RMT, Inc.
Suite 124
1406 East Washington Ave.
Madison, WI 53703-3009
Phone: 608-255-2134
FAX: 608-255-0234

A-E QUALITY CONTROL AND SAMPLING PLAN FOR ADDITIONAL INVESTIGATIONS

AT THE
NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT
FRIDLEY, MINNESOTA

JANUARY 1988

CONTRACT NO. DACA45-86-C-0015
MODIFICATION NO. P00003

Keith E. Bandt
Project Engineer

Stephen D. Johannsen
Manager, Hydrogeology and
Applied Chemistry

Eric Gredell, P.E.
Project Manager

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Date 1-22-88 Registration No. 013728

Thomas P. Kunes, P.E.
President, Northern Region

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1. INTRODUCTION

RMT, Inc., (RMT) has been retained by the Omaha District of the U.S. Army Corps of Engineers (COE) to complete the Remedial Investigation/Feasibility Study (RI/FS) for the Naval Industrial Reserve Ordnance Plant (NIROP) located in Fridley, Minnesota. This project is conducted under the Navy Installation Restoration Program (IRP).

This A-E Quality Control Plan (A-E QCP) is one of four planning documents prepared under Modification No. P00003 to Contract No. DACA45-86-C-0015. The remaining three documents are the following:

- Project Workplan
- Site Operations Plan (SOP)
- Health and Safety Plan (HSP)

The A-E QCP has been prepared to maintain a high standard of quality for the data generated during the field investigations. It defines the technical approach, procedures, and schedules which will apply to work conducted by RMT and its subcontractors. The A-E QCP was developed using USEPA and U.S. Army Corps of Engineers guidance documents.

Specific purposes of the A-E QCP are as follows:

- To define the respective COE and RMT responsibilities for quality control.
- To define project data quality objectives covering sampling, sample handling, custody, documentation, and analytical procedures.
- To define procedures so that data collected are legally and scientifically defensible.

The A-E QCP is a "working document" structured to facilitate revisions which may be required during the project. Revisions which may

be required will be distributed in the form of new and/or replacement pages to this document.

Any deviations to procedures described in the approved A-E QCP, as well as corrective actions, will be described in A-E Quality Control Summary Reports (A-E QCSRs). A-E QCSRs will be prepared following completion of each phase of field work, and after analysis of lab data and A-E Daily Quality Control Reports (A-E DQCRs).

2. PROJECT DESCRIPTION

2.1 Project Background

The Naval Industrial Reserve Ordnance Plant (NIROP) is a government-owned, contractor-operated facility. The plant is operated by the Northern Ordnance Division of FMC Corporation. The NIROP manufactures advanced naval weapons systems. Operations include development, design, engineering, and testing. The NIROP began production in 1941, making it the first plant to mass-produce naval guns during World War II. The NIROP has continued to produce naval guns and has expanded into the production of guided missile launching systems, torpedo tubes, and hydraulic and electric power drive and control systems.

The NIROP is located in the northern portion of the Minneapolis/St. Paul, Minnesota metropolitan area within the city limits of Fridley, Minnesota (see Figure 2-1). It is situated approximately one-half mile east of the Mississippi River and less than one mile south of Interstate 694. The facility is bordered on the west by East River Road and on the east by the Burlington Northern rail yard. The government-owned, contractor-operated portion of the plant occupies about 83 acres. The plant is located in an industrial area which has a number of adjacent manufacturing facilities.

In previous years, the storage yard in the northern quarter of the site had been used for the disposal of drummed waste by burial in 8- to 10-foot-deep trenches or in pits. The materials disposed were thought to include waste oil, plating sludge, paint sludge, cleaning solvents, and degreasing solvents, which may contain hazardous chemicals such as

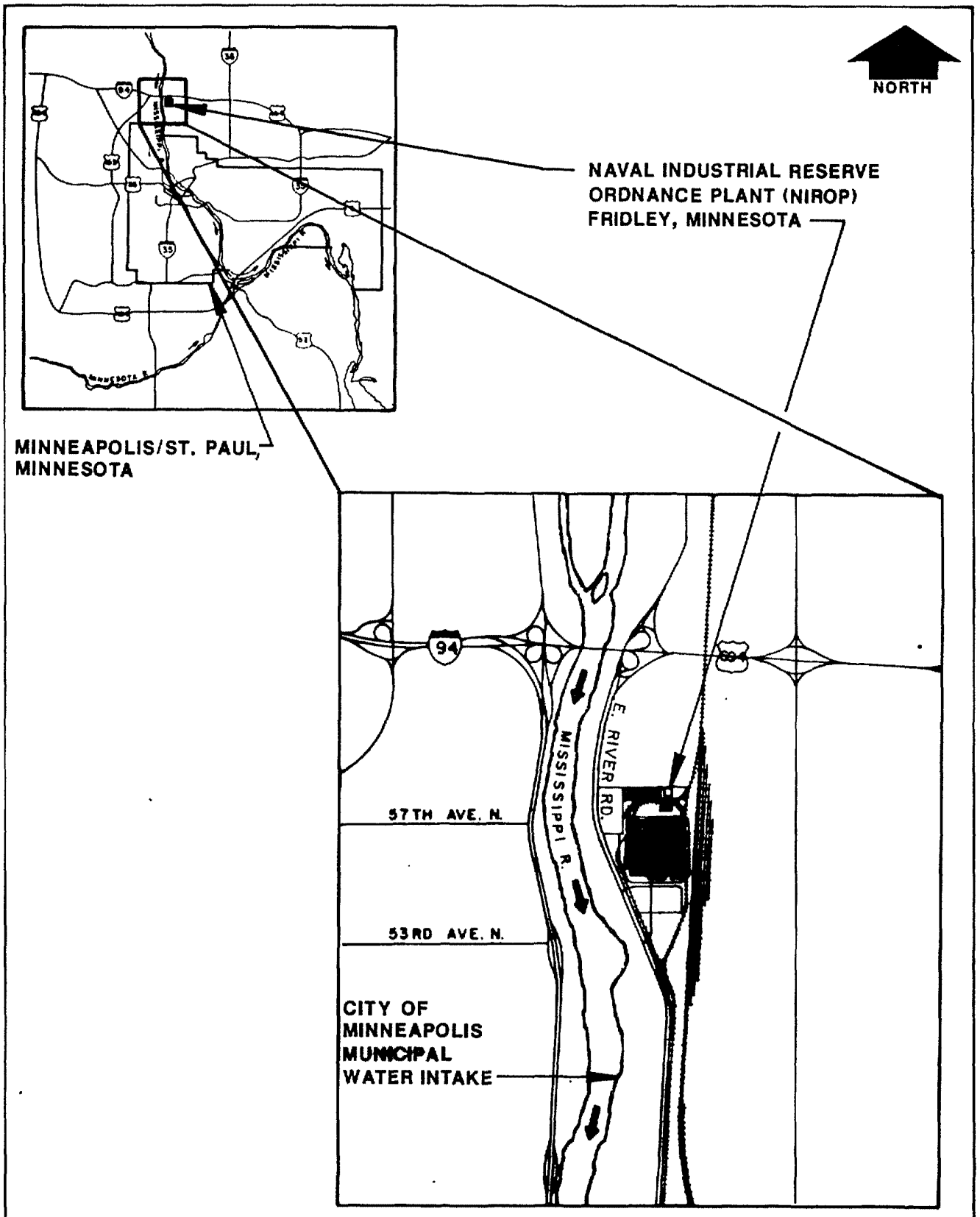


FIGURE 2-1
GENERAL VICINITIES MAP

RMT	DWN. BY: MDZ
	DATE: 4/15/87
	PROJ.# 1332.22

cyanide, trichloroethylene (TCE), methyl ethyl ketone (MEK), and 1,1,1-trichloroethane (RMT, 1987b).

Initial remedial action cleanup activities began in November 1983. Nine areas were excavated, and 43 drums and approximately 1,200 cubic yards of soil were removed. The majority of the drums contained inert solids; others contained PCB wastes, flammable solids, base solids, and inert liquids; and some were empty. The hazardous soils and drums were disposed in an EPA-approved landfill. Samples were subsequently taken from the excavations and analyzed for volatile organics. Two trenches showed VOCs above one part per million; however, no further testing was done at that time. The trenches were backfilled with clean fill, and removal activities were completed in March 1984.

Fourteen monitoring wells were installed at the NIROP between May and August 1983. Seven additional on-site monitoring wells were installed in May and June 1985. Installation of 12 off-site monitoring wells was completed in February 1986. The purpose of these wells was to determine ground water flow direction and the general extent of ground water contamination. Water level measurements and samples have been collected from these wells on an intermittent basis through November 1986.

RMT prepared an Interim Report (RMT, 1987a) and an RI Report (RMT, 1987b) which presented and evaluated data collected by RMT and the Corps of Engineers for the Navy at the NIROP facility. The information contained in those documents forms the basis for the present field investigations.

2.2 Scope of Work

The Corps of Engineers' Scope of Services under this Contract Modification addressed three primary tasks:

- Preparation of a Feasibility Study (FS) Report
- Additional Field Investigations
- Preparation of an Addendum to the Remedial Investigation (RI) Report issued in June 1987 (RMT, 1987b)

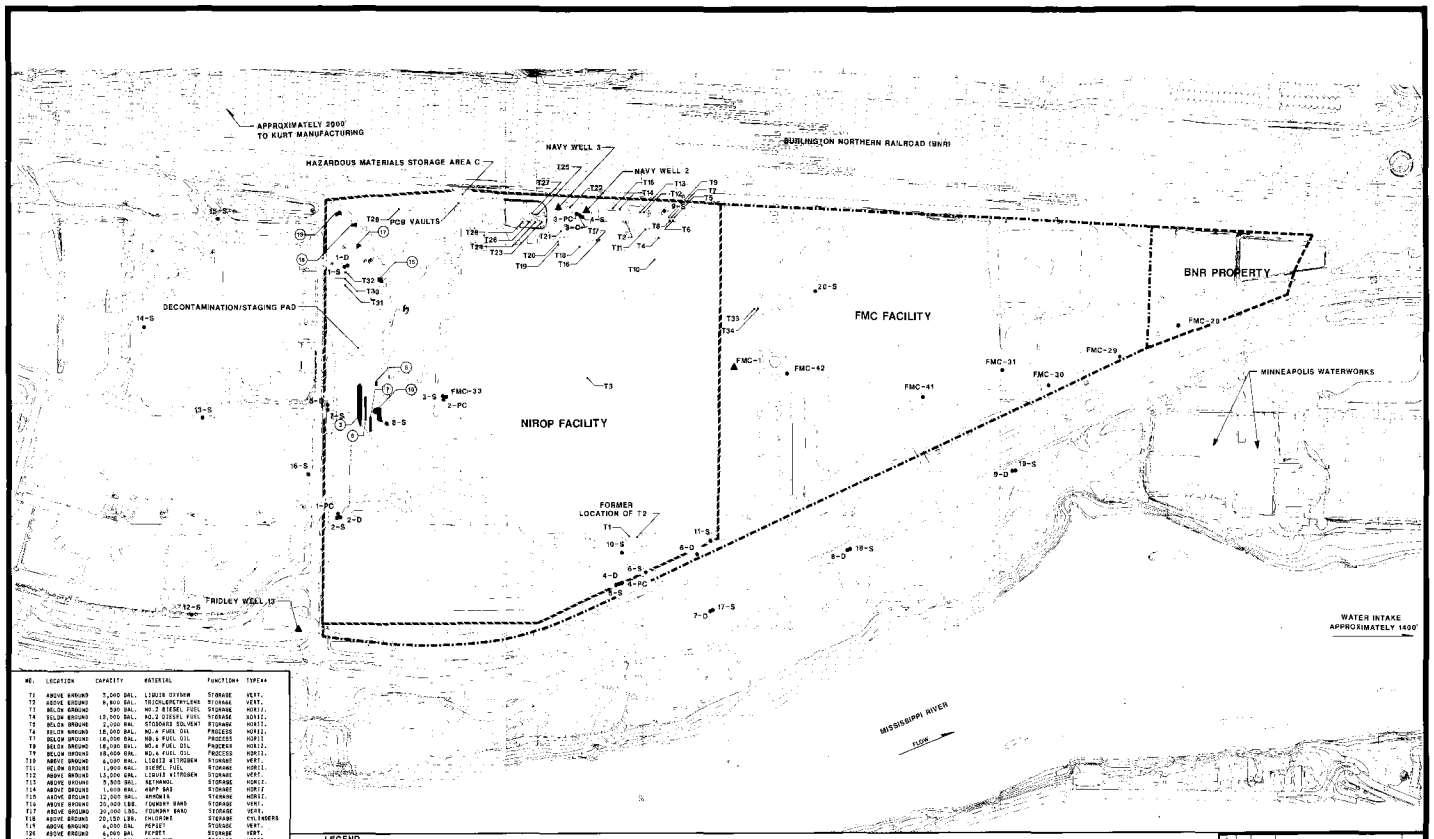
These three tasks were further broken down and organized into the following six elements for RMT costing and planning purposes:

Element 1 - FS Report
Element 2 - Planning Documents
Element 3 - Field Investigations
Element 4 - Laboratory Services
Element 5 - Reports
Element 6 - Review Meetings

This document (A-E QCP) was prepared under Element 2 for the purpose of addressing activities under Elements 3 and 4. Element 3 - Field Investigations at the NIROP facility (Figure 2-2), will center around the following four main tasks:

Task 1 - Soil Gas Survey (Section 4.3)
Task 2 - Well Installation (Section 4.4)
Task 3 - Sampling (Section 4.4)
Task 4 - Aquifer Testing (Section 4.5)

A soil gas survey (Task 1) will aid as a screening technique for identifying potential volatile organic compound (VOC) contamination, and to assist in the placement of monitoring wells. Soil gas sampling will be conducted in two phases, with the results of Phase I further defining the sampling scheme under Phase II. Near-surface soil samples will be collected using soil probes and by hand augering. Samples will be analyzed using an HNU meter (HNU Systems, Inc., Model PI 101



NO.	LOCATION	CAPACITY	MATERIAL	FUNCTION*	TYPE**
T1	ABOVE GROUND	3,000 GAL.	LIQUID OXYGEN	STORAGE	VERT.
T2	ABOVE GROUND	8,000 GAL.	TRICHLOROETHYLENE	STORAGE	VERT.
T3	BELOW GROUND	500 GAL.	NO.2 DIESEL FUEL	STORAGE	HORIZ.
T4	BELOW GROUND	13,000 GAL.	NO.2 DIESEL FUEL	STORAGE	HORIZ.
T5	BELOW GROUND	2,000 GAL.	STODDARD SOLVENT	STORAGE	HORIZ.
T6	BELOW GROUND	18,000 GAL.	NO.6 FUEL OIL	PROCESS	HORIZ.
T7	BELOW GROUND	18,000 GAL.	NO.6 FUEL OIL	PROCESS	HORIZ.
T8	BELOW GROUND	18,000 GAL.	NO.6 FUEL OIL	PROCESS	HORIZ.
T9	BELOW GROUND	18,000 GAL.	NO.6 FUEL OIL	PROCESS	HORIZ.
T10	ABOVE GROUND	6,000 GAL.	LIQUID NITROGEN	STORAGE	VERT.
T11	BELOW GROUND	1,000 GAL.	DIESEL FUEL	STORAGE	HORIZ.
T12	ABOVE GROUND	13,000 GAL.	LIQUID NITROGEN	STORAGE	VERT.
T13	ABOVE GROUND	9,500 GAL.	METHANOL	STORAGE	HORIZ.
T14	ABOVE GROUND	1,000 GAL.	ARGON GAS	STORAGE	HORIZ.
T15	ABOVE GROUND	12,000 GAL.	AMMONIA	STORAGE	HORIZ.
T16	ABOVE GROUND	20,000 LBS.	FOUNDRY SAND	STORAGE	VERT.
T17	ABOVE GROUND	20,000 LBS.	FOUNDRY SAND	STORAGE	VERT.
T18	ABOVE GROUND	20,150 LBS.	CHLORINE	STORAGE	CYLINDERS
T19	ABOVE GROUND	4,000 GAL.	PERSET	STORAGE	VERT.
T20	ABOVE GROUND	4,000 GAL.	PERSET	STORAGE	VERT.
T21	BELOW GROUND	2,000 GAL.	GASOLINE	STORAGE	HORIZ.
T22	ABOVE GROUND	100,000 GAL.	WATER	STORAGE	VERT.
T23	ABOVE GROUND	65,000 GAL.	NO.6 FUEL OIL	STORAGE	VERT.
T24	ABOVE GROUND	65,000 GAL.	NO.6 FUEL OIL	STORAGE	VERT.
T25	ABOVE GROUND	65,000 GAL.	NO.6 FUEL OIL	STORAGE	VERT.
T26	ABOVE GROUND	65,000 GAL.	NO.6 FUEL OIL	STORAGE	VERT.
T27	ABOVE GROUND	65,000 GAL.	NO.6 FUEL OIL	STORAGE	VERT.
T28	ABOVE GROUND	65,000 GAL.	NO.6 FUEL OIL	STORAGE	VERT.
T29	ABOVE GROUND	90,000 GAL.	PROPANE	STORAGE	HORIZ.
T30	ABOVE GROUND	17,000 GAL.	PROPANE	STORAGE	HORIZ.
T31	ABOVE GROUND	17,000 GAL.	PROPANE	STORAGE	HORIZ.
T32	ABOVE GROUND	17,000 GAL.	PROPANE	STORAGE	HORIZ.
T33	BELOW GROUND	1,000 GAL.	GASOLINE	STORAGE	HORIZ.
T34	BELOW GROUND	1,000 GAL.	GASOLINE	STORAGE	HORIZ.

* STORAGE, PROCESS, ETC.
** TANKS, BINS, DRUMS, ETC.

TANK LOCATIONS FROM ENVIRODYNE, 1983

LEGEND

- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING BUILDING
- EXISTING FENCE
- 400 EXISTING 5' CONTOUR
- EXISTING 1' CONTOUR
- 1.0557 EXISTING SPOT ELEVATION
- TREES AND / OR BRUSH
- EDGE OF WATER
- WET AREA
- 16-S MONITORING WELL LOCATION
- WATER SUPPLY WELL
- T1 LOCATION AND NUMBER OF STORAGE TANKS (SEE SUMMARY TABLE)
- 10 EXCAVATED WASTE DISPOSAL PITS/TRENCHES
- NIROP PROPERTY LINE (APPROXIMATE)
- FMC PROPERTY LINE (APPROXIMATE)

BASE MAP PROVIDED BY CORPS OF ENGINEERS, DATE OF SURVEY AND DATUM UNKNOWN. MONITORING WELL LOCATIONS ARE APPROXIMATE, BASED ON PROXIMITY TO LANDMARKS.

SCALE 1" = 200'
0 200 400 800 FEET

CONTRACT NO. DACA45-86-C-0015

NO.	BY	DATE	REVISION	APPD.
3.				
2.				
1.				

PROJECT: A-E QUALITY CONTROL PLAN
COE-NIROP FRIDLEY, MINNESOTA
SHEET TITLE: FIGURE 2-2
NIROP FACILITY MAP

DRAWN BY: JMM MDZ | SCALE: 1" = 200' | PROJ. NO. 1232.26
CHECKED BY: | DRWG. NO.
APPROVED BY: | DATE PRINTED: JAN 20 1993
DATE: 01/19/93

RMT
Suite 124
1400 Gen Washington Ave
Norristown, PA 19403
Phone 215-279-2700

Photoionization Meter) and a portable field gas chromatograph (GC) unit (Photovac Inc., Model 10S50 Portable Gas Chromatograph). Soil gas sampling is discussed further in Section 4.3.

Well installations (Task 2) will be of two types: monitoring (observation) wells and production wells. Monitoring wells will be used to collect water samples for chemical analysis and to measure ground water gradients. Production wells will have a larger diameter and will be used to extract large volumes of water for aquifer tests of hydraulic properties under Task 4. Production wells will also be used for pumping and time-series analyses as part of an evaluation of potential off-site, upgradient contaminant sources. The well installation and aquifer test plan is discussed in sections 4.4 and 4.5.

Ground water and soil samples collected during and after well construction (Task 3) will be analyzed using standard EPA-approved procedures. Analysis results will provide information on soil and lithology, and on the extent of contamination by hazardous substances. One round of sampling is planned for all existing on-site and off-site monitoring wells, including the newly constructed wells. The sampling plan for soil and ground water is discussed in Section 4.4.

