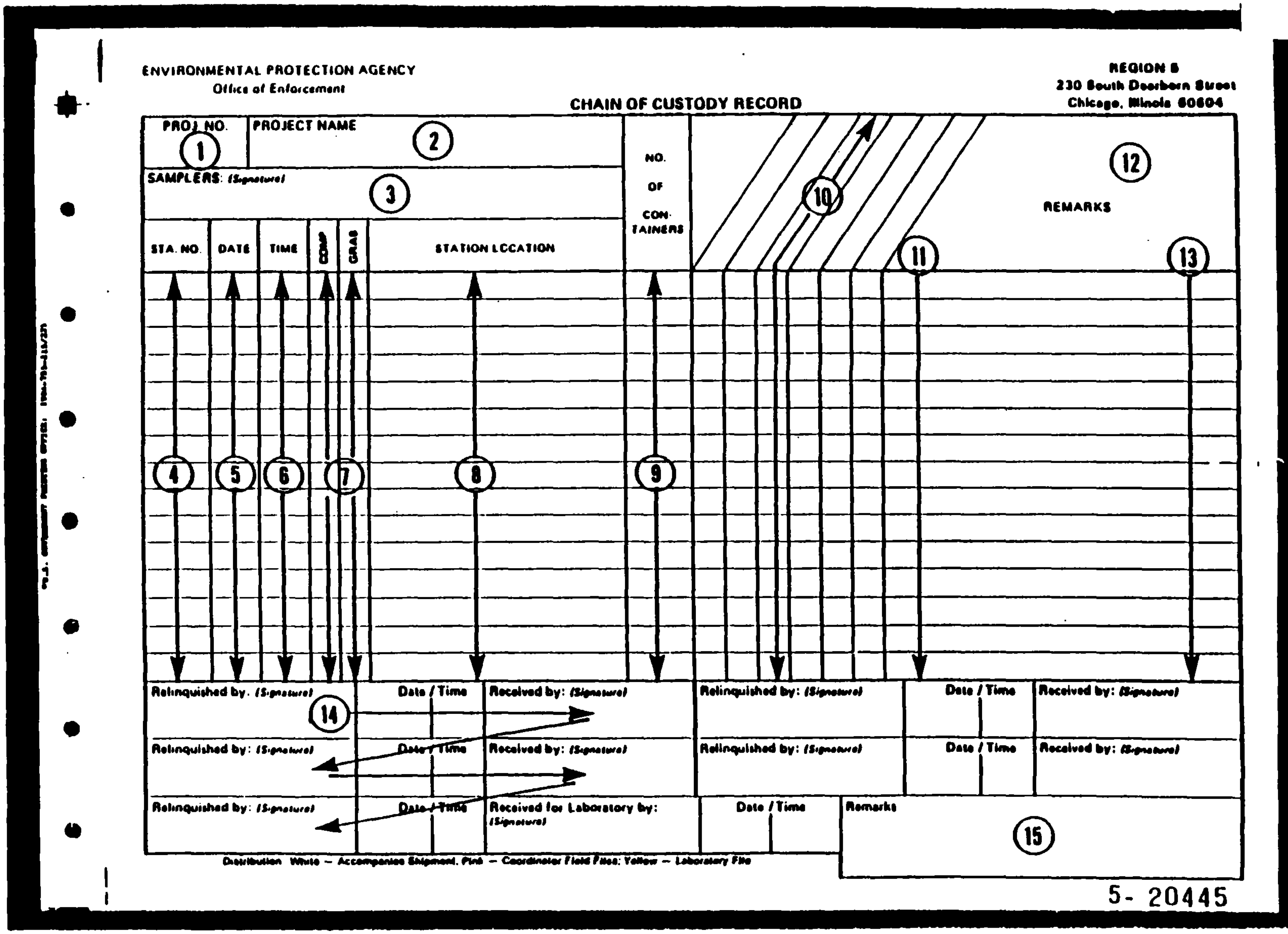
8. List CH2M HILL sample numbers.

9. Enter number of containers per sample.

10. List analyses individually.

11. Enter column heading for traffic label number and list serial numbers for corresponding sample identification codes.

12. Write in the words "CASE No. :" or "SAS No. :" and enter the correct number.



ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 5
230 South Dearborn Street
Chicago, Illinois 60604

CHAIN OF CUSTODY RECORD

PROJ. NO. (1)	PROJECT NAME (2)	NO. OF CON-TAINERS	(10)	REMARKS (12)
SAMPLERS: (Signature) (3)				

STA. NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CON-TAINERS	(10) (11)	REMARKS (13)
(4)	(5)	(6)	(7)		(8)	(9)		

Relinquished by: (Signature) (14)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks (15)	

Distribution: White – Accompanies Shipment; Pink – Coordinator Field Files; Yellow – Laboratory File

5- 20445

NOTE: For purposes of illustration forms are reproduced at 70% of original size.

FIGURE 6

13. Enter column heading for "tag number" and list tag numbers for each sample container.

14. Obtain signature of sample team leader and carry out chain-of-custody procedures.

15. State carrier service and airbill number, lab service, and custody seal numbers.

Combined Chain of Custody and Traffic Report Forms (Figure 7)

A. Project Code: Leave blank.

B. Account Code: Leave blank.

C. Regional Information: If sampling is in support of oversight activities, indicate here. If not—leave blank.

D. Non-Superfund Program: If sampling is not done under the Superfund program, enter the name of the program (e.g., RCRA).

E. Site Name, City, State: Complete as instructed.

F. Site Spill ID: Enter ID code provided by the office.

G. Region No.: Enter "Region 5."

H. Sampling Company: Enter "CH2M HILL."

I. Sampler Information: Complete as instructed.

J. Type of Activity:

SF—Superfund lead
PRP—PRP lead
ST—State lead
FED—Federal lead
PA—Preliminary assessment
SSI—Screening site investigation
LSI—Listing site investigation
RIFS—Remedial Investigation/Feasibility Study
RD—Remedial design
O&M—Operation & Maintenance
NPLD—National Priorities List delete
CLEM—Classic emergency
REMA—Removal assessment
REM—Removal
OIL—Oil response

COMBINED CHAIN OF CUSTODY AND TRAFFIC REPORT FORMS

EPA — United States Environmental Protection Agency, Contract Laboratory Program Sample Management Office, PO Box 818 Alexandria, VA 22313, 703-557-2490 FTS 557-2490

Organic Traffic Report & Chain of Custody Record
(For Organic CLP Analysis)

SAS No. (if applicable) (M) | Case No. (M)

1. Project Code (A) | Account Code (B) | 2. Region No. (G) | Sampling Co. (H) | 4. Date Shipped (K) | Carrier (K)

Regional Information (C) | Sampler (Name) (I) | Airbill Number (K)

Non-Superfund Program (D) | Sampler Signature (I) | 5. Ship To (L)

Site Name (E) | 3. Type of Activity (J): SF, PRP, ST, FED, PA, SS, LSI, NPLD, CLEM, REM, RI, O&M, UST

City, State (F) | Site Spill ID (F)

6. Preservative (Enter in Column D)
1. HCl
2. HNO_3
3. $NaHSO_4$
4. H_2SO_4
5. Other (SAS) (Specify)
6. Ice only
N. Not preserved

7. Sample Description (Enter in Column A)
1. Surface Water
2. Ground Water
3. Leachate
4. Rinsate
5. Soil/Sediment
6. Oil (SAS)
7. Waste (SAS)
8. Other (SAS) (Specify)

CLP Sample Numbers (from labels)	A Enter # from Box 7	B Conc. Low Med High	C Sample Type: Comp./Grab	D Preservative from Box 6	E RAS Analysis VOA	BNA	Pest/PCB	High ARO/TOX	F Regional Specific Tracking Number or Tag Numbers	G Station Location Number	H Mo/Day/Year/Time Sample Collection	I Sampler Initials	J Corresp. CLP Inorg. Samp. No.	K Designated Field QC
(N)	(O)								(P)	(Q)	(R)	(S)	(T)	(U)

Shipment for Case complete? (Y/N) (V) | Page 1 of ___ (W) | Sample used for a spike and/or duplicate (X) | Additional Sampler Signatures (Y) | Chain of Custody Seal Number (Z)

CHAIN OF CUSTODY RECORD

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
(AA)					
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Received by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks Is custody seal intact? Y/N/none	

Split Samples ☐ Accepted (Signature) ☐ Declined (BB)

EPA Form 9110-2 (Rev. 5-91) Replaces EPA Form (2075-7), previous edition which may be used
DISTRIBUTION:
Blue - Region Copy Pink - SMO Copy White - Lab Copy Yellow - Lab Copy for Return to SMO

FIGURE 7

UST—Underground storage tank response

K. Shipping Information: Complete as instructed.

L. Ship To: Enter lab name, address and sample recipient/custodian.

M. SAS/Case No.: Complete as instructed.

N. Sample Numbers: For routine organic/inorganic samples, enter the CLP numbers from the "stick-on" labels. For SAS samples, enter the SAS sample numbers (SAS number plus a unique sequential numeric suffix).