Information derived from these tasks is necessary to complete the development and evaluation of remedial alternatives.

2.3 Site Toxic or Hazardous Substances

Inorganic and organic substances that are considered potentially toxic or hazardous, and which have been found in ground water at the NIROP facility, are listed in Table 2-1. The most frequently detected

TABLE 2-1

LIST OF TOXIC OR HAZARDOUS CONSTITUENTS DETECTED
IN PREVIOUS GROUND WATER SAMPLES

Inorganic Constituents	Organic Constituents	Potential Degradation Products of Concern
Arsenic	1,1,1 Trichloroethane	1,1 Dichloroethane Chloroethane
Barium	1,1-Dichloroethane	Chloroethane
Cadmium	1,1-Dichloroethylene	Vinyl Chloride
Chromium	Benzene	
Copper	Bis (2 ethylhexyl) Phthalate	
Lead	Chloroform	
Manganese	1,2-Dichloroethylene	Vinyl Chloride
Mercury	Ethyl Benzene	
Nickel	Methylene Chloride	
Selenium	PCB 1242	
Silver	PCB 1248	
Zinc	PCB 1254	
	PCB 1260	
	Tetrachloroethylene	1,2 Dichloroethylene 1,1 Dichloroethylene Trichloroethylene Vinyl Chloride
	Toluene	
	Trichloroethylene	1,2 Dichloroethylene 1,1 Dichloroethylene Vinyl Chloride
	Trichlorofluoromethane	
	Xylene	

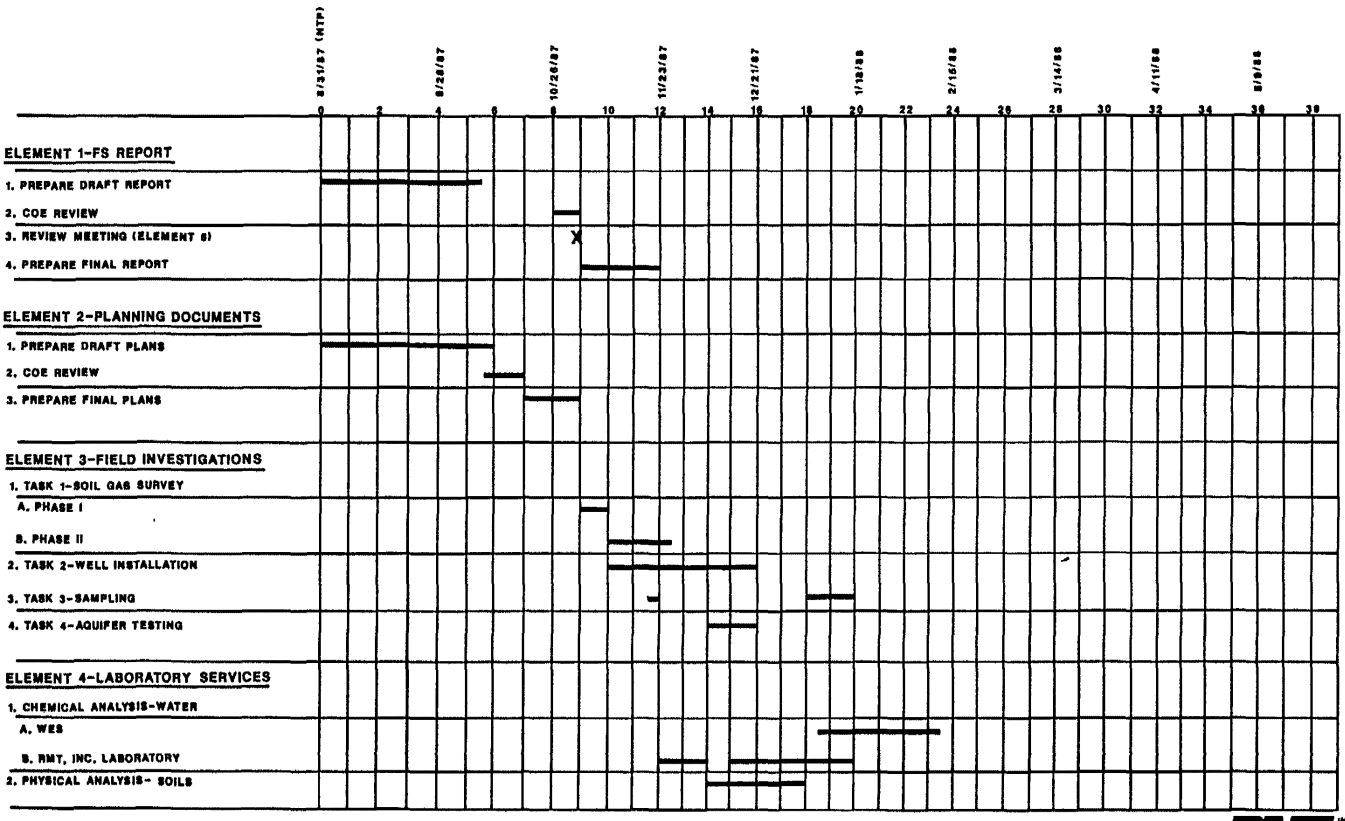
organic substance was trichloroethylene. Potential degradation products of concern for this substance and others are also shown in Table 2-1. Health and safety aspects are further addressed in the Health and Safety Plan.

2.4 Project Schedule

The estimated project schedule is shown on Figure 2-3. The schedule will be updated each month to show actual work progress and any projected revisions to date for remaining project milestones and key events. The updated schedule will be submitted with the monthly progress reports.

Figure 2-3 indicates an anticipated Notice to Proceed (NTP) date of August 31, 1987. RMT began work under this Contract Modification on September 2, 1987.

FIGURE 2-3
ESTIMATED SCHEDULE
NIROP
FRIDLEY, MINNESOTA
CONTRACT MOD. NO. P00003



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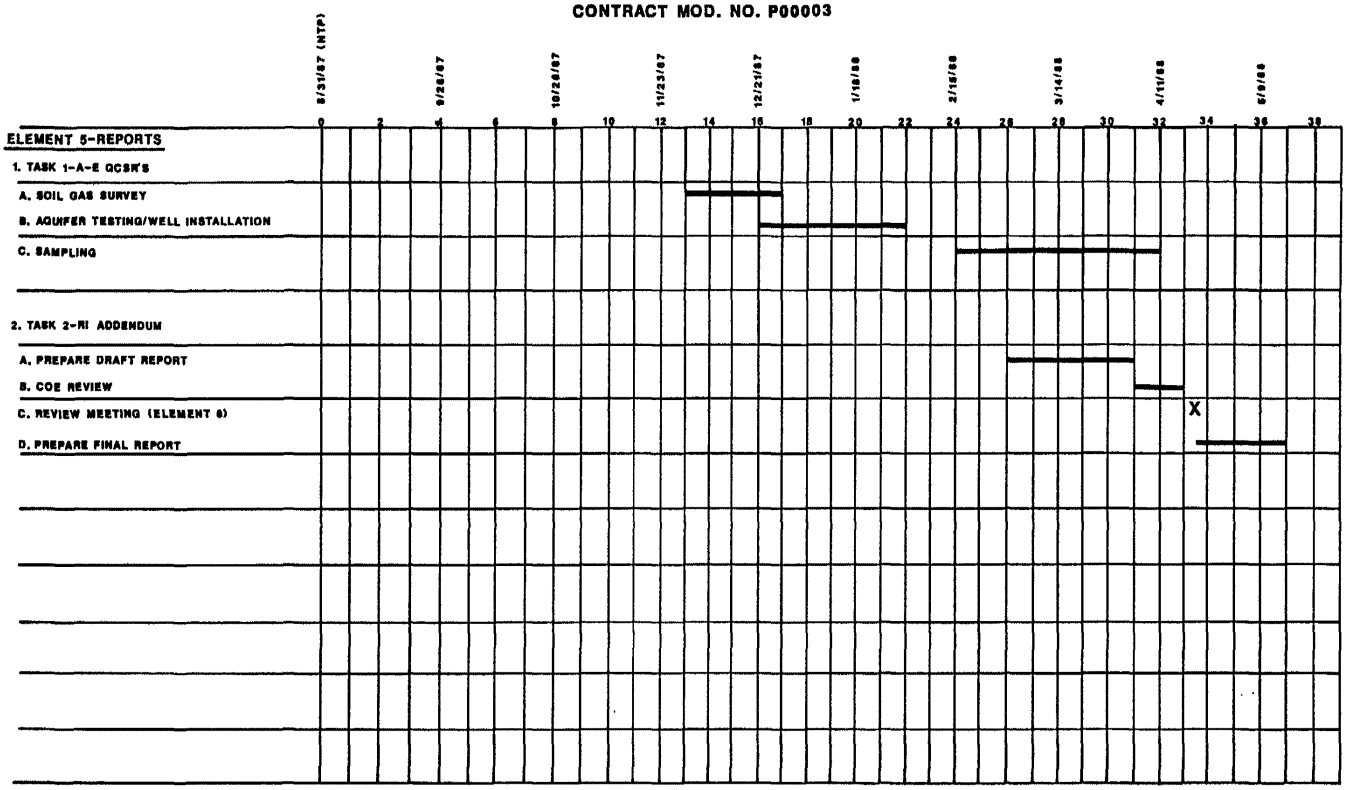
ESTIMATED SCHEDULE
NIROP
FRIDLEY, MINNESOTA
CONTRACT MOD. NO. P00003



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3. PROJECT ORGANIZATION AND QM RESPONSIBILITIES

3.1 Project Organization

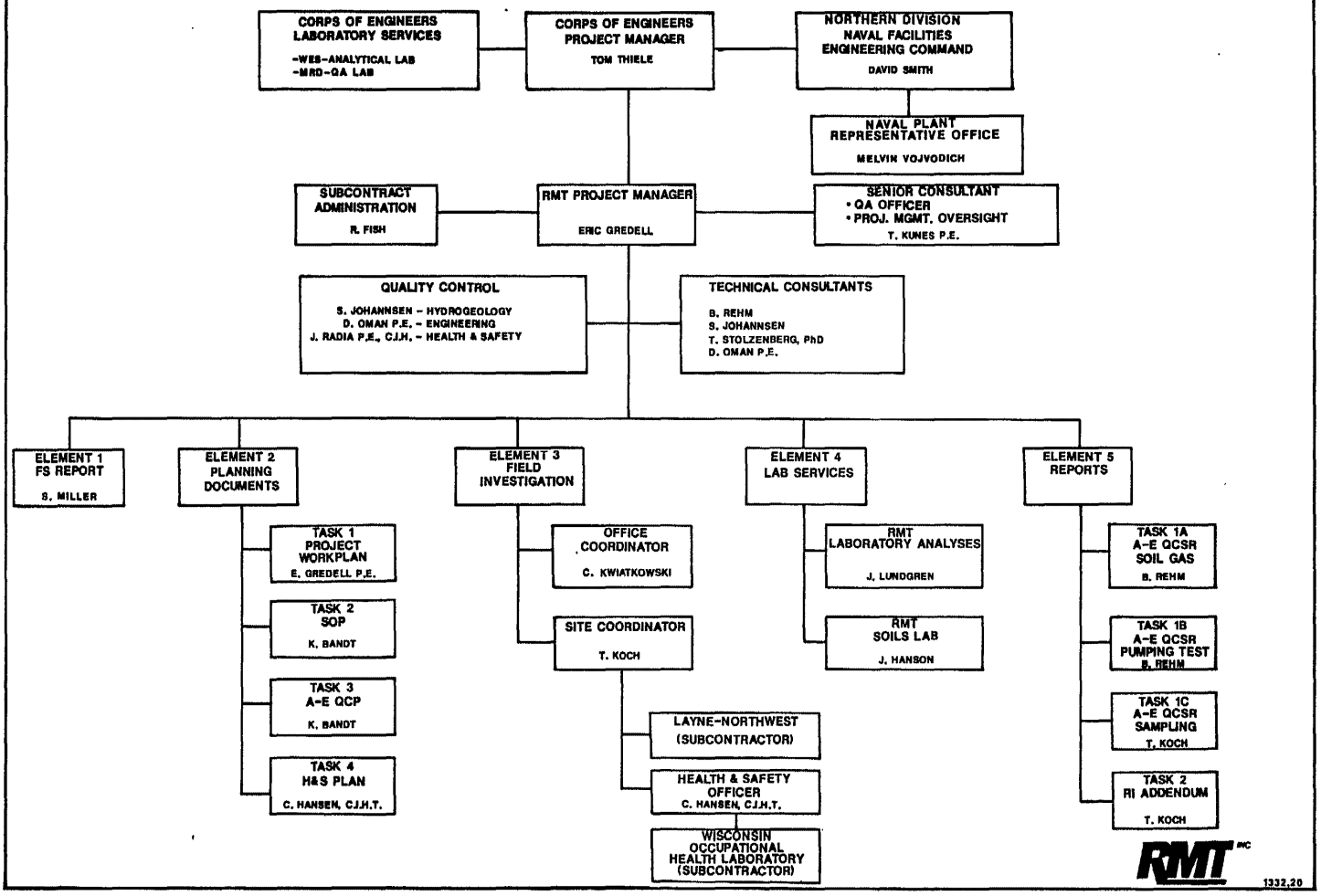
An organizational chart for the Corps of Engineers (COE) and the RMT project team for the Scope of Services under this Contract Modification is illustrated on Figure 3-1. The designated Corps of Engineers Project Manager is Tom Thiele. Mr. Thiele will provide day-to-day management of the project and serve as the primary contact between RMT and the COE.

The RMT project team is composed of engineers, hydrogeologists, industrial hygienists, scientists, and support staff. This multi-disciplinary project team provides the mechanism for completing the Scope of Services in a systematic and comprehensive manner.

Layne-Northwest of Pewaukee, Wisconsin, will install the monitoring and pumping wells, and assist with the pumping tests, under subcontract to RMT. Air samples required to support the site health and safety assessment will be analyzed by the Wisconsin Occupational Health Laboratory of Madison, Wisconsin, also under a subcontract with RMT.

RMT projects are typically organized into Project Elements which correspond to the major work types and outputs. Project Tasks further define the specifics of the work to be done under each Element. Primary responsibility for managing the production of specific outputs is often assigned to individuals on the technical staff. Figure 3-1 identifies individuals assigned the responsibility for specific outputs at the Project Element or Task level. Each Element or Task leader will organize and manage the output production including duties such as: identifying additional technical staff input needs and issuing staff

FIGURE 3-1
PROJECT ORGANIZATIONAL CHART



requests to supervisors; compiling the draft output; scheduling QC and QA reviews; incorporating review comments from outside parties; scheduling output reproduction; and distributing output. Each Element or Task Leader reports to the Project Manager for directions and resolution of questions related to output production.

3.2 Key Individuals

Key individuals are defined as persons having responsibility for major work components, critical technical input, QA/QC above the peer review QC level, primary client coordination, and overall project management and oversight. The individuals assigned these responsibilities for this project are identified below. Resumes for these personnel are included in Appendix C.

Person	RMT Position Title	Project Assignment
Thomas P. Kunes, P.E.	President, Northern Region	. QA Officer
Mark E. Smith, P.E.	Director of Technical Operations	. QC Officer . Project management oversight
Eric Gredell, P.E.	Project Manager	. Project Manager
Richard P. Fish	Manager - Technical Services	. Subcontract Administration
Stephen D. Johannsen	Manager - Hydrogeology and Applied Chemistry Deptartment	. QC Reviewer - Hydrogeology . Technical Consultant
Daniel E. Oman, P.E.	Manager - Environmental Process Engineering Department	. QC Reviewer - Engineering . Technical Consultant
Jitendra T. Radia, P.E., CIH	Manager - Industrial Hygiene and Air Pollution Control Engineering Department	. QC Reviewer - Health and Safety

Bernd Rehm	Manager - Hydrogeologic Services Group	. Technical Consultant
Thomas R. Stolzenberg, Ph.D.	Manager - Applied Chemistry Group	. Technical Consultant
Chris Hansen, C.I.H.T.	Industrial Hygienist	. Health and Safety Officer
Joel Lundgren	Assistant Director RMT Laboratory, Inc.	. QA Reviewer - RMT Analytical Laboratory
John P. Hanson	Director RMT Soils Laboratory	. QA Reviewer - RMT Soils Laboratory
Thomas E. Koch	Hydrogeologist	. Site Coordinator
Scott A. Miller	Project Engineer	. Element Leader - FS Report

3.3 Project Quality Management (QM) Responsibilities

Primary site investigation activities will be performed by RMT, Inc., Madison, Wisconsin. Quality management responsibilities for the field activities will be shared by RMT office and field personnel. In general, typical responsibilities for the various personnel include the following:

- Site Coordinator: Technical supervision, oversight, and review for daily on-site operations. Responsible for conformance with project plans, schedule, and procedures on-site. Daily review and signing of notes and logs. Ongoing coordination with the RMT project manager on work progress, interim results, and problems.

- Peer Review: Ongoing checking in the field and office of calculations, procedures, issues, and logic.

- Project Manager: Responsible for meeting the overall project objectives and identifying major project issues. Provides quality control review and conformance with project plans. Ongoing review for logic and reasonableness of interim results. Approves and signs all reports. Coordinates activities of the Quality Assurance (QA) officer and other QA reviewers to provide objective oversight.

- Quality Assurance Officer: Provides overall independent quality assurance oversight for the project. Follows the project closely to audit QA/QC procedures and ensure conformance with quality assurance objectives. Coordinates his activities with discipline-specific quality assurance reviewers for review of project methods and performance.

- Quality Assurance Reviewers: Discipline-specific reviewers of portions of the project workplans, progress, problems, and outputs. Used systematically for some reviews, but primarily when called upon by the QA officer.

Drilling and aquifer testing activities will be performed by Layne-Northwest under subcontract to RMT. It is the responsibility of the subcontractor to assure that subcontracted work activities conform to the requirements of this document. However, RMT personnel will be present on-site whenever work is being performed.

3.4 Analytical Laboratory Qualifications

Ground water samples and Quality Control samples (duplicates and field blanks) collected as discussed in Section 4.4 will be analyzed at the COE Waterways Experiment Station (WES) in Vicksburg, Mississippi. Quality Assurance samples (splits and field blanks) will be analyzed at the COE Missouri River Division laboratory (MRD-ED-L) in Omaha, Nebraska.

Ground water samples collected during aquifer testing and for bench-scale testing as discussed in Section 4.5 will be analyzed by the RMT Laboratories. The qualifications of RMT's analytical laboratory, including facilities, equipment, and key personnel, are presented in Appendix A.

4. FIELD MEASUREMENTS AND SAMPLING PLAN

4.1 Documentation

4.1.1 Field Records

This section describes requirements and procedures for documentation of field activities. Documentation of the sampling team's field activities provides the basis for technical site evaluations and related written reports. Additionally, records and notes generated in the field may be considered pertinent in the discovery process as part of potential future litigation. It is essential that all field documentation provide a clear, unbiased picture of field activities. Field records of activities at the NIROP facility will be in the form of an A-E Daily Quality Control Report (A-E DQCR) and daily logs.

Daily logs will be used to document site activities. The Site Coordinator will be responsible for providing bound, serialized field notebooks and for documenting the assignment of each field notebook to be used for the daily logs. Entries into field notebooks will be legibly written in indelible ink and will provide a clear record of all field activities.

The following information must be provided on the inside front cover or first page of the field notebooks:

- Project Name (site name)
- Site Location
- RMT Project Number
- COE Contract Number
- Date of Issue
- Name of the individual to whom the notebook is assigned

- Authors of the notes (daily entries will be initialed by the respective author)

In addition to recording field data such as water levels, pH, conductivity, etc., the daily field logs should include information neessary for the A-E DQCR listed later in this Section.

The Site Coordinator will distribute and keep track of users of bound and numbered field notebooks. Transfers of field notebooks to other individuals who have been designated to perform specific tasks on the project will be recorded. None of the documents are to be destroyed or thrown away, even if they are illegible or contain inaccuracies. Voided documents will be returned to the originator and sent to the project file.

The A-E DQCR is a separate record provided for the COE Project Manager. These reports will be mailed weekly unless problems are encountered, in which case reports will be provided within 48 hours.