O. Sample Information: Complete as instructed.

P. Regional Specific Tracking Number or Tag Number: Enter sample tag number(s).

Q. Station Location Number: Enter sample identifier (as defined in the QAPP).

R. Time/Date: Complete as instructed. Use military time.

S. Sampler Initials: OPTIONAL.

T. Corresponding CLP Organic/Inorganic Sample Number: Enter CLP sample number (from "stick-on" labels) of corresponding sample from same location. Not applicable to SAS forms.

U. Designated Field QC: Indicate QC status when applicable (field blanks, trip blanks, duplicates, MS/MDS, etc.).

V. Sampling Status: Is the sampling for this Case/SAS complete? Circle one.

W. Page 1 of : Record number of documents enclosed in cooler.

X. MS/MSD and/or Duplicate: List samples.

Y. Additional Samplers Signatures: OPTIONAL.

Z. Chain of Custody Seal No.: Enter the numbers that appear on the custody seals to be used to seal the cooler (there should be two).

AA. "Relinquished by" and "Time/Date:" Complete as instructed. Use military time.

BB. Split Samples: PRP representative (PRP contractor) shall sign off here if work is oversight.

Distribution: The **Lab Copy** and **Lab Copy for Return to SMO** are included with the shipment. The **Region Copy** and **SMO Copy** are returned to the office.

Notice of Transmittal (Figure 8)

1. Enter name of team leader.
2. Enter team leader's firm name.
3. Enter CH2M HILL project number.
4. Enter case number.
5. Enter date.
6. Enter number of samples shipped.
7. Enter matrix of samples.
8. Enter the site name in words.
9. Enter the location of the site (city, state).

Central Regional Laboratory Sample Data Report (Figure 9)

The Central Regional Laboratory Sample Data Report is filled out by the CH2M HILL Sample Documentation Coordinator. A separate report is filled out for each laboratory that receives samples.

1. Enter the case number or SAS number.
2. Enter the site name.
3. Enter the laboratory name.
4. Enter the date shipped.
5. Enter the Superfund D.U. number.
6. Enter the EPA RPM.
7. Enter the CERCLIS number.
8. Enter the page numbers.
9. Enter the CRL numbers.

NOTICE OF TRANSMITTAL

DATE:

TO: CH2M HILL - REM/FIT Office, Reg. V-X (WI)
310 West Wisconsin Avenue, Suite 700
P.O. Box 2090
Milwaukee, Wisconsin 53201

Attn.: Shirley Stringer

FROM: ______1______ / ______2______
(name) (firm)

CH2M HILL PROJECT #: ______3______

Enclosed are appropriate copies of the sample documentation forms completed under Case # ______4______ for the ______5______, 19 5 shipment of ______6______ (qty) ______7______ (matrix) samples from the ______8______ site located in ______9______, ______9______.

GLT85/15

FIGURE 8

CENTRAL REGIONAL LABORATORY SAMPLE DATA REPORT
ORGANICS/INORGANICS
THIS FORM IS TO BE USED FOR SAMPLES SENT TO CONTRACT ONLY

CASE NUMBER/SAS No. ____ 1 ____ SITE NAME ____ 2 ____ LABORATORY ____ 3 ____ DATE SHIPPED ____ 4 ____

SUPERFUND OU NUMBER ____ 5 ____ EPA RPM or OSC (S M S)/ICES) ____ 6 ____ CERCLIS NUMBER ____ 7 ____ PAGE 8 OF ____

ACTIVITY NUMBER

CRL LOG NUMBER	ORGANIC TRAFFIC REPORT NUMBER or SAS Packing List No.	INORGANIC TRAFFIC REPORT NUMBER	WATER OR LIQUIDS	SEDIMENTS or SOILS
9	10	10	11	

NOTE: For purposes of illustration forms are reproduced at 70% of original size.

FIGURE 9

10. Enter the organic or inorganic traffic report number or the SAS packing list number.

11. Check the appropriate boxes for the analyses to be performed.

Packaging and Shipping Procedures

Low-Concentration Samples

1. 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 or use performed poly-foam liner.
   - Place appropriate traffic reports, SAS packing lists, or regional field sheets and chain-of-custody records with corresponding custody seals on top of each cooler.

2. Arrange decontaminated sample containers in groups by sample number.

3. Mark volume levels on bottles with a grease pencil.

4. Secure appropriate sample tags around lids of containers with string or wire.

5. Secure container lids with strapping tape.

6. Arrange containers in front of assigned coolers.

7. Affix appropriate adhesive labels from assigned traffic report to each container. Protect with clear label protection tape.

8. Seal each container within a separate plastic bag.

9. Arrange containers in coolers so that they do not touch.

10. If ice is required to preserve the samples, cubes should be repackaged in double zip-lock bags and placed on and around the containers (especially on VOA vials).

11. Fill remaining spaces with vermiculite (or place poly-foam liner cover on top of samples).

12. Sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express.

13. Separate copies of forms. Seal proper copies within a large zip-lock bag and tape to inside lid of cooler. Distribute remaining copies as indicated in the following sections.

14. Close lid and latch.

15. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape (Figure 10).

16. Tape cooler shut on both ends, making several complete revolutions with strapping tape. **Do not** cover custody seals (see Figure 10).

17. Relinquish to Federal Express. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

18. Telephone the SMO in Alexandria, Virginia.

    (Note: This step should be omitted for samples sent to the CRL).

    Ms. Leslie Braun (subject to change)
    703/557-2490

    Provide the following information:

    - Your name
    - Project name
    - Case number
    - Number of samples sent to each laboratory for analysis
    - Airbill numbers

    This must be done IMMEDIATELY following sample shipment. If the SMO is closed at that time, call in the information first thing the next day.

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 (Figures 10 and 11). Second, "Flammable Liquid N.O.S." or "Flammable Solid