The A-E DQCR will include information such as the following:

1. Date
2. Weather (temperature, wind speed and direction, precipitation, etc.)
3. Work performed
4. Sampling performed (specifics as to location, type of sample, log number, etc.)
5. Field analysis performed, including instrument checks, calibration, etc.
6. Problems encountered and corrective actions taken (specifics regarding sampling problems and alternate sampling methods utilized); questions or uncertainties, etc.
7. Quality control activities initiated
8. Signature of Site Coordinator

Any problems encountered which are not immediately corrected and/or which could jeopardize the integrity of the data will be reported to the RMT Project Manager and the COE Project Manager immediately.

4.1.2 Sample Identification

Each sample will be uniquely identified. Sample splits and duplicates will receive different identification numbers.

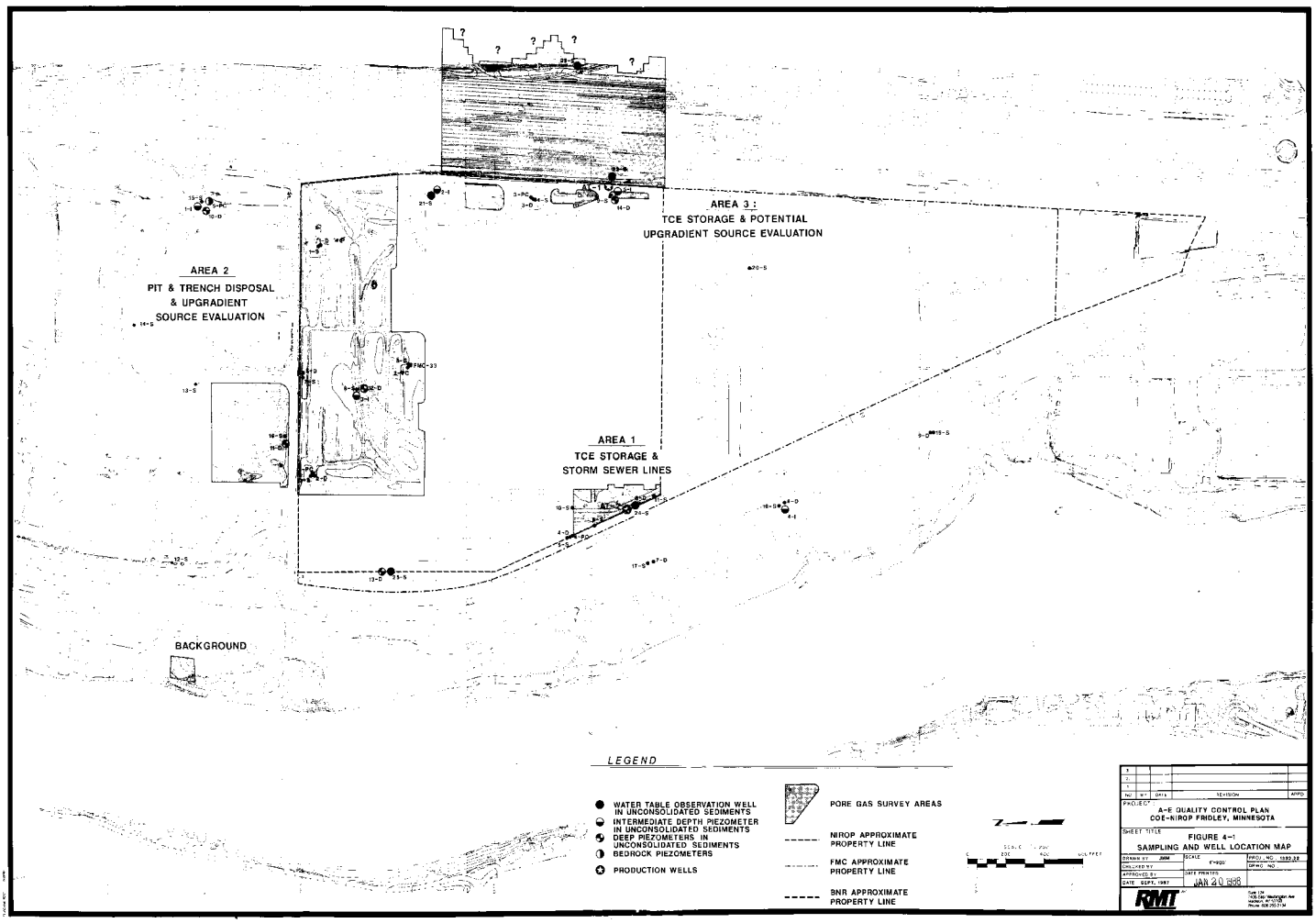
Sample containers will be prelabeled with the laboratory control number. Field sample identification numbers will incorporate identifiers listed elsewhere in this planning document. Sample identification numbers from ground water wells will be consistent with the well designations shown on Figure 4-1.

Field sample identification numbers will be included on chain-of-custody forms (Section 4.4.8). A copy of the chain-of-custody form with its assigned sample numbers will be kept in the field office files and in the laboratory to help identify lost or missing samples.

4.2 Decontamination Procedures

Decontamination of sampling equipment is essential to prevent cross-contamination of samples with the sampling device.

All sampling equipment will be decontaminated before sampling and between each sample unless samples are to be composited. Sampling equipment will be decontaminated by washing with a brush and non-phosphate laboratory-grade detergent, rinsing with tap water, rinsing with methanol, and double-rinsing with distilled water. Split-spoon samplers will be washed between samples with a brush and detergent, followed by a rinse with tap water, or by steam cleaning.



LEGEND

- WATER TABLE OBSERVATION WELL IN UNCONSOLIDATED SEDIMENTS
- INTERMEDIATE DEPTH PIEZOMETER IN UNCONSOLIDATED SEDIMENTS
- DEEP PIEZOMETERS IN UNCONSOLIDATED SEDIMENTS
- BEDROCK PIEZOMETERS
- PRODUCTION WELLS
- PORE GAS SURVEY AREAS
- NIROP APPROXIMATE PROPERTY LINE
- FMC APPROXIMATE PROPERTY LINE
- BNR APPROXIMATE PROPERTY LINE

NO.	BY	DATE	REVISION	APPD.
3				
2				
1				

PROJECT: A-E QUALITY CONTROL PLAN
COE-NIROP FRIDLEY, MINNESOTA

SHEET TITLE: FIGURE 4-1
SAMPLING AND WELL LOCATION MAP

DRAWN BY: JMM	SCALE: 1"=100'	PROJ. NO. 1692.22	
CHECKED BY:		DRWG. NO.	
APPROVED BY:			
DATE: SEPT. 1987	DATE PRINTED: JAN 20 1988		

RMT
Suite 100
7700 Olson Memorial Hwy
Minneapolis, Minnesota
Phone: 546-2637M

Larger equipment such as drilling rigs will be decontaminated by steam-cleaning. Water used for steam-cleaning will be obtained from a potable water supply serving the NIROP facility. This water supply will be tested for VOC content, since the water rotary drilling method employed will also utilize this supply.

Spent decontamination fluids will be dispersed over the ground near the drill site unless a nuisance could result, in which case a nearby unpaved area should be chosen. Soil from drilling and soil sampling activities will be removed as part of site restoration, and disposed on NIROP property at a location specified by the FMC Construction Supervisor.

4.3 Soil Gas Sampling

4.3.1 Purpose and Scope

Soil gas monitoring will be used as a screening technique to aid in identifying potential VOC-contaminated areas and in selecting final locations for monitoring wells. Contamination may be present as a result of either direct contamination of the soil or migrating vapors from the liquid product.

Specific objectives of this portion of the field investigation are the following:

- To compare two gas monitoring methods and choose the more appropriate technique for further investigations.
- To locate contaminated soil that may be a source of VOC contamination in ground water.
- To assist in selecting final locations for ground water monitoring wells.

In-field soil gas monitoring has the advantage of being faster and less expensive than laboratory analysis of soil samples. More samples can be analyzed with a much faster response time by using field analysis of soil gas than by performing laboratory analysis of soil samples.

The disadvantages of in-field soil gas monitoring for locating contamination include both physical and analytical limitations. The occurrence and migration of contaminated soil gas is both transient and unpredictable. The transient nature of contaminated soil gas is due to changing weather conditions. Barometric pressure changes can cause vertical movement of contaminants in near-surface soil gas. Heavy rains can wash volatile organics from soils and block upward migration from greater depth until the soil pores re-open. Ice cover will also block escape at the surface.

The unpredictable nature of soil gas migration is due to geological heterogeneities. Soil gas will preferentially move through subsurface channels which are characterized by connected void spaces. Rarely is the knowledge of subsurface geology of such detail to enable prediction of migration patterns.

Analytical limitations include the restriction to volatiles. Non-volatiles cannot be measured. In addition, portable analytical equipment generally does not provide the level of resolution available from permanent instrumentation. However, this limitation is offset by a general increase in accuracy over volatile samples shipped to a laboratory which can undergo unacceptable losses during transport and handling.

Soil gas monitoring will be conducted in four general areas on and adjacent to the site (Figure 4-1) as follows:

Area 1: TCE storage area and storm sewers
Area 2: Pit and trench disposal area (upgradient source evaluation)
Area 3: TCE storage area (potential upgradient source evaluation)
Area 4: Background

The soil gas monitoring will be divided into two phases. In Phase I, two methods of monitoring soil gas composition will be compared - soil pore gas monitoring and soil headspace analysis. Both a non-specific VOC analyzer (an HNU Systems, Inc., Model PI 101 photoionization meter) and a portable gas chromatograph (a Photovac, Inc., Model 10S50 Portable Photoionization Gas Chromatograph) will be used to analyze pore gas and headspace gas. Twenty (20) sample locations will be chosen and analyzed during Phase I. The methods will be evaluated in several areas as follows:

- Sensitivity
- Reproducibility
- Ease of field operation
- Relationship between portable GC and HNU results
- Ability to measure direct soil contamination or migrating contaminant vapors

Methods of collecting and analyzing soil gas samples will be optimized for the actual conditions encountered. Based on the results of Phase I, the appropriate method will be selected for Phase II work.

In Phase II, a larger number of samples will be analyzed (approximately 120). Sampling will be done on a regular grid system, with more concentrated sampling in areas of particular interest (e.g., close to sewers). Phase II is intended to both identify the most

contaminated areas and provide a basis for selecting final monitoring well locations.

4.3.2 Selection of Sampling Locations

Phase I

Twenty locations will be sampled during Phase I. Two of the 20 locations will be in background areas (Area 4), and 18 will be in areas of suspected contamination. The 18 locations will be as follows (see Figure 4-1):

- 6 locations on the southeast side of the building above storm sewer(s) and the former TCE storage tank area (Area 1). Reference point is well 10-S.
- 8 locations in the pit/trench area, primarily at pits 3 and 6 (Area 2). Reference point is well 8-S. Trench locations to be determined relative to well 8-S, and well 8S will also be used for identification of the sample locations.
- 4 locations near well 9-S and the existing TCE tank (Area 3). Reference point is west edge of TCE tank.

The reference points given above will be used for locating the sampling locations. Descriptions of sampling locations are given in more detail in Table 4-1. Note that 13 pore gas and 7 headspace samples will be analyzed. The reason for this proportion is that the majority of samples will be collected from Area 2 (pit/trench area) where only pore gas sampling is feasible. In order for the headspace technique to be effective, actual contaminated soil would have to be collected. Actual contaminated soil is beyond the range of hand augering, so pore gas analysis will have to be relied upon in this area.

If relatively high VOC concentrations are found at several points, up to four of these locations will be sampled using both sampling

TABLE 4-1

PHASE I SOIL GAS SAMPLING LOCATION AND ANALYSIS PLAN[a]

Sample Identification	Sample Location	Analysis[b] Pore Gas	Analysis[b] Headspace
SG-1	Background Bench mark and sampling locations for background samples to be established in the field	X	
SG-2	Background see Background sample 1		X
SG-3	Area 1 75 ft west, 75 ft south of well 10-S		X
SG-4	Area 1 75 ft west, 150 ft south of well 10-S	X	
SG-5	Area 1 75 ft west, 300 ft south of well 10-S	X	
SG-6	Area 1 75 ft south of well 10-S		X
SG-7	Area 1 150 ft south of well 10-S	X	
SG-8	Area 1 300 ft south of well 10-S	X	
SG-9	Area 2 40 ft from south end of trench 3	X	
SG-10	Area 2 80 ft from south end of trench 3	X	
SG-11	Area 2 100 ft from south end of trench 3	X	
SG-12	Area 2 120 ft from south end of trench 3	X	
SG-13	Area 2 140 ft from south end of trench 3	X	
SG-14	Area 2 30 ft from south end of trench 6	X	

TABLE 4-1 (Cont'd)

PHASE I SOIL GAS SAMPLING LOCATION AND ANALYSIS PLAN[a]

Sample Identification	Sample Location	Analysis[b] Pore Gas	Analysis[b] Headspace
SG-15	Area 2 60 ft from south end of trench 6	X	
SG-16	Area 2 90 ft from south end of trench 6	X	
SG-17	Area 3 15 ft west, 25 ft north of TCE tank (west edge)		X
SG-18	Area 3 15 ft west, 25 ft south of TCE tank (west edge)		X
SG-19	Area 3 25 ft east, 25 ft north of TCE tank (west edge)		X
SG-20	Area 3 25 ft east, 25 ft south of TCE tank (west edge)		X
	TOTAL NO. OF SAMPLES	13	7

a For every 5 field samples collected, 1 duplicate sample must be collected and analyzed for quality control purposes. In addition, duplicate VOA vial samples are always collected for portable GC analysis, and analyzed if uncertainty about the field GC results makes it desirable to have duplicate analysis.

b If relatively high VOC concentrations are found at several points, up to four of these locations will be sampled using both sampling techniques to allow a direct comparison of the techniques.

techniques to allow a direct comparison of the techniques. Since the intent of Phase I is to compare the two sampling methods, some modification of the sampling plan either with regard to location or methods may be necessary. Discussions of any proposed modification will involve field personnel as well as the RMT Project Manager. Any significant modification to the Phase I sampling plan will be discussed first with the COE Project Manager. The results of Phase I soil gas sampling will also be discussed with the COE Project Manager prior to starting Phase II work.

Phase II

A total of 120 sample locations will be analyzed in Phase II. The methods to be used for collecting soil gas samples will be based on the results of Phase I. The sampling locations chosen will be based on a regular grid system laid over each of the four sampling areas. Samples will be collected at equidistant intervals within each grid. The intervals will be shortened in areas where contamination is anticipated or has been observed in Phase I. In areas of no known contamination, the intervals will be spaced farther apart. Each grid will be tied to an easily identifiable point of reference (e.g., monitoring well, building corner, etc.). The anticipated grid sizes are given in Table 4-2.

Ninety samples will be taken from the areas of no known contamination, and thirty from areas of known or suspected contamination. Any modification of the Phase II sampling plan because of site conditions or unforeseen circumstances will be discussed with the COE Project Manager before the modification is implemented.

TABLE 4-2

PHASE II SOIL GAS SAMPLING LOCATION AND ANALYSIS PLAN

Area	Number of Samples [a]	Bench Mark(s)	Anticipated Grid Size
1	5	Well 10-S	(based on Phase I results)
2	49	Well 8-S	150'
3	32	Well 3-D	150'
Background	4	Established during Phase I	At corners of background area
Intensive sampling of suspected contaminated area	30	Established during sampling in Phase II	Not applicable

a For every 5 field samples collected, 1 duplicate sample must be collected and analyzed for quality control purposes. In addition, duplicate VOA vial samples are always collected for portable GC analysis, and analyzed if uncertainty about the portable GC results makes it desirable to have duplicate analysis.

4.3.3 Data Collection/Sample Summary

Soil gas sample information has been summarized in Tables 4-1 and 4-2. To the extent presently possible, these tables specify sampling locations, sampling methods, and the quantity of samples to be collected during Phases I and II.

4.3.4 Data Collection Procedures

Two methods of collecting and analyzing soil gas will be employed. Detailed procedures are discussed in Appendix B.

The first method called "pore gas," will involve driving a steel probe to a 3-foot depth. A Tedlar® bag will be used to collect a soil pore gas sample through the probe. Pore gas will be analyzed on-site for VOCs using the HNU meter, and specifically for trichloroethylene and cis/trans 1,2-dichloroethylene using the portable gas chromatograph (GC).

"Headspace analysis" will be employed as the second method. Using a hand auger, soil samples will be collected in Ball jars from a depth of 3 feet for VOC analysis, and in 40-ml VOA vials for portable GC analysis. Headspace analysis will then be performed on-site using the HNU meter and portable GC. Ball jars and VOA vials will be inverted during equilibration.

During Phase I, in accordance with Table 4-1, both soil gas monitoring techniques will be used. If relatively high VOC concentrations are found at several points, up to four of these locations will be sampled using both sampling techniques to allow a direct comparison of the techniques. In some areas, such as in Area 2 where drums were

- The depth at which the hole diameter changes
- The depth of the static water level and date of measurement
- Total depth of completed well
- Depth of any grouting or sealing
- Nominal hole diameters
- Amount of cement used for grouting or sealing
- Depth and type of well casing
- Description (to include length, location, diameter, slot sizes, material, and manufacturer) of well screen(s)
- Any sealing off of water-bearing strata
- Static water level upon completion of the well and after development
- Drilling date or dates
- Other construction details of the monitoring well, including grain size and source of well filter pack material, and location of all seals and casing joints

Well Development

Within two weeks after each well has been constructed, but no sooner than 48 hours after grouting is completed, RMT staff will direct a program for the development of the well without the use of dispersing agents, acids, or explosives. The objectives of well development are as follows:

- Assure that ground water enters the well screen freely, thus yielding a representative ground water sample and an accurate water level measurement.
- Remove all water or other drilling fluid that may have been introduced during drilling and well installation.
- Remove very fine-grained sediment in the filter pack and nearby formation so that ground water samples are not highly turbid and so that silting of the well does not occur.

Development will consist of surging and bailing until little or no sediment enters the well. This will continue for at least two hours. At the end of that time, an additional 5 well volumes of water will be pumped or bailed from the well. If the water is still cloudy or sediment or drilling fluid is still entering the well, then surging and bailing will continue for another hour or until all sediment is removed from the well. The bedrock well will be pumped until all drilling fluid and/or water is removed from the well and the water is clear. Temperature, pH, and specific conductance will be monitored periodically throughout development.

If the addition of water is required to facilitate surging and bailing, only formation water from that well will be used. If this is not practical due to tightness of the formation, then only bailing will be done. In all cases, the utmost care will be taken not to collapse well screens during development activities. At least as much water as the quantity introduced during drilling will be removed from each well. After final development of the well, RMT staff will collect approximately one (1) liter of water from the well in a clear glass jar, label and photograph it with a 35 mm color slide, and submit the slide as part of the final well log. The photograph will be suitably back-lit to show the clarity of the water. The nephelometric turbidity of the water will be determined in accordance with ASTM D 1889 and shown on the final well construction log.

Survey

Coordinates and elevations shall be established for each monitoring well. The coordinates will be to the closest 1.0 foot and referenced to the State Plane Coordinate System. If the State Plane Coordinate System is not readily available, an existing local grid system will be used. A ground elevation to the closest 0.01 foot and an elevation for the top of the casing to the closet 0.01 foot will be obtained at each well. These elevations will be referenced to the National Geodetic Vertical Datum of 1929. The same bench marks will be used as those used in previous surveys of monitoring wells at the facility. The location of the wells shall be plotted on the site map. A tabulated list of the monitoring wells and monuments, copies of all field books, and all computation sheets will be prepared and submitted to the COE Project Manager. The tabulation will consist of the designated number of the well or monument, the X and Y coordinates, and all the required elevations. These items will be submitted to the Omaha District no later than the draft RI Addendum Report.

4.4.4 Data Collection/Sample Summary

Soil samples will be taken at 5-foot intervals or at changes in lithology in the deepest boring at seven well locations as shown in Table 4-3. All samples will be visually classified by ASTM D 2488, and at least three samples from each location will undergo analyses at the RMT Soils Laboratory. The geotechnical testing will consist of the following tests as applicable:

- 27 Grain-size distributions by ASTM D 421 and ASTM D 422

- 10 Atterberg limits by ASTM D 4318
- 27 Moisture contents by ASTM D 2216

A round of ground water sampling will be completed following the installation of the monitoring wells. This round of sampling will include both the new monitoring wells (16) and the existing wells (34). Samples will be shipped to the WES for analysis. Two storm sewer outfalls and the two new on-site production wells will also be sampled if possible. Storm sewer outfalls will be located in consultation with the NIROP facility representative, as discussed in Section 4.4.1. A ground water sample summary is presented in Table 4-4. Parameters for analysis by the WES are shown in Table 4-5.

Ground water sample collection procedures used by RMT have been developed based on USEPA methods (Gibb, et al., 1981; Scalf, et al., 1981; USEPA 1976a; USEPA 1976b; USEPA 1982; USEPA 1977).

4.4.5 Data Collection Procedures

Soil Samples

During drilling, the RMT hydrogeologist and drill crew will collect soil samples for logging and geotechnical analysis. Soil samples will be taken at a minimum of five-foot intervals, or where a change in materials occurs, to the end of the boring. Where well nests are installed, samples will be taken only in the deepest well in the nest. The deepest well in the nest will be drilled first where possible. Additional samples will be taken as necessary to characterize the geology at each well location.

TABLE 4-4

GROUND WATER SAMPLE SUMMARY[a]

Parameters	Field Samples	QC Duplicates	QC Blanks		QA Duplicates	QA Blanks	
			Trip Blanks	Field Blanks[c]		Trip Blanks	Field Blanks[c]
Volatile Organics	52	5	10[b]	5	5	1	5
Dissolved Metals	52	5	--	5	5	--	5

a Field samples and QC samples will be analyzed by COE-WES using bottles and coolers supplied by RMT. QA samples will be analyzed by COE-MRD using bottles and coolers supplied by RMT. Bottles supplied by RMT will be ICHEM pre-cleaned bottles or the equivalent.

b Trip blanks for volatiles only, assuming one trip per day for ten days.

c Sampler rinsate.

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TABLE 4-5

CHEMICAL PARAMETERS FOR ANALYSIS IN GROUND WATER SAMPLES

Volatile Organic Compounds[1]	Metals[2] (Dissolved)
Vinyl Chloride	Barium
Methylene Chloride	Selenium
Trichlorofluoromethane	Manganese
1,1 Dichloroethylene	Zinc
1,1 Dichloroethane	
Cis and Trans 1,2 Dichloroethylene	
Chloroform	
1,1,1 Trichloroethane	
Trichloroethylene	
Benzene	
Tetrachloroethylene	
Toluene	
Ethyl Benzene	
Xylene	

1 VOCs selected for analyses were based on the list of VOCs detected to date as reported in the RI Report (RMT, 1987b); recommendations made in the RI Report also included xylene due to its detection in pits/trenches; and vinyl chloride which was added to the list due to being a breakdown product of TCE.

2 Metals selected for analyses were based on Table 7-2 of the RI Report (RMT, 1987b). Parameters selected are those metals that exhibited a determinable off-site health risk. Selenium was added due to its detection at well 9-S at a concentration exceeding its MCL.

NOTE: Analysis methods will follow EPA SW-846 methods, 3rd edition, November 1986.

Sampling will be done with a split-spoon sampler (ASTM D 1586-84) or thin-walled sampler (ASTM D 1587-83) using standard sampling techniques.

Ground Water Level Measurement

The measurement of ground water levels in wells will be conducted in conjunction with ground water sampling. The data from such measurements are needed to determine well purging requirements, establish ground water gradients, and ultimately, to determine the direction of ground water flow.

All ground water level measurements will be made using the established reference point on the well casing. This reference point will be documented in field records.

A battery-operated water level indicator will be the primary device for water level measurements. The indicator is a self-contained transistorized instrument equipped with a cable and sensor which activates a buzzer and a light when it comes in contact with the water. The depth to water is read from permanent one-foot increment markings on the cable. A one-foot engineer's rule is then used to measure the depth to the nearest 0.01 foot.

In case of instrument failure, depth to ground water will be measured by a popper tape which is a bell- or cup-shaped weight attached to a measuring tape. When lowered into the well, a "plopping" or "popping" sound is made when the weight strikes the surface of the water. An accurate reading can be determined by lifting and lowering the weight in short strokes, and reading the tape when the weight barely

strikes the water. Depth to water will be recorded to the nearest 0.01 foot. The water level indicator and/or popper will be decontaminated between each well according to the decontamination procedures discussed in Section 4.2. The water level indicator will be calibrated against the popper tape.

Well Purging

Well purging will be performed to remove stagnant water from the well casing prior to collecting a sample, because it is not representative of actual ground water chemistry. The purging will draw in water from the surrounding area which is more representative of the water quality.

Well purging will be accomplished by removing either 5 well volumes or until stable pH, conductivity, and temperature readings are reached. The well volumes will be calculated by subtracting the depth to water from the depth of well and multiplying the difference by the cross-sectional area of the well bore, with appropriate conversion factors. In the field, RMT personnel use pre-calculated conversion formulas to determine the number of gallons that must be removed to reach the five well volumes criterion. The well data needed to determine the purge volumes of existing wells are shown in Table 4-6. The data in this table will be supplemented with information on newly constructed wells as it becomes available. Specific conductance, pH, and temperature measurements will be taken after each well volume is removed until three successive readings yield equivalent values within the following ranges: specific conductance (temperature corrected): ± 10 umhos/cm; pH: ± 0.1 pH unit; temperature: ± 0.5°C. Methods for determining pH and conductivity are detailed in later sections of this plan.

TABLE 4-6

MONITORING WELL HISTORIC CONSTRUCTION DATA

WELL NUMBER	TOP OF CASING ELEVATION (feet above MSL)	WELL DEPTH * (ft)	NOMINAL WELL DIAMETER
1-S	837.14	34.98	2"
1-D	836.75	115.54	2"
1-PC	837.63	208.66	4"
2-S	836.07	34.65	2"
2-D	836.04	112.3	2"
2-PC	838.05	178.28	4"
3-S	836.75	34.75	2"
3-D	837.48	80.87	2"
3-PC	839.21	159.4	4"
4-S	837.45	34.85	2"
4-D	834.79	120.93	2"
4-PC	834.75	182.33	4"
5-S	835.06	34.71	2"
5-D	836.00	117.1	2"
6-S	835.73	34.65	2"
6-D	835.69	129.95	2"
7-S	835.97	29.94	2"
7-D	835.63	118	4"
8-S	835.76	29.9	2"
8-D	834.02	128	4"
9-S	836.68	29.3	2"
9-D	834.30	124	4"
10-S	835.89	31.3	2"
11-S	835.89	31.3	2"
12-S	838.51	35.9	2"
13-S	834.59	33.9	2"
14-S	835.99	34.4	2"
15-S	834.83	34.5	2"
16-S	837.26	35.8	2"
17-S	835.75	39	2"
18-S	834.08	40.75	2"
19-S	834.56	45	2"
20-S	837.62	35.6	2"
FMC-33	837.05	73.0	4"

* From top of casing as installed

Purging will be accomplished by one of two methods - bailing or pumping. For small-diameter wells, a bailer will be used. A submersible pump can be used with 4-inch diameter and larger wells. A calibrated bucket is used to measure the volumes of water removed. Purged water will be discharged to the ground.

Sampling of Wells

It is important not to contaminate or alter the sample during collection. The sampling device should be clean and constructed of a material which is compatible with the well construction material and the laboratory testing program (i.e., organics, metals, etc.). The most chemically inert material available for sampling organics is Teflon(TM). RMT will use Teflon(TM) bailers when collecting organic samples. Teflon(TM) is also an excellent choice for metals and cyanide analysis. However, since the portion of the wells that is normally in contact with the water is constructed of stainless steel, bailers constructed of stainless steel may also be used. Nylon rope attached to ten-foot-long Teflon™-coated stainless steel cable leaders is used to raise and lower the bailers. New rope will be used for each well.

To ensure that samples are not contaminated by field techniques, the following steps are also taken:

- Bailers and stainless steel leaders will be cleaned between wells following decontamination procedures discussed in Section 4.2.
- A new, clean plastic dropcloth will be used at each well to protect equipment from contact with soil around the well.
- A field blank sample consisting of distilled water which has been subjected to the same field methods (sampler rinsate) as the samples (discussed elsewhere) will be used.

Filtering

Filtering in the field will be required for some parameters to prevent changes due to precipitation or biological activity and to collect a more representative sample of the water moving through the ground. In many cases, there may be a small amount of silt or clay in the water after purging the well. This sediment is not representative of constituent transport in ground water flow systems in porous media. The filtering is performed in the field because even short delays may drastically change the water chemistry. The field filtering apparatus consists of a battery-powered vacuum pump and membrane filters with a 0.45 micron opening.

Field-filtered samples will be required for the dissolved metals listed in Table 4-5. Filtering is not appropriate for trace organics because of the possible loss through adsorption on the filter or volatilization.

Measurement of pH

The pH measurements will be made electrometrically using a combination electrode and portable pH meter. The measurements will be recorded to the nearest 0.1 pH unit. Portable meters with provisions for temperature compensation will be used. Combination electrodes will be used in conjunction with the meters. Reference will be made to the instrument operator's manual for pH measurement procedures and instrument operation instructions.

The meter will be checked before each field trip and daily while in the field for any mechanical or electrical failures, weak batteries, and cracked or fouled electrodes. The meter and electrode also will be checked against standard buffer solutions of known pH values (e.g., 4, 7, and 10). While in the field, the meter will be checked several times per day with fresh buffers. In case of an apparent discrepancy in a pH measurement, the electrode will be checked with pH 7.0 buffer and rebuffered to the closest reference buffer. The sample will then be re-analyzed. Duplicate analyses must agree within 0.1 pH units. The buffer solution containers will be refilled each day from fresh stock solution.

Decontamination of the pH probe and cup will be done by rinsing each three times with distilled water. Additionally, the cup will be rinsed three times with the next sample prior to obtaining a reading.

A log book will be maintained and will contain the property number of each pH meter. All calibrations and repairs will be noted in the log book indicating the date, the repairs made, the person making the repairs, calibration records, and the time used in the field for each meter.

Measurement of Conductivity

A portable specific conductance meter, wheatstone bridge type or equivalent, will be used.

Each meter will be checked before each field trip and daily while in the field. Batteries will be checked, and conductivity cells will be cleaned and checked against known standards.

Reference will be made to the instrument instruction manual for temperature - conductance calculations. Duplicate field analyses should agree within ± 15 percent.

A log book will be maintained with all specific conductance meter property numbers. All repairs, calibrations, and field time usage will be noted. The log book will include dates, repairs made, and the name of the person making the repairs.

Results will be expressed in micromhos/centimeter (umhos/cm) corrected to 25°C, and reported to the nearest ten units.

Measurement of Temperature

All field thermometers will be initially calibrated against a National Bureau of Standards (NBS) certified thermometer. Field readings will be recorded to the nearest 1°C.

Each field thermometer will be inspected before each field trip to see that it is not cracked and that there are no air spaces or bubbles in the mercury. A cross-check with a calibrated NBS certified thermometer will be made semi-annually. Before using a thermometer in the field, field personnel will make a visual observation to ensure that it has not been damaged. Cross-checks and duplicate field analysis will agree to within ± 0.5°C.

A log book will be maintained with each thermometer property number recorded. All calibration information, individuals making the calibrations, and dates will be recorded. Each field calibration will be noted in the field notebooks indicating the temperature readings observed.

In-Situ Permeability Measurements

In-situ hydraulic conductivity tests will be completed by RMT staff by rising-head, single-well, response (bail-down) tests. A predetermined volume of water will be removed from the well, and periodic water level measurements will be made as the water returns to its pre-bailing level. The determination of hydraulic conductivity from these measurements will be based on the standard methods described by Hvorslev (1951); Cooper, Bredehoeft and Papadopoulos (1967); or Bouwer and Rice (1976). These tests will be performed on the following ten (10) wells: 23-S, 22-S, 25-S, 24-S, 15-S, 10-D, 1-I, 13-D, 4-I, and 5-PC.

4.4.6 Sample Containers, Preservatives, and Holding Times

Table 4-7 summarizes the requirements for sample containers, sample preservatives, and holding times for the parameters to be analyzed in ground water during this sampling round. COE sample handling protocol will be followed (U.S. Army Corps of Engineers, 1986). Sample containers for field samples, QC duplicates, and QC field blanks that will be analyzed by the WES will be supplied by RMT. Sample containers for QA duplicates and QA field blanks that will be analyzed by the Army Corps of Engineers, Missouri River Division (MRD-ED-L) will also be supplied by RMT.

Bottles supplied by RMT will be ICHEM pre-cleaned bottles or the equivalent. RMT sample bottle labels will contain the following information:

TABLE 4-7

GROUND WATER SAMPLE CONTAINER, PRESERVATIVE, AND HOLDING TIME SUMMARY

PARAMETER	CONTAINERS PER MONITORING WELL*	PRESERVATIVE	FIELD FILTERING**	HOLDING TIME
VOCs (EPA 8240)	Two 40-ml Glass vials with Teflon®-lined septum	4 drops concentrated HCl, Cool, 4°C	No	14 Days
Vinyl Chloride				
Methylene Chloride				
Trichlorofluoromethane				
1,1 Dichloroethylene				
1,1 Dichloroethane				
Cis and Trans 1,2 Dichloroethylene				
Chloroform				
1,1,1 Trichloroethane				
Trichloroethylene				
Benzene				
Tetrachloroethylene				
Toluene				
Ethyl Benzene				
Xylene				
METALS (Dissolved)				
Barium	One 250-ml polyethylene (One 500-ml polyethylene) with Teflon®-lined septum	Nitric acid to pH less than 2	Yes	6 Months
Selenium				
Manganese				
Zinc				

NOTE: Analysis methods will follow EPA SW-846, 3rd edition, November 1986.

* Bottle requirements shown are those supplied by RMT for analysis by WES. Bottles in parentheses are those supplied by RMT for analysis by MRD-ED-L.

** Using 0.45-micron filter.

1332.22 101:RTA:frid0911T5

- RMT's office address
- Client's name
- Job number
- Sample location, type, and date
- Sampler name
- Type of preservative
- Laboratory identification number

4.4.7 Sample Transportation

Ground water samples will be shipped by overnight service to the Corps of Engineers Waterways Experiment Station (WES) in coolers provided by RMT (no Saturday or Sunday deliveries). The primary laboratory shipping address is as follows:

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halsferry Road
Vicksburg, MS 39180
Attn: Ann Strong
(601) 634-2726

Samples for external quality assurance will be sent to the following address:

U.S. Army Engineer Division, Missouri River
Attn: MRDED-L (Joe Solsky)
427 S. 18th Street
Omaha, NE 68102

Completed chain-of-custody forms will be placed in a plastic bag, sealed, and taped to the inside cover of the cooler. After icing the samples, the coolers will be sealed, dated, and shipped to the appropriate laboratories using an overnight delivery service. The labs will be notified of sample shipment at least one week in advance. Sample packaging and shipment will follow COE sample handling protocol (U.S. Army Corps of Engineers, 1986).

4.4.8 Sample Chain-of-Custody

The possession of ground water samples must be traceable from the time of collection through the use of chain-of-custody procedures. Specific chain-of-custody forms must accompany all sample shipping containers to document the transfer of the shipping containers and samples from the field collection to the laboratory receiving the samples for analysis. The procedures to be implemented are as follows:

- Preparation of pre-labeled sample containers by RMT, with chain-of-custody seals on shipping containers.
- Proper identification and labeling of each sample in the field.
- Completion of chain-of-custody forms in the field, indicating sample identification, containers filled, sampling date, sampling time, and sample collector.
- Repacking of shipping container with samples, chain-of-custody forms, and ice packs. Each set of containers to be shipped together is assigned a chain-of-custody form, which travels with the sample container.
- Sealing and shipping of containers to the appropriate laboratory. Common carriers or intermediate individuals shall be identified on the chain-of-custody form, and copies of all bills-of-lading will be retained.
- Receiving and checking of shipping containers in the laboratory for broken seals or damaged sample containers. If no problems are noted, samples are logged into the laboratory and the chain-of-custody form is completed.
- Inclusion of copies of the chain-of-custody form with the analytical data.
- Unused sample containers are returned to RMT with the chain-of-custody forms.

An example chain-of-custody form is shown on Figure 4-6. If an error is discovered on a sample chain-of-custody form, the person who made the error should correct it when possible. Corrections or insertions are made by inserting the correction needed. The date and the

RMT, INC.

CHAIN-OF-CUSTODY RECORD

PROJECT NO.	PROJECT NAME
SAMPLERS: (Signature)	

RMT NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NUMBER OF CONTAINERS							REMARKS

Relinquished by: (Signature) 1	Date/Time	Received by: (Signature) 2	Relinquished by: (Signature) 3	Date/Time	Received by: (Signature) 4
Relinquished by: (Signature) 5	Date/Time	Received by: (Signature) 6	Relinquished by: (Signature) 7	Date/Time	Received by: (Signature) 8
Relinquished by: (Signature) 9	Date/Time	Received by: (Signature) 10	Relinquished by: (Signature) 11	Date/Time	Received by: (Signature) 12
Relinquished by: (Signature) 13	Date/Time	Received for Laboratory by: (Signature) 14	Date/Time	Remarks	

FIGURE 4-6

correcting person's initials will be written beside the correction. This procedure applies to words or figures inserted or added to a previously recorded statement.

If a chain-of-custody form is lost in shipment, a written statement will be prepared by the RMT field technician detailing the pertinent information, including how the sample was collected. The statement should include information such as field logbook entries regarding the sample. Copies of the statement will be distributed to the COE's COR and put into the RMT project files.

4.5 Pumping/Time Series and Bench-Scale Test Procedures

4.5.1 Purpose and Scope

This section will define the procedures and quality control measures applicable to aquifer pumping and testing, as well as subsequent bench-scale test procedures to support development of remedial alternatives. Specific objectives of this portion of the field investigation are the following:

VOC Source Assessment - Determine if the source of VOCs observed in well 9-S originates from the NIROP facilities, or if an off-site, upgradient source is responsible.

Aquifer Testing - Obtain information on aquifer properties (chemical and physical) that will affect the selection of remedial alternatives (i.e., extraction and treatment).

Bench-Scale Testing - Conduct bench-scale evaluations of various remedial alternatives, simulating field conditions and the physical operation of remedial equipment.

4.5.2 General Approach

In order to meet the objectives of Section 4.5.1, standard geotechnical investigation techniques will be employed.

For the VOC source determination, strategically located small-diameter observation wells will be sampled and the results compared to assess any off-site upgradient source. The presence of TCE in wells upgradient of the NIROP facility on Burlington Northern Railroad (BNR) property would indicate a contributing, off-site source. If this comparison is inconclusive, a large-diameter production well will be installed and pumped. Movement of ground water past the smaller observation wells may also move any contaminated water into the observation wells where it would be detected by sampling.

Ground water extraction and treatment may be a practical remediation measure. In order to design a well system and subsequent treatment system, aquifer hydraulic properties would have to be characterized. Chemical characteristics of extracted water are also important in selecting a remediation technique. Hydraulic properties of the unconsolidated aquifer will be evaluated using standard aquifer testing ("pump test") procedures (USDI 1971, 1981; Kruseman 1979). Chemical characteristics of extracted water from the pump test will be analyzed, particularly those constituents that cause scaling and blinding of treatment equipment. Field bench-scale testing will be performed to simulate actual conditions of the extraction and treatment process.

4.5.3 VOC Source Assessment

As stated in Section 4.5.1, the purpose of this task is to determine if the source of VOCs observed in well 9-S originates from the NIROP facilities, or if an off-site, upgradient source is responsible.

Monitoring wells 22-S and 23-S, installed on BNR property as described in Section 4.4 and shown on Figure 4-1, will be sampled and analyzed for the list of VOCs in Table 4-8. Samples will be collected as soon as possible after installation and development in order to expedite analysis. Four samples will be collected in total: 1 sample each from wells 22-S and 23-S, plus 1 duplicate and 1 blank. Sample collection, preservation, transportation, and lab analysis procedures will conform to Section 4.4, except that samples will be analyzed at RMT instead of the WES.

If the results of these analyses do not indicate an off-site source, or are inconclusive, a 6-inch diameter pumping well (AT-1) will be installed as detailed on Figure 4-7 at the location shown on Figure 4-1. Well AT-1 will be drilled and constructed as described in Section 4.4 for observation wells. This pumping well will extract 50-100 gpm of water continuously over a 5-day pumping period. A line tap will be installed in the discharge line to facilitate sample collection.

Water from surrounding wells 9-S, 5-I, 14-D, and 22-S will also be sampled during the pumping of well AT-1. Samples collected from these wells and well AT-1 will be analyzed for trichloroethylene (TCE) concentration by RMT Laboratories, and the data will be evaluated using time-series analysis.