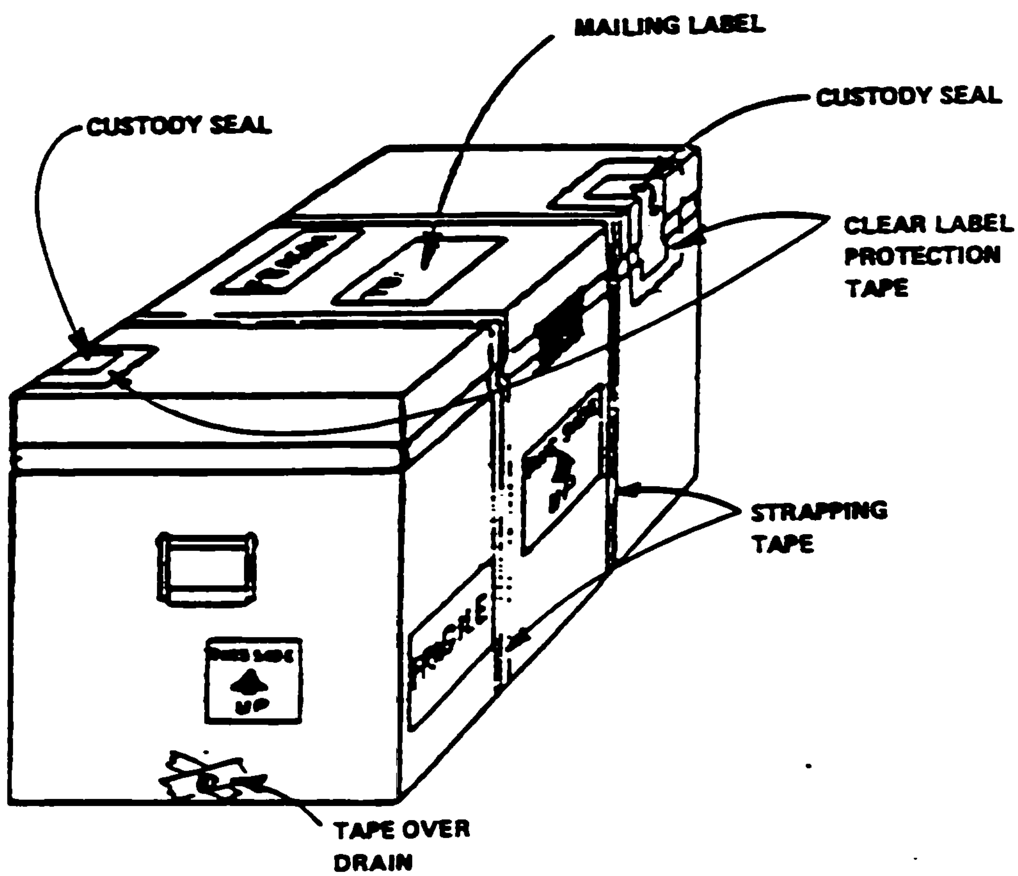

MAILING LABEL
CUSTODY SEAL
CUSTODY SEAL
CLEAR LABEL
PROTECTION
TAPE
STRAPPING
TAPE
TAPE OVER
DRAIN

FIGURE 10

FEDERAL EXPRESS

QUESTIONS? CALL 800-238-5355

AIRBILL
PACKAGE

2043974402

2036H 2043974402

5317

6208

CUSTOMER:
PLEASE REMOVE ONE OF THESE LABELS AND PLACE IT ABOVE THE AIRBILL ON YOUR PACKAGE

2043974402

2043974402

1 0532-2443-1

414-272-2426

CH2M HILL

310 W WISCONSIN AVE STE 700

MILWAUKEE WI 53203

28

YOUR INTERNAL BILLING REFERENCE INFORMATION

IF HOLD FOR PICK-UP, Print FEDEX Address Here

PAYMENT

SERVICES (Check only one box)

Priority Overnight

Standard Overnight

11 YOUR PACKAGING

16 FEDEX LETTER

12 FEDEX PAK

13 FEDEX BOX

14 FEDEX TUBE

51 YOUR PACKAGING

56 FEDEX LETTER

52 FEDEX PAK

53 FEDEX BOX

54 FEDEX TUBE

Economy Two-Day

Government Overnight

30 ECONOMY

46 GOVT LETTER

41 GOVT PACKAGE

Freight Service

70 OVERNIGHT FREIGHT

80 TWO-DAY FREIGHT

DELIVERY AND SPECIAL HANDLING (Check services required)

1 HOLD FOR PICK-UP

2 DELIVER WEEKDAY

3 DELIVER SATURDAY

4 DANGEROUS GOODS

5

6 DRY ICE

7 OTHER SPECIAL SERVICE

8

9 SATURDAY PICK-UP

10

11

12 HOLIDAY DELIVERY

Total Total Total

DIM SHIPMENT

L x W x H

SERVICE CONDITIONS, DECLARED VALUE AND LIMIT OF LIABILITY

Federal Express Use

Base Charges

Declared Value Charge

Other 1

Other 2

Total Charges

099

ORIGIN COPY

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FIGURE 11

N.O.S." 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.

1. Place approximately ½ inch of vermiculite in the bottom of the can.

2. Position the sample jar in the zip-lock bag so that the sample tags can be read through the plastic bag.

3. Place the jar in the can and fill the remaining volume with vermiculite.

4. Close the can and secure the lid with metal clips.

5. Write the traffic report number on the lid.

6. Place "This Side Up" and "Flammable Liquid N.O.S." (or "Flammable Solid N.O.S.") labels on the can.

7. Place the cans in the cooler.

Special Instructions for Shipping Samples by Federal Express (Figures 11 and 12)

1. 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 NANo. 9188.

   - Label cooler with "Hazardous Substance, N.O.S." and "liquid" or "solid," as applicable.

2. Complete the special shipping bill for restricted articles (Figures 10 and 11).

   - 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.

395461054

SHIPPER'S CERTIFICATION FOR RESTRICTED ARTICLES

(TYPE OR PRINT)

PROPER SHIPPING NAME	CLASSIFICATION	IDENTIFICATION NO.	NET QUANTITY

ADDITIONAL DESCRIPTION REQUIREMENTS FOR RADIOACTIVE MATERIALS (SEE BACK)

THIS SHIPMENT IS WITHIN THE LIMITATIONS PRESCRIBED FOR PASSENGER AIRCRAFT CARGO AIRCRAFT ONLY (DELETE NONAPPLICABLE)

IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS OR TREATMENT.

I HEREBY CERTIFY THAT THE CONTENTS OF THIS CONSIGNMENT ARE FULLY AND ACCURATELY DESCRIBED ABOVE BY PROPER SHIPPING NAME AND ARE CLASSIFIED, PACKED, MARKED, AND LABELED, AND IN PROPER CONDITION FOR CARRIAGE BY AIR ACCORDING TO APPLICABLE NATIONAL GOVERNMENTAL REGULATIONS.

NOTE: For purposes of illustration forms are reproduced at 70% of original size.

FIGURE 12