TABLE 4-8

CHEMICAL PARAMETERS TO BE ANALYZED IN
GROUND WATER SAMPLES FROM WELLS 22-S AND 23-S
AS PART OF THE VOC SOURCE ASSESSMENT

Parameter
Vinyl Chloride
Methylene Chloride
Trichlorofluoromethane
1,1 Dichloroethylene
1,1 Dichloroethane
Cis and Trans 1,2 Dichloroethylene
Chloroform
1,1,1 Trichloroethane
Trichloroethylene
Benzene
Tetrachloroethylene
Toluene
Ethyl Benzene
Xylene

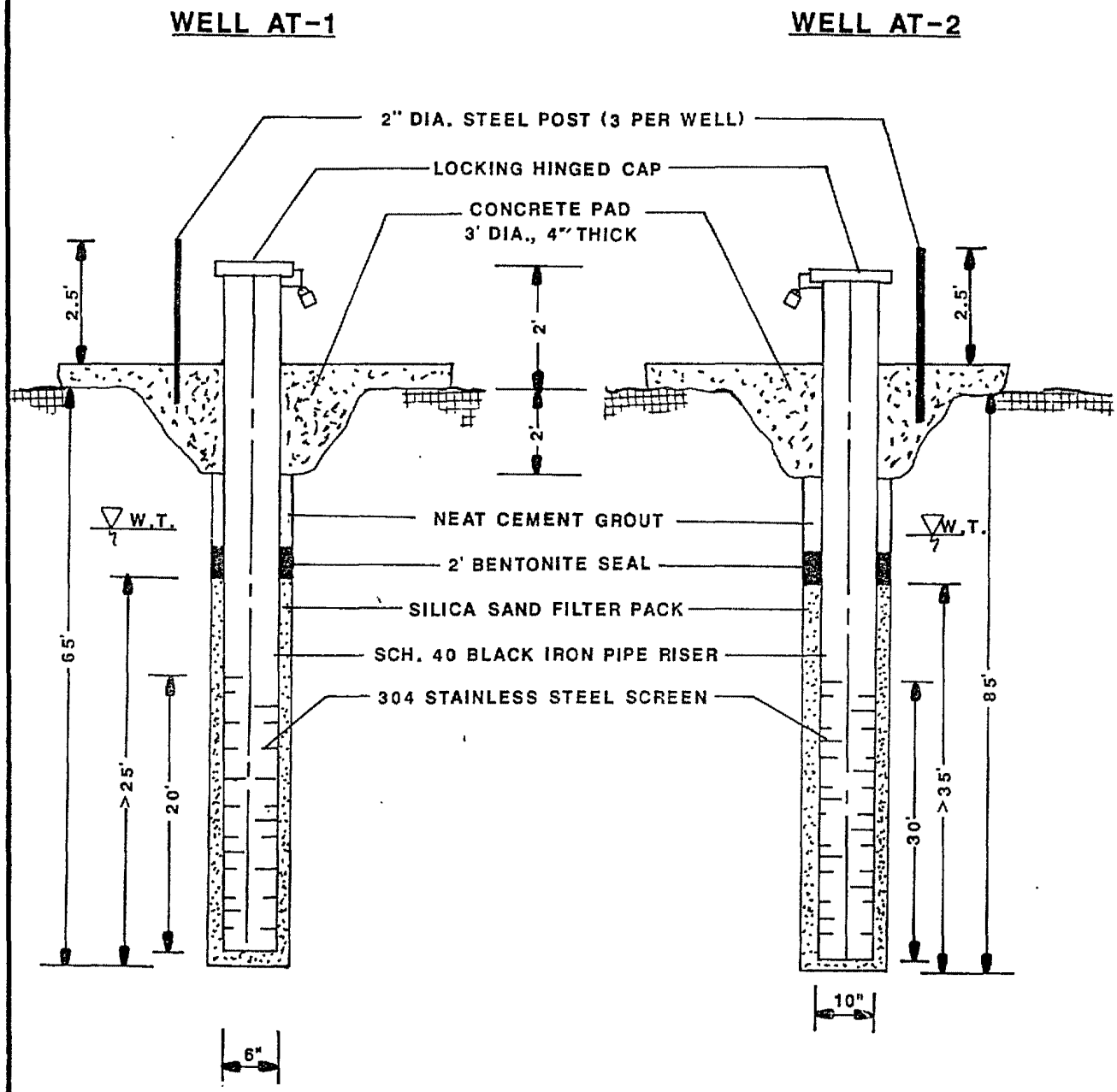


FIGURE 4-7
PRODUCTION WELL DETAILS

(NOT TO SCALE)

RMT	DWN. BY: MCS
	DATE: 9/87
	PROJ #: 1332

Samples will be collected from production well AT-1 and monitoring wells 9-S, 5-I, 14-D, and 22-S according to the schedule in Table 4-9. Table 4-9 also identifies field blanks, trip blanks, and duplicate sample collection for quality control. A total of 34 samples will be analyzed for TCE by RMT Laboratories. Water sample collection and sample handling procedures for these samples will also conform to Section 4.4.

4.5.4 Aquifer Testing

As stated in Section 4.5.1, the purpose of this task is to characterize the chemical and hydraulic properties of the unconfined aquifer for consideration of subsequent remedial alternatives. Hydraulic properties that will be estimated are transmissivity, storativity, and boundary conditions. This information will be useful in designing an aquifer pumping system proposed as a remedial alternative. These aquifer properties will be estimated using data from a 5-day pumping test (3 days continuous pumping followed by a 2-day recovery period). The test will be conducted according to standard industry practice (USDI, 1971 and 1981), and will be supervised 24 hours per day by RMT personnel.

Chemical properties that will be analyzed include alkalinity, calcium, pH, and iron. Both total and dissolved forms of iron will be analyzed. Analysis of these parameters will be made from the discharge water of the pumped well to evaluate those characteristics which might affect the physical operation of remedial equipment (i.e., scaling or blinding).

TABLE 4-9

SAMPLE COLLECTION SCHEDULE FOR THE TCE
TIME-SERIES ANALYSIS STUDY NEAR WELL 9-S

	Well				
Day	AT-1	9-S	5-I	14-D	22-S
Day 1 (Start of Pumping)	X	X*	X	X	X
Day 2	X	X	X	X	X
Day 3	X	X*	X	X	X
Day 4	X	X	X	X	X
Day 5	X	X*	X	X	X

* In addition to the field sample, a field blank, trip blank, and duplicate sample will be generated and analyzed by RMT Laboratories.

Pumping Well Design

A 10-inch pumping well will be installed near wells 24-S and 6-D, identified as well AT-2 on Figure 4-1. The design of this well will be such that it could be converted from a test well to part of a ground water remediation system. Approximate pumping rate and optimum well diameter for this test were determined previously by RMT (RMT, 1987d). Well construction details are shown on Figure 4-7. The well and pump will be designed to continuously deliver 150-200 gpm. It will be installed to a total depth of 85 feet.

A 30-foot 304 stainless steel screen will be installed over the 55- to 85-foot interval below ground surface. Screen slot size will be determined on-site by the drilling subcontractor and will be based primarily on the type of material encountered. The well riser will be constructed from schedule 40 black iron pipe. Filter pack material size will reflect the screen slot size selected by the subcontractor. With the previous exceptions, all drilling and construction methods will conform to Section 4.4 for monitoring wells.

Monitoring Wells

Monitoring wells used for water level monitoring during the pumping test will consist of well 24-S and existing wells 4-D, 6-D, 5-S, 6-S, 10-S, 11-S, 17-S, and 7-D (Figure 4-1). Well 24-S will have been constructed and developed in accordance with Section 4.4. The response of each observation well will be tested prior to the pump test by removing a slug of ground water and monitoring the response (USDI, 1971). The horizontal distance between each of the observation wells

and the pumping well AT-2 will be measured with a steel tape. The inside diameter of each observation well, total depth, and screened interval will also be recorded. At least one monitoring well will be located within 50 feet of well AT-2 to increase the pump test accuracy.

Pumped-Well Discharge

Discharge from the pumping well will be measured and periodically recorded and will be valve-controlled to maintain a constant discharge flow rate. The discharge rate will require frequent monitoring and may require periodic adjustment. At no time will the discharge rate be allowed to vary by more than 10 percent once the optimum pump discharge rate is set and the pump test started. The discharge rate will be recorded every 15 minutes for the first 6 hours, every 30 minutes for the next 6-hour period, and once per hour thereafter for the duration of the test.

Pumped water will be discharged to the NIROP sanitary sewer system. The Metropolitan Waste Control Commission (MWCC) will be notified by telephone at least 48 hours prior to the start of discharge from the pumping test. Prior written approval from the MWCC will be obtained to discharge the pumping test water.

Water Level Measurements

Frequent water level measurements will be required from each of the monitoring wells as well as the pumped well. Monitoring well measurements will conform to Section 4.4 procedures for monitoring wells. Water level measurement at the pumped well will be by a pneumatic

pressure sensor. The pneumatic sensing system will be installed and tested prior to starting the pumping test by the drilling subcontractor.

The frequency of measurement at each well will be as shown on the RMT field pumping test form (Figure 4-8). This form will be used to record all field data during the test. The frequency of measurement during the early part of the aquifer test may be reduced for those wells distant to the pumped well, where rapid drawdown response is not expected. Manual water level measurements will be supplemented by automatic water level recorders as necessary. Following the first 2-3 hour period, it will not be necessary to make simultaneous measurements from each well, but measurements should be made at approximately the same time so that nearly uniform plots of drawdown can be prepared in later data reduction tasks. All watches will be synchronized prior to starting the pumping test, and a provision will be made to notify each of the observers at the instant measurements should begin.

Data Reduction

Field data will be analyzed using standard procedures including those employed by the U.S. Geological Survey (USDI, 1971). Other standard references will also be utilized (Kruseman, 1979; USDI, 1981). The data reduction process will yield estimates of aquifer transmissivity, storativity, and a definition of boundary conditions.

4.5.5 Bench-Scale Testing

During the pumping test at AT-2, the chemical characteristics of the ground water will be evaluated for potential effects on the physical operation of air stripping and carbon adsorption equipment. Either of

RMT, INC. AQUIFER TEST RECORD

Project_____

Monitoring/Production Well #_____ r = _____ft H = _____ft

DATE	ELAPSED TIME, t (min)	TIME (hr:min)	DEPTH TO WATER (ft)	DRAW-DOWN, s (ft)	s^2 (ft)	$s^2/2H$ (ft)	s' (ft)	r^2/t (ft^2/min)	REMARKS
	1.0								
	1.2								
	1.5								
	2.0								
	2.5								
	3.0								
	4.0								
	5.0								
	6.0								
	7.0								
	8.0								
	10								
	12								
	15								
	20								
	25								
	30								
	40								
	50								
	60								
	70								
	80								
	100								
	120								
	150								
	200								
	250								
	300								
	400								
	500								
	600								
	700								
	800								
	1000								
	1200								
	1500								
	2000								
	2500								
	3000								
	4000								
	5000								
	6000								
	7000								
	8000								
	10000								

FIGURE 4-8
RMT AQUIFER TEST RECORD

these remedial technologies are being evaluated for use in remediation of the ground water. The bench-scale test results will provide information to foresee potential problems if implementation is pursued.

Ground water at the NIROP site may be in a chemically reduced condition. If so, the water may contain enough dissolved iron to cause problems when it is brought to the surface. Within a carbon adsorption treatment system or in an air stripping tower, the ground water will absorb oxygen from the atmosphere. The dissolved iron could then oxidize and precipitate as iron hydroxide, causing fouling of the equipment.

To test the potential for iron hydroxide precipitation, 5 samples of pumped water will be collected from well AT-2 and analyzed before and after equilibration with the atmosphere. To speed up equilibration with the atmosphere, air will be bubbled through the sample. Dissolved and total iron, suspended solids, and pH will be measured by RMT Laboratories. While aerating, pH should be measured frequently. The air bubbling simulates the close air-water contact occurring during remediation using air stripping.

Similarly, the precipitation of calcium carbonate from ground water may foul remediation equipment. This can occur because the ground water may be supersaturated with carbon dioxide with respect to the atmosphere. As the water loses carbon dioxide to the atmosphere, the pH rises and calcium carbonate may precipitate. To test for potential problems of this nature, the 5 pumped water samples from well AT-2 discussed above will also be analyzed by RMT Laboratories for pH, alkalinity, and calcium concentrations. In this way, a chemical

equilibrium calculation can be made to determine the amount of calcium carbonate which could precipitate.

As in the iron test, ground water samples will be equilibrated with the atmosphere by bubbling air through the sample. The filtered and total fractions will be analyzed for calcium. This test may verify the calculated amount of calcium carbonate precipitation. However, the test may result in an underestimate because of the difficulty caused by unpredictable calcium carbonate precipitation kinetics and by specific effects of the surface configuration of remedial equipment (as in a carbon adsorption system). Therefore, the calculation of the amount of potential precipitation may be a better value to use in projecting fouling problems.

Sample collection, filtration, preservation, transportation, and lab analysis procedures will conform to Section 4.4. Sample analysis will be performed by RMT Laboratories.

5. FIELD QUALITY CONTROL PLAN

5.1 Introduction

The overall objective of the Field Quality Control Plan is to develop and implement procedures for field sampling, chain-of-custody, and reporting that will provide legally defensible results and provide representative samples. Specific procedures to be used for sampling, chain-of-custody, instrument calibration, reporting, internal quality control, and preventive maintenance are described in the following sections.

5.2 Organization/Qualifications

Project organization and qualifications of key personnel are outlined in Section 3.

5.3 Quality Control Responsibilities

Quality control and management responsibilities are discussed in Section 3.

5.4 Sampling Procedures

The quality of soil gas and ground water samples must be reliable. It is essential that proper quality control measures be utilized during sampling.

During sampling, several activities require attention to proper quality control measures, including the following:

- Sample collection
- Sample handling

- Sample preservation
- Field measurements
- Verification of quality assurance/quality control

Measures to ensure proper QA/QC during sample collection are discussed in Section 4.3.4 (Soil Gas) and Section 4.4.5 (Ground Water). QA/QC measures regarding sample handling and preservation for ground water samples are discussed in Sections 4.4.6 through 4.4.8. Verification of quality assurance/quality control will be accomplished throughout the field activities by completion of the A-E DQCR, field logs, and chain-of-custody procedures.

5.5 Field Analytical Methods and Procedures

Proper field analytical methods and procedures will be adhered to at all times during field activities at the NIROP. The following steps are taken to ensure that all data gathered in the field are both valid and unbiased:

- Field technicians are thoroughly trained in the use of each piece of equipment.
- Operation manuals accompany each piece of equipment in the field.
- Preventive maintenance programs are carried out on a scheduled basis.
- Spare key components will be taken into the field in case of equipment failure or damage.
- Instruments will be calibrated on a daily basis and rechecked at various times daily.
- All readings and calibrations will be documented in the A-E DQCR.

- Daily QC checks of field notes will be performed.
- All A-E DQCRs will be reviewed upon completion of field activities.

Specific procedures for each field instrument to be used at the NIROP have been discussed in Section 4.3.4 and 4.4.5.

5.6 Analytical/Statistical/Control Parameters

5.6.1 Accuracy, Sensitivity, and Precision

The accuracy, sensitivity, and precision of the field analytical techniques (pH, temperature, and specific conductance) are dependent upon the specifications for the instruments used, as well as the QC techniques employed during their use. The following specifications have been excerpted from the instrument instruction manuals.

Orion Research Analysis pH Meter

pH range: 0 to 14 with + 0.02 pH repeatability and ± 0.05 accuracy.

pH EXP range: -1.4 to +1.4 pH about any pH value from 0 to 14, with +0.005 repeatability and ±0.01 accuracy.

mV range: ±700 MV, with ± 2.0 mV repeatability and ±5 mV accuracy.

YSI 33 S-C-T Meter

Conductivity

Range: 0-500, 0-5,000, 0-50,000 umhos/cm.

Accuracy: ±2.5% max. error at 500, 5,000, and 50,000 plus probe.

±3.0% max error at 250, 2,500, and 25,000 plus probe.

Readability: 2.5 umhos/cm on 500 umhos/cm range.
25 umhos/cm on 5,000 umhos/cm range.
250 umhos/cm on 50,000 umhos/cm range.

Temperature

Range: -2 to +50°C

Accuracy: ±0.1°C at -2°C
±0.6°C at 45°C

Readability: ±0.5°C at -2° to ±0.37°C at 45°C.

Probe

Accuracy: ±2% of reading for conductivity. Error of ±0.1°C at 0°C and ±0.3°C at 40°C.

Instrument

Range: A maximum error of ±0.1% of the reading per °C change in instrument temperature can occur.

5.6.2 Quantity and Types of Samples

Several types of ground water samples are to be collected and analyzed for the parameters listed in Section 4.4.4. The various types of samples to be collected and quantities of each are listed below.

Samples - A total of 54 primary samples representative of a portion of the ground water medium will be collected.

Duplicate Samples - Duplicate samples are samples collected simultaneously from the same source under identical conditions into separate containers. A total of 5 duplicate ground water samples will be collected. These samples represent 10 percent of the total number of primary samples and will be used for external quality control. External quality control samples will be sent to the U.S. Army Corps of Engineers Waterways Experiment Station.

Control or Background Samples - Background or control samples are taken in an area known or thought to be free from the constituents of concern. Wells considered to be background wells include the following: 12-S, 13-S, 14-S, 15-S, and 16-S.

Sample Aliquot - A sample aliquot is a portion of a sample that is representative of the entire sample. Sample aliquots will be used to determine various field parameters (e.g., pH).

Trip Blank - A trip blank is a set of sample bottles which will be filled in the laboratory directly from a deionized or distilled water source. The trip blank will accompany sample bottles to the site as well as to the laboratory.

Field Blank - A field blank is a set of sample bottles that is filled with deionized or distilled water in the field. The deionized/distilled water is handled in the same manner as the sample (e.g., if the sample is ground water that has been filtered, the deionized/distilled water will be poured into a bailer and then filtered).

5.6.3 Internal QC Checks and External QA Samples

Internal quality control checks of ground water sampling will be provided by the use of trip blanks, field blanks, duplicate samples, and background samples. Definitions and quantities of each have been provided in the previous section.

External quality assurance will be provided by the use of duplicate samples, trip blanks, and field blanks. Quality Assurance samples will be analyzed by the COE-MRD Laboratory.

5.6.4 Representative Samples

All measurements will be made so that results are representative of the media and conditions being measured. The evaluation of representativeness includes the analytical techniques, sample collection techniques, and the sampling site locations. The analytical techniques and sample collection techniques described herein have been developed to ensure representative samples. The rationale for the sampling site locations is outlined in Section 4.4.2 and is detailed in the Conceptual Workplan (RMT, 1987c).

5.6.5 Data Comparability

Data must be comparable between this sample round and previous sampling activities. The intended uses of data gathered during this sample round are discussed in Section 4.3, 4.4, and 4.5. In order to ensure data comparability, the primary laboratory services will be provided by the U.S. Army Corps of Engineers Waterways Experiment Station (WES) Laboratory. The WES has performed analytical services for the seven previous NIROP ground water sampling events. No problems with data comparability are anticipated.

5.7 Calibration Procedures and Frequency

Field instruments are calibrated on a daily basis with additional checks performed at various times during use. Calibration procedures are discussed in Section 4.3.4 and 4.4.5.

5.8 Preventive Maintenance

Field preventive maintenance will include a cursory check of instrument operation without the need of disassembly or test equipment. If any of these preliminary checks proves negative, the instrument is not functioning properly and the back-up meter will be used. Field check procedures for the various instruments are described below.

pH Meter

1. Remove electrodes (and recorder, if used). Insert ORION shorting strap (Cat. No. 040030) securely to input and reference jacks.

2. With function switch in OFF position, check that the meter needle reads exactly center scale; if not, adjust the zero adjust screw in the center of the panel for exactly center scale.

3. Make sure that the line cord is securely attached to the instrument. If batteries are being used, check their condition before plugging cord into a power outlet. Turn the function switch to BATT. The needle should read in or to the right of the green BATT OK arc. If meter reads to the left of the BATT OK arc, leave instrument plugged into power outlet for twenty-four hours to recharge batteries. Continue checkout with line cord plugged into power outlet.

4. Zero Check: Turn function switch to the mV mode. The meter needle should be at exactly center scale.

   Stability Check: Turn function switch to the pH EXP mode. Adjust the calibration control so that the needle is at center scale. The needle should remain stable.

   Slope Check: Turn function switch to the pH mode. Turn temperature compensator knob fully counterclockwise. Adjust calibration control so that the needle is at exactly zero pH (zero on the left side of meter). Turn temperature compensator knob fully clockwise. The meter needle should be at 2.9 ± 0.2 on the black pH scale.

5. Set slope indicator dial to 100%, and turn temperature compensator knob until white arrow points to 29°C. Turn calibration control counterclockwise to check for full-scale left deflection of the needle. Repeat in a clockwise direction to check for full-scale right deflection.

pH Electrode

1. Testing electrode operation:

   a. Connect electrode to a working meter.

   b. Set function switch to absolute mV mode.

   c. Immerse electrode in fresh pH 7 buffer.

   d. Displayed value should be 0 ± 30 mV.

   e. Rinse electrode and immerse in fresh pH 4 buffer.

   f. Displayed value should be approximately 160 mV greater than in Step d.

2. If electrode fails this procedure, clean thoroughly as directed in the maintenance section of the operating manual. Then "heat cycle" the electrode in hot pH 7 buffer (about 85°C) for 10 minutes, shake down to remove air bubbles, and repeat test procedure when electrode has cooled to room temperature.

3. If cleaning and maintenance fail to rejuvenate the electrode, proceed as follows:

   a. For separate pH and reference half cells, substitute each electrode (one at a time) with a known working electrode and repeat test procedure. By process of elimination, determine which electrode should be replaced.

      Note: The appropriate portion of a working combination pH electrode may be used for test purposes. To substitute for the reference half cell, connect only the small pin tip connector of the combination electrode; for the pH half cell, connect only the larger U.S. standard connector.

   b. For combination electrodes, replace the entire electrode.

Conductivity Meter

The only maintenance required is battery replacement. Two "D" size alkaline flashlight cells, such as Eveready E95 or equivalent, will provide 200 hours of operation. Accuracy will not be maintained if zinc-carbon "D" cells are used. Battery replacement is indicated when the redline adjustment cannot be accomplished.

Replace batteries every six months to reduce the danger of corrosion due to leaky batteries. To replace batteries, remove the six screws from the rear plate. The battery holders are color coded. The Positive (+ button) end must go on red.

Conductivity Probe

When the cell test indicates low readings, the probable cause is dirty electrodes. Hard water deposits, oils, and organic matter are the most likely contaminants.

For convenient normal cleaning, soak the electrodes for 5 minutes with a locally available bathroom tile cleaning preparation such as:

Dow Chemical "Bathroom Cleaner"; Horizon Industries "Rally, Tile, Porcelain, and Chrome Cleaner"; or Lysol Brand "Basin, Tub, Tile Cleaner."

For stronger cleaning, a 5-minute soak in a solution made of 10 parts distilled water, 10 parts isopropyl alcohol and 1 part HCl can be used.

Always rinse the probe after cleaning and before storage.

CAUTION: Do not touch the electrodes inside the probe. Platinum black is soft and can be scraped off.

If cleaning does not restore the probe performance, re-platinizing is required.

Re-Platinizing - Equipment required:

1. YSI #3140 Platinizing Solution, 2 fl. oz. (3% platinum chloride dissolved in 0.025% lead acetate solution).

2. YSI Model 33 or 33M S-C-T Meter.

3. 50-ml glass breaker or equivalent bottle.

4. Distilled water.

Procedure:

1. Clean the probe as in Section (a) of the operating manual using either method.

2. Place the cell in the beaker and add sufficient YSI #3140 solution to cover the electrodes. Do not cover the top of the probe.

3. Plug the probe into the Model 33 or 33M, and switch to the X100 scale to platinize the electrode. Move the probe slightly to obtain the highest meter reading and continue platinizing for the approximate time shown below:

Meter Reading umhos/cm	Meter Reading mS/M	Time (minutes)
30,000	3,000	5
25,000	2,500	6
20,000	2,000	8
15,000	1,500	11
10,000	1,000	16

4. After the elapsed time, remove the probe and rinse in fresh water.

5. Return the solution to its container. Two ounces of solution should be sufficient for 50 treatments.

Storage: It is best to store conductivity cells in deionized water. Cells stored in water require less frequent platinization. Any cell that has been stored dry should be soaked in deionized water for 24 hours before use.

Probe Use:

1. Obstructions near the probe can disturb readings. At least two inches of clearance must be allowed from non-metallic underwater objects. Metallic objects such as piers or weights should be kept at least 6 inches from the probe.

2. Weights are attached to the cable of the YSI 3310 and 3311 Probes. The YSI 3327 Weights are supplied in pairs with a total weight of 4 ounces per pair. Should it become necessary to add more weight to overcome water currents, the total weight should be limited to two pounds (8 pairs). For weights in excess of two pounds, use an independent suspension cable. In either case, weights must be kept at least 6 inches away from the probe.

3. Gentle agitation by raising and lowering the probe several times during a measurement ensures flow of specimen solution through the probe and improves the time response of the temperature sensor.

5.9 Field Data Analysis and Reporting

Field data analysis and reporting procedures are discussed where appropriate under Sections 4.3, 4.4, and 4.5.

6. LABORATORY ANALYTICAL METHODS/PROCEDURES

6.1 Analytical Methods

All analytical methods used in the laboratory are USEPA procedures or Standard Methods procedures depending on the regulatory requirements. Methods are summarized in Appendix A for RMT Laboratories.

6.2 Analytical/Statistical/Control Parameters

6.2.1 Precision, Accuracy, Sensitivity, and Completeness

The precision, accuracy, and sensitivity of the laboratory analytical techniques are dependent upon the specifications for the instruments used, as well as the QC techniques employed during their use. Specific information regarding this is given in Appendix A for RMT Laboratories.

6.2.2 Quantity and Types of Samples

The quantity and types of samples required for QA/QC analysis at RMT Laboratories are listed in Appendix A.

6.2.3 Internal QC Checks and External QA Samples

Internal quality control checks of ground water sampling at the RMT Laboratories begin with the use of trip blanks, field blanks, and duplicate samples. Definitions of each are as follows:

Samples - Representative samples collected from the ground water medium.

Duplicate Samples - Duplicate samples are samples collected simultaneously from the same source under identical conditions into separate containers. Normally, a total of one duplicate sample is collected for every 10 samples. This sample represents 10 percent of the total number of primary samples.

Sample Aliquot - A sample aliquot is a portion of a sample that is representative of the entire sample. Sample aliquots will be used to determine various field parameters (e.g., pH).

Trip Blank - A trip blank is a set of sample bottles which will be filled in the laboratory directly from a deionized or distilled water source. The trip blank will accompany sample bottles to the site as well as to the laboratory.

Field Blank - A field blank is a set of sample bottles that is filled with deionized or distilled water in the field. The deionized/distilled water is handled in the same manner as the sample (e.g., if the sample is ground water that has been filtered, the deionized/distilled water will be poured into a bailer and then filtered). One field blank will be prepared for analysis.

Quality control techniques are also used in the laboratory to ensure accurate results. These are discussed further in Section VII - Quality Control in Appendix A. All quality control data are documented and kept on file for inspection. The RMT Director of Laboratory Services is responsible for assuring that quality control procedures are implemented.

6.2.4 Representative Samples

Measurements will be made so that results are representative of the media and conditions being measured. The evaluation of representativeness includes the analytical techniques, sample collection techniques, and the sampling site locations as discussed in Section 4. The techniques described in Section 4 have been developed to provide representative samples.

6.2.5 Data Comparability

Data must be comparable between this sample round and previous sampling activities. The intended uses of data gathered during this sample round are discussed in Sections 4.3, 4.4, and 4.5. Problems with data comparability are not anticipated. Analyses will continue to be performed at the WES Laboratory as in the past, and similar types of analyses will be performed.

6.3 Calibration Procedures and Frequency

All laboratory equipment is maintained according to manufacturer's recommendations. The major pieces of equipment are under the special maintenance programs detailed below.

ANALYTICAL BALANCES

The analytical balances are covered by a service contract. Once a year the instruments are completely cleaned and checked for accuracy by the manufacturer's service representative. In addition to the yearly service, a set of Class S-1 weights are available for periodic accuracy checks performed according to the guidelines given in ASTM, PART 41, 1976, entitled "Single Arm Balances Testing."

INDUCTIVELY COUPLED PLASMA (ICP), ATOMIC ABSORPTION (AA) AND GAS CHROMATOGRAPHS (GC)

The ICP, AA, and GC instruments are covered by a manufacturer's service contract which calls for one to three visits per year for routine maintenance, cleaning, optics alignment, etc.

VISIBLE SPECTROPHOTOMETERS

The spectrophotometers are maintained according to manufacturer's guidelines. The wavelength alignment is checked monthly with colored reference solutions.

6.4 Preventive Maintenance

Preventive maintenance programs on major pieces of equipment at RMT Laboratories are established through service contracts with the manufacturer or the manufacturer's representative. Preventive maintenance on other equipment is accomplished prior to conducting routine analytical procedures.

6.5 Laboratory Data Analysis and Reporting

Analytical data produced during this study will be reduced, validated, and reported using the procedures found in this section.

Laboratory data reduction methods are dependent on the analytical technique. Each laboratory analyst is responsible for performing the initial calculations of test results. These results are checked by the laboratory supervisor for completeness and accuracy. After the data have been reduced, they are sent on for validation.

Validation of laboratory data is accomplished by several different steps. Quality control checks of precision and accuracy are used to confirm the validity of the results. Established quality control limits for precision and accuracy will be generated and used by the QC Coordinator to check the acceptability of the data before it is submitted to the Project Laboratory Coordinator. Data which do not conform to the acceptability limits will be dealt with using the procedures described in Section 4.6 of this document. Validation procedures will include precision and accuracy checks, field and laboratory blanks, reference standards, and calibration standards. Data reported by the laboratory will be reviewed by the Project Laboratory

Coordinator before it is placed into the reports. The Project Laboratory Coordinator is responsible for the accuracy of the final laboratory reports.

Corrective actions will be instituted whenever potential conditions or existing conditions are identified that may negatively affect project quality. It is the responsibility of project staff members to 1) report project activity or product discovered in nonconformance with established plans and procedures; and 2) initiate the nonconformance report and disposition process.

The individual who detects or suspects nonconformance to established criteria or protocol in equipment, instruments, data, methods, etc., will also immediately notify the Task Leader. The QA reviewer will be notified of the nonconformance. The individual and the Task Leader will then investigate the extent of the problem and take the necessary corrective steps. The corrective actions will be reviewed with the Project Manager. After the corrective action has been implemented, a copy of the nonconformance report prepared by the individual and the Task Leader will be submitted to the QA reviewer, Project Manager, and project file.

Laboratory data which are found to fall outside of quality control limits will be considered nonconforming and will require corrective action. The corrective action steps to be implemented in nonconforming situations are as follows:

- The Laboratory QA Coordinator will review calculations and procedures to assess the source and extent of the error.
- The laboratory must recommend a corrective action strategy to resolve quality control problems to the Project Laboratory Coordinator.

- The laboratory must document the corrective action taken by identifying the sample, analyzing the nature of the problem, and describing the corrective action taken in a memorandum to the Quality Assurance Reviewer-Laboratory, Project Manager, and project file.

The Project Laboratory Coordinator is responsible for reporting and documenting corrective actions.

6.6 Performance Audits

Performance audits of RMT Laboratories are conducted quarterly through the use of USEPA reference samples. These performance audits are used as a check on the accuracy of the measurement process employed for each testing parameter. Such performance and any corrective actions necessary are coordinated by an internal quality assurance staff, which is independent of the laboratory testing units.

buried, pore gas only will be measured since it is unlikely that headspace analysis will provide adequate sensitivity.

4.4 Monitoring Well Installation and Sampling

4.4.1 Purpose and Scope

Sixteen additional ground water monitoring wells will be installed at the NIROP and on property adjacent to the NIROP. The location and depth criteria for the proposed monitoring wells are based on the hydrogeology and the extent of hazardous constituents defined in the RI Report (RMT, 1987b). The results of the soil gas sampling may suggest changes or additions to the monitoring well network.

The installation of additional monitoring wells will serve two purposes. The first purpose is to improve understanding of the hydrogeology in several areas, including the following (Figures 2-2 and 4-1):

- Geologic units and vertical flow components near the southeast corner of the NIROP building (near well 9-S).
- Geologic units and ground water flow north of the NIROP (near wells 15-S and 16-S).
- Geologic units and ground water flow on the west side of the NIROP (between wells 1-PC and 4-PC).

This information will be used to refine the understanding of the geology and the impact of the geology on ground water flow patterns.

The second purpose of the monitoring wells is to better delineate the extent of hazardous substances in the ground water. The studies to date still leave some uncertainty regarding sources of hazardous substances (both on-site and upgradient) and the extent of hazardous substances beneath and along the downgradient boundary of the NIROP.

In addition to monitoring wells, up to two storm sewer outfalls will be grab-sampled (if flowing) to assess potential contaminant loading to the Mississippi River (RMT, 1987b). The location of these outfalls will be determined by the RMT Site Coordinator in consultation with the NIROP facility representative.

4.4.2 Selection of Installation Locations

Sixteen additional monitoring wells will be installed during this investigation (Figure 4-1). Construction details of the proposed monitoring wells (Table 4-3) are based on the hydrogeology and the extent of hazardous constituents defined in the RI Report (RMT, 1987b). The results of the soil gas evaluations may suggest changes or additions to the monitoring well network. These changes would be discussed with the COE Project Manager before beginning well installation. Final drill site locations will receive approval from qualified Navy and FMC personnel. This is necessary for utility clearance purposes, and also to verify that well locations will not interfere with plant activities or emergency services.

Monitoring wells will be placed north of the NIROP facility to better assess the quality of upgradient ground water. Three proposed wells (5-PC, 10-D, and 1-I) will be completed adjacent to existing monitoring well 15-S. Wells 1-I and 10-D will be placed in the middle and at the bottom of the unconsolidated sediment aquifer, respectively (Table 4-3). Well 5-PC will be placed 30 feet into the Prairie du Chien/Jordan aquifer. A fourth well (11-D) will be placed at the base of the unconsolidated sediments adjacent to well 16-S.

TABLE 4-3

MONITORING WELL CONSTRUCTION DATA

Conceptual Workplan Well Identifier	Proposed Well Identifier*	Estimated Depth (ft)	Depth to Bedrock (ft)	Screen Length (ft)	Riser Length (ft)	Nominal Well Diameter (in)	Depth Interval Requiring 5-Foot Samples	Filter Pack (ft)	Cement Bentonite Grout (ft)
E	21-S	35	--	15	20	2	0	17	10
I	22-S	35	--	15	20	2	0	17	10
J	23-S	35	--	15	20	2	0-35	17	10
M	24-S	35	--	15	20	2	0	17	10
O	25-S	35	--	15	20	2	0	17	10
C	1-I	75	--	10	65	2	0	12	55
F	2-I	75	--	10	65	2	0-75	12	55
K	3-I	75	--	10	65	2	0	12	55
N	4-I	75	--	10	65	2	0	12	55
G	5-I	60	--	10	50	2	0	12	48
Subtotal		**535**		**125**	**410**		**110**	**145**	**318**
B	10-D	130	130	10	120	3	0-130	12	110
D	11-D	130	130	10	120	3	35-130	12	110
L	12-D	130	130	10	120	3	30-130	12	110
P	13-D	130	130	10	120	3	0-130	12	110
H	14-D	100	100	10	90	3	30-100	12	80
Subtotal		**620**		**50**	**570**		**525**	**60**	**520**
A	5-PC	200	130	**	180	4	200' = 12" hole w/8" casing to br; 4" casing to P.C., 20' open hole - cont. core from top of rock 5' sample intervals in overburden		

* S = water table
I = intermediate depth
D = deep
PC = bedrock

** Open hole

1332.22 101:RTA:frid0911T5

New monitoring wells (21-S and 2-I) will be placed immediately downgradient of Hazardous Waste Storage Area C. The wells will be placed at the water table and in the middle of the unconsolidated sediment aquifer to determine whether significant releases of hazardous constituents from the storage area have occurred and are contributing to the hazardous substances observed to be leaving the NIROP southwest of the plant.

Two wells (5-I and 14-D) will be placed adjacent to well 9-S in the middle and bottom of the unconsolidated sediment aquifer, respectively, to assess vertical concentration gradients and TCE extent. Monitoring wells 22-S and 23-S will be placed at the water table and upgradient of well 9-S (on Burlington Northern Railroad property) to determine horizontal contaminant concentration gradients. Data from these new wells will help to differentiate the incremental increase in hazardous constituents resulting from a possible source(s) at the NIROP facility from constituents that are migrating onto the NIROP from the east.

Wells 3-I and 12-D will be placed at the middle and bottom of the unconsolidated aquifer, respectively, to help define the vertical distribution of hazardous constituents in the area of well 8-S, a water table well.

Two proposed wells (24-S and 4-I) will be installed on the downgradient (southwest) side of the NIROP facility, adjacent to existing wells 6-D and 18-S. Well 24-S, near well 6-D, would be completed at the water table. Boring logs in this area indicate that clay layers or lenses may be present immediately north of this location. The proposed monitoring well 24-S will be placed above the

clay layer elevation. Proposed well 4-I, adjacent to well 18-S, will be placed in the middle of the unconsolidated sediment aquifer, between the intakes for wells 18-S and 8-D.

A well nest consisting of a water table well (25-S) and a deep piezometer (13-D) at the base of the unconsolidated aquifer will be installed along the northern portion of the western property boundary. Data from this nest will be used to determine whether hazardous substances are migrating westward from the pit area as well as to determine hydrogeology along the northwest property line.

The COE will obtain permission from the property owners for access and drilling of monitoring wells off-site. Seven (7) of the sixteen (16) monitoring wells are to be installed outside of the NIROP facility. Wells 5-PC, 10-D, 1-I, and 11-D will be located north of the NIROP facility. Well 4-I will be southwest of the facility on City of Fridley property, and wells 22-S and 23-S will be east of the NIROP in the Burlington Northern Railroad right-of-way.

4.4.3 Installation

Well Design

Monitoring wells will be installed at four different depths: water table, intermediate, deep, and bedrock, as described in the Conceptual Workplan (RMT, 1987c). Water table and intermediate wells will have two-inch diameter casings and screens. Deep wells will have three-inch diameter casings and screens. The bedrock well will be finished as an open hole in the Prairie du Chien Dolomite and will be cased from the overlying formations as described below.

All well materials will be steam-cleaned immediately before installation and will remain clean until installed in the boring, or the material will be steam-cleaned again.

The well riser will consist of new threaded, black iron pipe, schedule 40, which will conform to the requirements of ASTM A 120-84. Water table and intermediate wells will be two inches in inside diameter. Deep wells will be three inches in inside diameter. The bedrock well will have an eight-inch diameter outer casing (may be welded instead of threaded) installed to the top of the first bedrock formation (St. Peter Sandstone) and a four-inch diameter casing set through the St. Peter Sandstone into the top of the Prairie du Chien Dolomite. Casings will have centralizers installed every 25 feet, but none shall be installed on the screens. Centralizers will be constructed of tubular steel or steel banding material attached to the monitoring well with steel clamps.

The well screens will be 10 feet in length for piezometers, 15 feet for water table monitoring wells, and constructed of 304 stainless steel with 0.010-inch slot size.

Drilling Methods

An RMT hydrogeologist will be on-site during all well drilling, installation, development, and testing activities. Drilling will be accomplished by water rotary methods with casing and with NX core in the bedrock.

The driller will be responsible for obtaining the appropriate drilling permits and clearances from the facility personnel and utility

companies as necessary prior to any drilling. The driller will also be responsible for relocating holes moved for utility clearance, to suitable locations which accomplish the intent of the original location. Prior to actual drilling, however, relocations will have received approval from the RMT hydrogeologist. The distance to the new location shall be as close as possible to the original location, and both locations will be shown on the drill log.

Potable water for drilling, steam-cleaning, and other necessary field activities will be obtained on-site. It is expected that a fire hydrant on the facility will be made available.

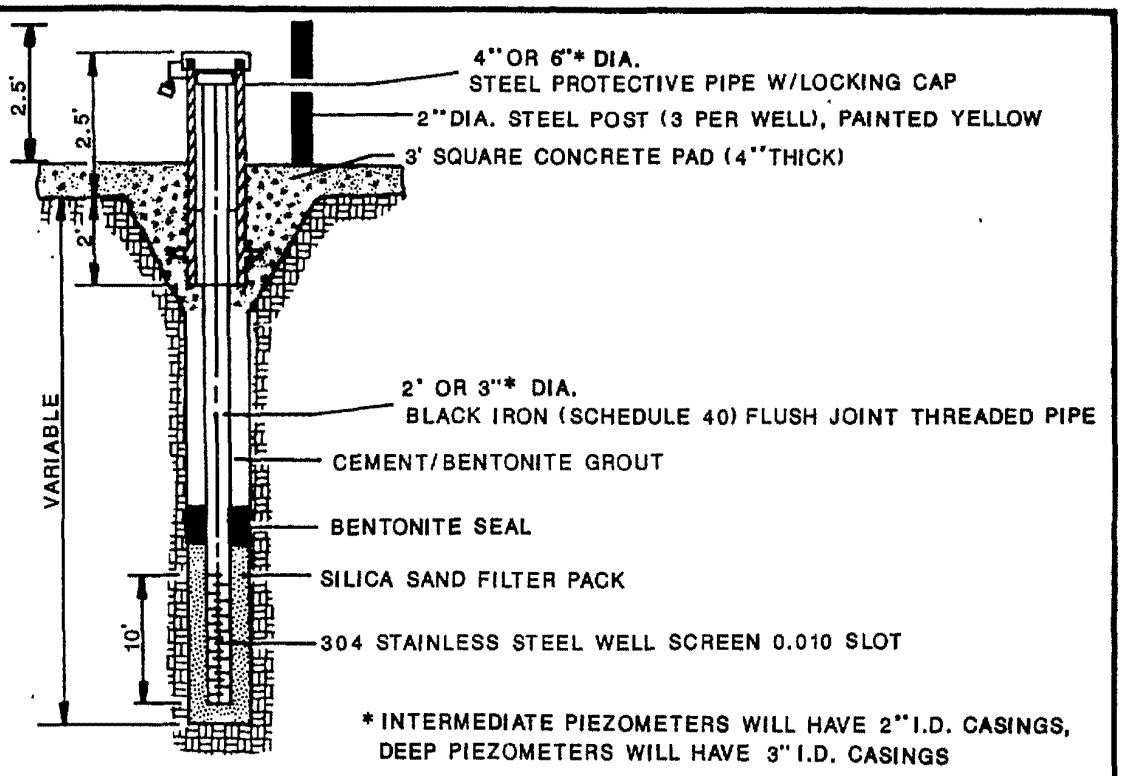
The site will be restored to its original state when field investigations are complete. The restoration efforts will meet the approval of the designated facility contact.

Cuttings will be removed as part of site restoration, and disposed on NIROP property at a location specified by the FMC Construction Supervisor. Decontamination of drilling equipment and supplies between boring locations will be in accordance with Section 4.2.

Well Installation

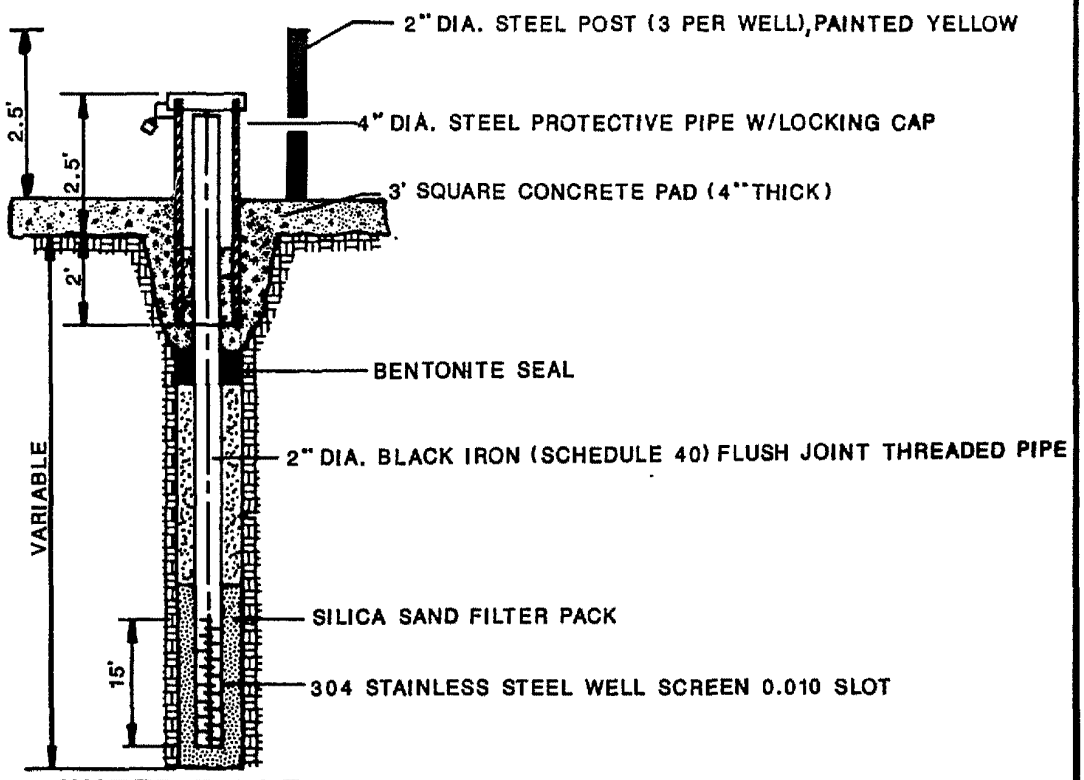
The wells will be installed as summarized on Figures 4-2 and 4-3, and as detailed below. If other than the uppermost water yielding zone is penetrated during drilling, as with installation of well 5-PC, double-cased well construction techniques similar to that described below for 5-PC will be followed.

The annular space around the well screen will be backfilled with a clean, washed, silica sand filter pack that will extend approximately



PIEZOMETER

NOT TO SCALE



WATER TABLE MONITORING WELL

NOT TO SCALE

FIGURE 4-2

WELL CONSTRUCTION DETAILS

RMT	DWN BY	MCS
	DATE	9/87
	PROJ #	1332.22

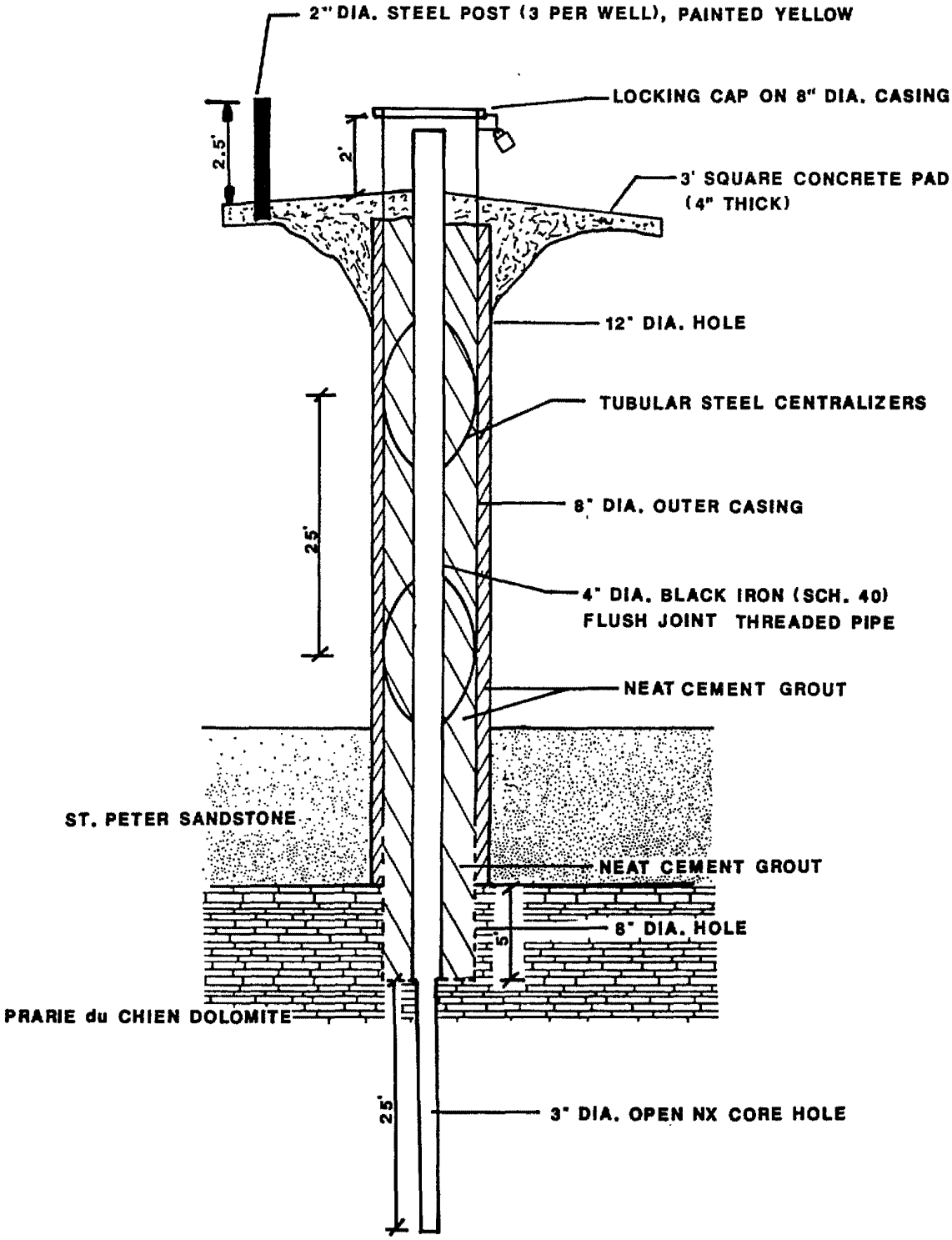


FIGURE 4-3
BEDROCK WELL DETAILS

(NOT TO SCALE)

RMT	DWN. BY: MCS
	DATE: 9/87
	PROJ.# 1332 .22

two feet above the top of the well screen. The grain size of the filter pack will be shown on the well construction log. If the existing formation material is such that the well can be adequately developed without the addition of an artificial filter pack, then the requirement for a filter pack will be waived. The well will be developed until it is sediment-free.

Riser sections will be joined by threaded couplings with Teflon(TM) tape to form water-tight unions. All risers will be set round, plumb, and true-to-line. A five-foot-long section of pipe, 1/4 inch less in diameter than the casing, will be run through the entire length of the well to check the alignment. The performance of this test will be documented in the A-E DQCR and daily logs. If this test cannot be passed, the well will not be accepted.

In wells with screens placed above the water table, a minimum two-foot-thick layer of very fine, washed silica sand will be placed in the annular space above the well screen and filter sand. A two-foot-thick bentonite seal will be installed in wells with screens below the water table surface instead of the fine sand layer. Cement grout will be placed above the fine sand layer to the ground surface using the tremie method. The cement grout will consist of a mixture of Portland Cement (ASTM C 150) and water in the proportion of not more than seven gallons of water per bag of cement (94 pounds). Additionally, 3 percent by weight of bentonite powder may be added if permitted by state regulations.

The bedrock well (5-PC) will be installed by drilling a 12-inch diameter hole to the top of the St. Peter Sandstone and installing the

8-inch diameter outer casing. A watertight seal will be made between the casing and the bedrock so no water enters the sandstone from the alluvium through the borehole. This will be accomplished by drilling five feet into the sandstone formation, and grouting the casing into the borehole with neat cement grout, or by driving the casing, equipped with a drive shoe, two to five feet into the bedrock.

The annular space between the casing and borehole will be grouted with neat cement grout. The grout will be allowed to set a minimum of 12 hours if fast-setting cement is used or a minimum of 48 hours if regular cement is used. When the grout has set, the boring will be advanced through the 8-inch diameter casing, through the St. Peter Sandstone Formation, and 5 feet into the Prairie du Chien Dolomite. The 4-inch diameter casing will be installed into the top of the dolomite formation.

The inner casing will be sealed 5 feet into the top of the dolomite formation in the same manner as the 8-inch diameter casing was sealed. The annular space between the inner and outer casing will be grouted with neat cement grout. After the grout has set (as required above), the boring shall be advanced 30 feet into the Prairie du Chien Dolomite.

At all times during the progress of the work, precautions will be used to prevent tampering with the well or the entrance of foreign material into it. Upon completion of the well, a suitable vented cap will be installed to prevent material from entering the well. Each well riser will be equipped with a locking cap and will rise at least 24 inches above the ground level. Locks will be provided by the Corps of Engineers. The 8-inch diameter outer casing on the bedrock well will be equipped with a locking cap.

A minimum 3-foot-square, 4-inch-thick concrete pad, sloped away from the well, will be constructed around the well casing at the final ground level elevation. Three 2-inch diameter or larger steel posts will be equally spaced around the well and embedded in the concrete pad. The ground immediately surrounding the top of the well will be sloped away from the well.

Any well that is to be temporarily removed from service or left incompleted due to delay in construction will be capped with a watertight cap and equipped with a "vandal-proof" cover satisfying applicable state or local regulations or recommendations.

Each well will receive a permanent marking or tag to the outer steel protective casing which clearly identifies the well number, the U.S. Army Corps of Engineers, Omaha District, and the adjusted top-of-casing elevation.

Borehole and Well-Construction Logs

The on-site hydrogeologist will maintain a complete and accurate drill log for each monitoring well borehole (see Figure 4-4). Two copies of each field drilling log will be sent to the COE Project Manager within 10 days after completion of drilling. Each drill log will contain, at a minimum, the following information:

- Name of the project and site
- Hole number
- Location of the boring
- Type of drill rig
- Size and type of bit used

RMT

LOG OF TEST BORING

F-204 (R 01-87)

BORING NO. _____

SHEET NO. _____ OF _____

PROJECT NAME _____

PROJECT NO. _____

LOCATION _____

INSTALLATION DATE _____

DRILLING CONTRACTOR _____

SURFACE ELEVATION _____

DRILLING METHOD _____

BOREHOLE DIA. _____

SAMPLING NOTES						VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS	GENERAL WELL CONSTRUCTION
INTERVAL		% RECOVERY		MOISTURE			
NO.	TYPE	N			DEPTH		
					45		
					50		
					55		
					60		
					65		
					70		
					75		
					80		
					85		

FIGURE 4-4

RMT BORING LOG

- Depth of each change of stratum
- Thickness of each stratum
- Identification of the material of which each stratum is composed according to the Unified Soil Classification System, or standard rock nomenclature, as necessary
- Depth interval from which each formation sample was taken
- Hole diameter and depth at which hole diameter (bit sizes) changes
- Depth at which ground water is first encountered
- Depth to the static water level and changes in static water level with hole depth
- Total depth of hole
- Depth or location of any loss of drill water circulation, loss of tools or equipment, and any other problems encountered
- Location of any fractures, joints, faults, cavities, or weathered zones
- Reference point for all depth measurements
- Drilling date(s)

Well construction logs detailing construction practices will be maintained for each well (see Figure 4-5). Final construction logs will be submitted in the final RI Addendum Report. The logs will be prepared by a qualified hydrogeologist present during all drilling operations. Two legible copies of each field well construction log will be completed and sent to the COE Project Manager within 10 days of well completion. Information provided in the logs will include, but not be limited to, the following:

- Reference point for all depth measurements
- Project and site names
- Dates of installation

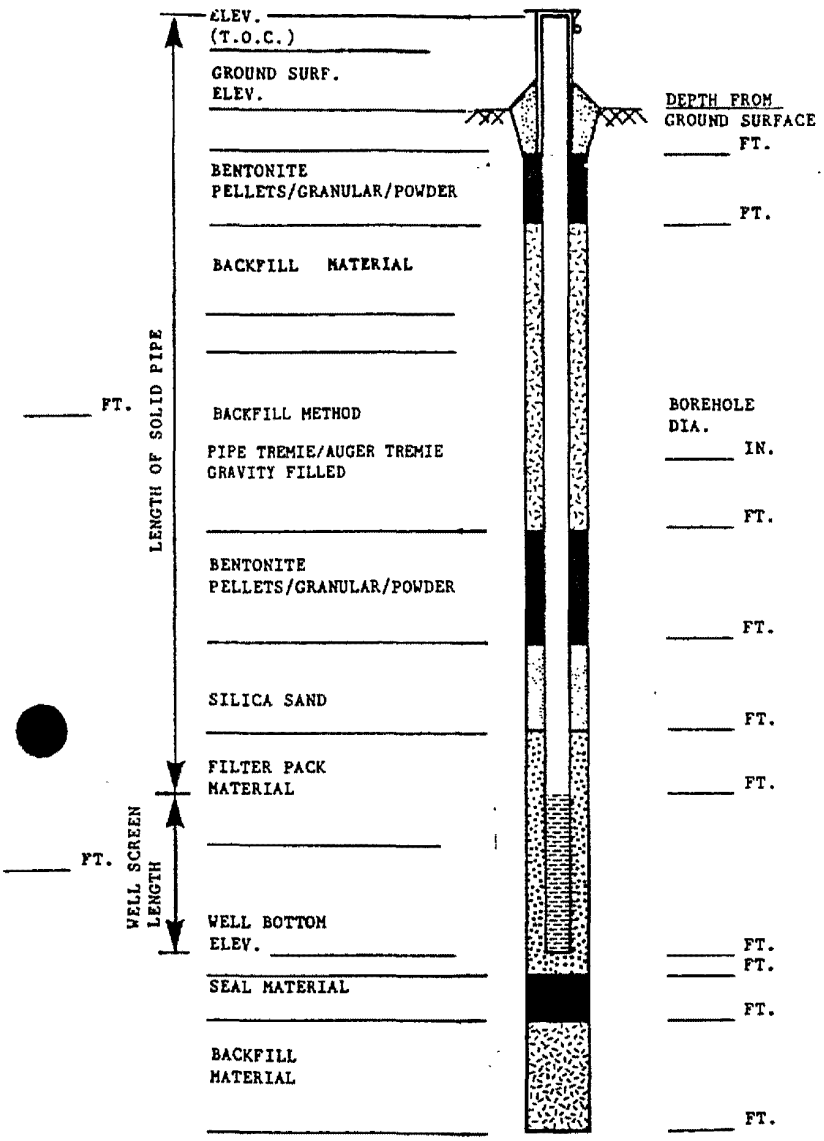
RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: _____ NO. _____

WELL NO. _____

DATE INSTALLED _____



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER _____

PIPE SCHEDULE _____

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?), OTHER _____

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER _____

E) WELL SCREEN SLOT SIZE _____

F) PIPE DIA: ID IN. _____ OD IN. _____

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. ____ IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER _____

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? _____

C) APPROXIMATE WATER VOLUME: REMOVED _____

ADDED _____

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

_____ FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME _____ FT.

DATE/TIME _____ FT.

DATE/TIME _____ FT.

ADDITIONAL COMMENTS: _____

FIGURE 4-5
RMT WELL CONSTRUCTION LOG

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U.S. Environmental Protection Agency. 1982. Handbook for sampling and sample preservation of water and wastewater. EPA-600/4-82-029.

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U.S. Environmental Protection Agency. 1979b. Methods for chemical analysis of water and wastes. EPA-600/4-79-020.

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USDI. 1981. Ground water manual - A Water Resources Technical Publication. Water and Power Resources Service, U.S. Department of the Interior.

RMT, INC. LABORATORY
QUALITY CONTROL PROGRAM

I. PERSONNEL

STAFF MEMBER	TITLE	ACADEMIC
KENNETH C. BRUNNER	LABORATORY DIRECTOR, ACTING	
OPEN	ASST. LAB DIRECTOR	
SUSAN E. WELLS	ADMINISTRATIVE SUPERVISOR	B.S.
ERIC L. THOMAS	INORGANICS SUPERVISOR	B.S.
OPEN	ORGANICS SUPERVISOR	
KARLA HALL	LEAD WORKER - METALS	B.S.
OPEN	LEAD WORKER - ORGANICS	
SYED ALAM	LABORATORY ANALYST	M.S.
KATHLEEN ARNOLD	LABORATORY AIDE	B.S.
JOE CEBE	LABORATORY AIDE	A.D.
MARIJANE CURRY	LABORATORY ANALYST	B.S.
LAURIE DUNN	LABORATORY AIDE	M.S.
MARCIA ECKMEYER	LABORATORY AIDE	HIGH SCHOOL
ROSANNE GATES	SAMPLE ENTRY TECHNICIAN	HIGH SCHOOL
JEFF GEARHART	LABORATORY ANALYST	B.S.
JULIE HECKL	LABORATORY ANALYST	WORKING ON B.S.
SHARON KOCH	ADMINISTRATIVE ASSISTANT	HIGH SCHOOL
PAUL KORGER	LABORATORY ANALYST	B.S.
MICHAEL MILLER	LABORATORY ANALYST	A.D.
BRIAN MINIX	LABORATORY ANALYST	WORKING ON B.S.
DIANE MOXLEY	LABORATORY ANALYST	B.S.
MELANIE NIESEN	LABORATORY AIDE	HIGH SCHOOL
SANDRA RILEY	LABORATORY ANALYST	B.S.

BARBARA RUBIO	LABORATORY ANALYST	M.S.
KIM WERNER	LABORATORY ANALYST	WORKING ON B.S.
MAL GROSS	ANALYTICAL SERVICES SALES & MARKETING	B.S.

II. LABORATORY FACILITIES

LAB SPACE

TOTAL SQUARE FEET = 7,500

BENCH SPACE

TOTAL LINEAR FEET = 200

SINKS

3- HOT AND COLD RUNNING WATER
5- COLD WATER SINKS FOR CONDENSING WATER

ELECTRICAL SERVICES

110 AND 220 VOLT SUPPLIES AVAILABLE

EXHAUST HOOD

FOUR HOODS EIGHT FEET IN LENGTH AVAILABLE.
100 FEET/MIN FACE VELOCITY EXHAUSTING.
COLD WATER, SINKS, AND GAS AVAILABLE IN HOODS.

HIGH PURITY WATER SUPPLY

CONTINENTAL WATER SYSTEM USING CARBON ABSORPTION, WATER SOFTENING, REVERSE OSMOSIS AND CATION/ANION EXCHANGE IN SERIES. FINAL WATER QUALITY IS 18 MEGOHM-CM. WATER QUALITY IS MONITORED DAILY AND INFORMATION IS USED TO DETERMINE THE NEEDS TO REGENERATE RESIN TANKS, WATER SOFTENER AND R/O SYSTEM.

COMPRESSED AIR

COMPRESSOR DELIVERS 1.8 CFM (50 L/MIN.) @ 60 PSI OF AIR FOR ATOMIC ABSORPTION INSTRUMENT AND IN-HOUSE AIR. COMPRESSOR IS MOUNTED ON 38 LITER TANK BUILT TO A.S.M.E. SPECIFICATIONS. AIR SUPPLY IS FILTERED TO REMOVE PARTICULATES AND OIL.

VACUUM

DIRECT DRIVE PUMP WITH AN EVACUATION RATE OF 50 LITERS/MIN IS USED FOR FILTRATION AND DESSICATION.

III. LABORATORY PRACTICES

GLASSWARE

All glassware used in the laboratory is borosilicate based KIMAX or PYREX. All volumetric flasks and pipets are Class A and meet NBS criteria.

SAMPLE BOTTLES

GLASS - Borosilicate glass with teflon lined screw caps

PLASTIC - Linear polyethylene with polypropylene screw caps

VOA VIALS - Glass with Teflon lined septa

GLASSWARE CLEANING

GENERAL - Glassware is cleaned in phosphate-free detergent, rinsed three times with tap water, and rinsed three times with deionized water.

PIPETS - Metal Pipets are soaked in a HNO_3 solution, wet chemical pipets are soaked in a soap solution, and rinsed 1 hour with deionized water in automatic pipet washer.

SPECIAL CLEANING

PHOSPHORUS - All glassware used in phosphorus test is washed with 1:1 hydrochloric acid and rinsed three times with deionized water.

METALS - All glassware used for metals testing is washed with 1:1 nitric acid and rinsed five times with deionized water.

Organics - All glassware is rinsed with acetone and high purity water.

CHEMICALS AND REAGENTS

All chemicals used in the laboratory are "Analytical Reagent Grade" unless another grade is specified in the methodology. Chemicals are dated upon receipt and discarded after shelf life is exceeded. Reagents made in the lab are stored in containers specified in methods. All purchased reagents, buffers, and standards are traceable to National Bureau of Standards.

IV. LABORATORY EQUIPMENT

ITEM	MAKE/MODEL	SPECIFICATIONS
ANALYTICAL BALANCES (2)	METTLER H 35 AR	160 gram capacity, (0.1 mg sensitivity)
TOP LOADING BALANCES (5)	METTLER PC 4400, PJ400	DUAL RANGE 4000 grams (0.1 gram sensitivity) 400 grams (0.01 gram sensitivity)
VISIBLE SPECTROPHOTOMETERS (2)	PYE/UNICAM -MODEL 330; -MODEL 8650	SINGLE BEAM, 350-900 MM, DIGITAL DISPLAY, ABSORBANCE OR CONCENTRATION
pH METERS (2)	-CORNING #130; -ORION RESEARCH	SENSITIVITY OF 0.001 PH UNIT, TEMPERATURE COMPENSATING
SPECIFIC ION METERS (2)	-CORNING #130 -ORION RESEARCH	SENSITIVITY OF 0.1 MV SENSITIVITY OF 0.01 MV
ATOMIC ABSORPTION SPECTROPHOTOMETERS (2)	PERKIN-ELMER #2380; #5000	-DOUBLE BEAM -MICROPROCESSOR CONTROL -BACKGROUND CORRECTOR
AA ATTACHMENTS	HGA-400 #023	-GRAPHITE FURNACE -RECORDER -ELECTRODELESS DISCHARGE SUPPLY
	MHS-10	-HYDRIDE SYSTEM MERCURY ANALYSIS SYSTEM
	#7300 WORKSTATION	MICROPROCESSOR COMPUTER
INDUCTIVELY COUPLED PLASMA SPECTROPHOTOMETER	PERKIN-ELMER #6500 WITH #7300 COMPUTER	SEQUENTIAL ANALYZER
AUTOANALYZER	LACHAT/QUIKCHEM	FLOW INJECTION ANALYSIS (FIA) SYSTEM
CONDUCTIVITY METER	YSI 33	
DRYING OVENS (3)	BLUE M#OV-510A-2	MECHANICAL CONVECTION, 50-260°C
	AMERICAN SCIENTIFIC	40-200°C
DESSICATORS (2)	LABCONCO 55300	-

HOT PLATES (2)	-LINDBERG 53014 -THERMOLYNE 2200	- -
MUFFLE FURNACE	BLUE M#M25A-2A	30-2000°F
STEAM BATHS (3)	PRECISION #66738	ELECTRICALLY HEATED
WATER BATHS (2)	BLUE M#MW1120A1	UP TO 100°C CONSTANT TEMPERATURE
VACUUM PUMP	PRECISION DD-50	DIRECT DRIVE, 50 LITERS/MIN
CENTRIFUGE	IEC SIZE 2, MODEL K	CAPACITY OF FOUR LITERS
REFRIGERATORS (7)	JORDAN FT-2-TR	47 CUBIC FOOT CAPACITY
SHAKER	EBERBACH 6000	UP TO 260 OSCILLATIONS/MIN.
THERMOMETER		NBS CERTIFIED
FLASH POINT TESTER	GCA/PRECISION SCIENTIFIC	
OXYGEN BOMB CALORIMETER	PARR BOMB #1341 PLAIN	
TOC INSTRUMENT	DOHRMANN DC-80 WITH AUTO SAMPLER	UV PROMOTED OXIDATION METHOD WITH IR DETECTOR FOR CO_2
GAS CHROMATOGRAPHS (4) (WITH AUTO SAMPLERS)	HEWLETT-PACKARD 5880 A, 5990,5890A TRACOR 540	ECD AND FID DETECTORS HALL AND PID DETECTORS
PURGE AND TRAPS (2)	TEKMAR 4000,4200	AUTO SAMPLER ATTACHMENTS
TOH INSTRUMENT	DOHRMANN ANALYZER	MICROCOULOMETRIC TITRATION

EQUIPMENT MAINTENANCE

All equipment is maintained according to manufacturer's recommendations. Ten major pieces of equipment are under the special maintenance programs detailed below.

ANALYTICAL BALANCES

The analytical balances are covered by a service contract. Once a year the instruments are completely cleaned and checked for accuracy by the manufacturer's service representative. In addition to the yearly service, a set of Class S-1 weights are available for periodic accuracy checks performed according to the guidelines given in ASTM, PART 41, 1976 entitled "Single Arm Balances Testing".

INDUCTIVELY COUPLED PLASMA (ICP), ATOMIC ABSORPTION (AA) AND GAS CHROMATOGRAPHS (GC)

The, ICP, AA, and GC instruments are covered by a manufacturer's service contract which calls for one to three visits per year for routine maintenance, cleaning, optics alignment, etc.

VISIBLE SPECTROPHOTOMETERS

The spectrophotometers are maintained according to manufacturer's guidelines. The wavelength alignment is checked monthly with colored reference solutions.

V. METHODOLOGY

ALL METHODS USED IN THE LABORATORY ARE USEPA APPROVED PROCEDURES OR STANDARD METHODS PROCEDURES DEPENDING ON THE REGULATORY REQUIREMENTS. REFERENCES ARE GIVEN BELOW:

1. "METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES" EPA-600/4-79-020 MARCH 1979 WITH TECHNICAL ADDITIONS EPA-600/4-82-055 DECEMBER 1982 AND EPA-600/4-84-017 MARCH 1984

2. USEPA TEST METHODS FOR ORGANIC POLLUTANTS. FEDERAL REGISTER OCTOBER 26, 1984. 40 CFR 136

3. "STANDARD METHODS FOR EXAMINATION OF WATER AND WASTEWATER" 16TH EDITION; APHA, AWWA, WPCF 1985.

4. "TEST METHODS FOR EVALUATING SOLID WASTES" SW-846, USEPA, 3RD EDITION, VOLUMES 1-A, B,C. AND D., NOVEMBER 1986

The following table summarizes each parameter run in the lab along with methods and references.

PARAMETER	METHOD USED	REFERENCE
ACID EXTRACTABLE ORGANICS	GAS CHROMATOGRAPHY	EPA #604, 40 CFR 136
ACIDITY	TITRIMETRIC	EPA 305.1
ALKALINITY	-TITRIMETRIC	EPA 310.1
	-COLORIMETRIC	EPA 310.2
ALUMINUM	-FLAME AA	EPA 200.1
	-ICP	EPA 200.7
AMMONIA NITROGEN	DISTILLATION, NESSLERIZATION	EPA 350.2
ANTIMONY	-FLAME AA	EPA 204.1
	-ICP	EPA 200.7
ARSENIC	GRAPHITE FURNACE AA	EPA 206.2
BARIUM	-FLAME AA	EPA 208.1, 7080 (SW-846)
	-ICP	EPA 200.7, 6010 (SW-846)
BERYLLIUM	-FLAME AA	EPA 210.1
	-ICP	EPA 200.7
BORON	CURCUMIN, COLORIMETRIC	EPA 213.3
CADMIUM*	-FLAME AA	EPA 213.1
	-ICP	EPA 200.7
	-GRAPHITE FURNACE AA	EPA 213.2
CALCIUM	-FLAME AA	EPA 215.1
	-ICP	EPA 200.7
CHLORIDE	COLORIMETRIC, FERRICYANIDE	EPA 325.2
CHROMIUM, HEXAVALENT	COLORIMETRIC	EPA 7196,
CHROMIUM, TOTAL*	-FLAME AA	EPA 218.1
	-ICP	EPA 200.7
	-GRAPHITE FURNACE AA	EPA 218.2
C.O.D.	COLORIMETRIC	EPA 410.4
COBALT	-FLAME AA	EPA 219.1
	-ICP	EPA 200.7
CONDUCTIVITY	WHEATSTONE BRIDGE	EPA 120.1

COPPER	-FLAME AA -ICP	EPA 220.1 EPA 200.7
CYANIDE, TOTAL	DISTILLATION, COLORIMETRIC	EPA 335.2
FLASH POINT	PENSKY-MARTENS, CLOSED CUP	EPA 1010,
FLUORIDE	SPECIFIC ION	EPA 340.2
HARDNESS, TOTAL	EDTA TITRIMETRIC -COLORIMETRIC	EPA 130.2 EPA 130.1
HERBICIDES	GAS CHROMATOGRAPHY	STANDARD METHODS 509B
IRON	-FLAME AA -ICP	EPA 236.1 EPA 200.7
LEAD*	-FLAME AA -ICP -GRAPHITE FURNACE	EPA 239.1 EPA 200.7 EPA 239.2
LITHIUM	FLAME AA	STANDARD METHODS 303A
MAGNESIUM	-FLAME AA -ICP	EPA 242.1 EPA 200.7
MANGANESE	-FLAME AA -ICP	EPA 243.1, 7460 (SW-846) EPA 200.7, 6010 (SW-846)
MERCURY	COLD VAPOR FLAMELESS AA	EPA 245.1
MOLYBDENUM	FLAME AA	EPA 246.1
NICKEL	-FLAME AA -ICP	EPA 249.1 EPA 200.7
NITRATE NITROGEN	COLORIMETRIC, Cd REDUCTION	EPA 353.2
NITRITE NITROGEN	COLORIMETRIC	EPA 354.1
OIL & GREASE	GRAVIMETRIC,	EPA 413.1
pH	ELECTROMETRIC	EPA 150.1
PCB'S AND PESTICIDES	GAS CHROMATOGRAPHY	EPA #608 - 40 CFR 136
PHENOLS	DISTILLATION, COLORIMETRIC	EPA 420.2
PHOSPHORUS, ORTHO	ASCORBIC ACID COLORIMETRIC	EPA 365.2
PHOSPHORUS, TOTAL	PERSULFATE DIGESTION, ASCORBIC ACID COLORIMETRIC	EPA 365.2
POTASSIUM	FLAME AA	EPA 258.1

SELENIUM	GRAPHITE FURNACE AA	EPA 270, 7740 (SW-846)
SILVER	-FLAME AA -ICP	EPA 272.1 EPA 200.7
SODIUM	FLAME AA	EPA 273.1
SOLIDS, DISSOLVED	GRAVIMETRIC, DRIED AT 180°C	EPA 160.1
SOLIDS, SUSPENDED	GRAVIMETRIC, DRIED AT 105°C	EPA 160.2
SOLIDS, TOTAL	GRAVIMETRIC, DRIED AT 105°C	EPA 160.3
SOLIDS, VOLATILE	GRAVIMETRIC, IGNITE AT 550°C	EPA 160.4
SULFATE	COLORIMETRIC, METHYLTHYMOL	EPA 375.2
SULFIDE	TITRIMETRIC	EPA 376.1
SURFACTANTS (MBAS)	COLORIMETRIC	EPA 425.1
THALLIUM	-FLAME AA -ICP	EPA 279.1 EPA 200.7
TIN	-FLAME AA -ICP	EPA 282.1 EPA 200.7
TOTAL KJELDAHL NITROGEN	DISTILLATION, NESSLERIZATION	EPA 351.3
TOTAL ORGANIC CARBON	UV OXIDATION	EPA 415.1
TOTAL ORGANIC HALOGEN	MICROCOULOMETRIC TITRATION	EPA 9020,
VANADIUM	FLAME AA	EPA 286.1
VOLATILE ORGANICS	PURGE AND TRAP, GAS CHROMATOGRAPHY	EPA #601, 602, 603-40 CFR 136; 8010, 8015, 8020, 8240 (SW-846)
ZINC	-FLAME AA -ICP	EPA 289.1, 7950 (SW-846) EPA 200.7, 6010 (SW-846)

*GRAPHITE FURNACE METHOD USED FOR LOW LEVEL DRINKING WATER ANALYSIS

VI. SAMPLE COLLECTION, HANDLING AND PRESERVATION

PARAMETER	CONTAINER AND VOLUME REQUIRED	PRESERVATIVE	HOLDING TIME*
ACID EXTRACTABLE ORGANICS	AMBER GLASS, 1,000 ML	COOL, 4°C	7 DAYS, EXTRACTION 40 DAYS, AFTER EXTRACTION
ACIDITY	PLASTIC, 100 ML	COOL, 4°C	14 DAYS
ALKALINITY	PLASTIC, 100 ML	COOL, 4°C	14 DAYS
ALUMINUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
AMMONIA NITROGEN	PLASTIC, 500 ML	H_2SO_4 TO pH<2	28 DAYS
ANTIMONY	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
ARSENIC	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
BARIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
BERYLLIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
BORON	PLASTIC, 100 ML	COOL, 4°C	28 DAYS
CADMIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
CALCIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
CHLORIDE	PLASTIC, 100 ML	COOL, 4°C	28 DAYS
CHLORINATED ORGANICS	AMBER GLASS, 1,000 ML	COOL, 4°C	7 DAYS-EXTRACTION 40 DAYS-ANALYSIS
CHROMIUM, HEXAVALENT	PLASTIC, 200 ML	COOL, 4°C	24 HOURS
CHROMIUM, TOTAL	PLASTIC, 100 ML	HNO_3 to pH<2	6 MONTHS
C.O.D.	GLASS, 50 ML	H_2SO_4 TO pH<2	28 DAYS
COBALT	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
CONDUCTIVITY	PLASTIC, 100 ML	COOL, 4°C	28 DAYS
COPPER	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
CYANIDE, TOTAL	PLASTIC, 500 ML	NaOH TO pH>12	14 DAYS
FLASHPOINT	GLASS, 500 ML	COOL, 4°C	14 DAYS
FLUORIDE	PLASTIC, 100 ML	COOL, 4°C	28 DAYS

HARDNESS, TOTAL	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
HERBICIDES	AMBER GLASS, 1,000 ML	COOL, 4°C	7 DAYS, EXTRACTION 40 DAYS, AFTER EXTRACTION
IRON	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
LEAD	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
LITHIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
MANGNESIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
MANGANESE	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
MERCURY	GLASS, 200 ML	HNO_3 TO pH<2	28 DAYS
MOLYBDENUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
NICKEL	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
NITRATE NITROGEN	PLASTIC, 50 ML	Cool, 4°C	48 HRS
NITRITE NITROGEN	PLASTIC, 50 MLS	COOL, 4°C	48 HOURS
OIL & GREASE	GLASS, 500 ML	H_2SO_4 TO pH<2	28 DAYS
pH	PLASTIC, 50 ML	NONE	ANALYZE IMMEDIATELY
PCB'S AND PESTICIDES	AMBER GLASS, 1000 ML	COOL, 4°C	7 DAYS, EXTRACTION 40 DAYS, AFTER EXTRACTION
PHENOLS	GLASS, 500 ML	H_2SO_4 TO pH<2	28 DAYS
PHOSPHORUS, ORTHO	PLASTIC, 100 ML	COOL, 4°C	48 HOURS
PHOSPHORUS, TOTAL	PLASTIC, 100 ML	H_2SO_4 TO pH<2	28 DAYS
POTASSIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
SELENIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
SILVER	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
SODIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
SOLIDS, DISSOLVED	PLASTIC, 100 ML	COOL, 4°C	48 HOURS
SOLIDS, SUSPENDED	PLASTIC, 100 ML	COOL, 4°C	7 DAYS

SOLIDS, TOTAL	PLASTIC, 100 ML	COOL, 4°C	7 DAYS
SOLIDS, VOLATILE	PLASTIC, 100 ML	COOL, 4°C	7 DAYS
SULFATE	PLASTIC, 100 ML	COOL, 4°C	28 DAYS
SULFIDE	PLASTIC, 200 ML	ZINC ACETATE AND NaOH TO pH>9	7 DAYS
SURFACTANTS	GLASS, 500 ML	COOL, 4°C	48 HOURS
THALLIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
TIN	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
TOTAL KJELDAHL NITROGEN	PLASTIC, 500 ML	H_2SO_4 TO pH<2	28 DAYS
TOTAL ORGANIC CARBON	GLASS, 100 ML	H_2SO_4 TO pH<2	28 DAYS
TOTAL ORGANIC HALOGEN	AMBER GLASS, 1000 ML	COOL, 4°C	28 DAYS
VANADIUM	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS
VOLATILE ORGANICS	GLASS SEPTA VIAL 3 X 40 ML	COOL, 4°C	14 DAYS
ZINC	PLASTIC, 100 ML	HNO_3 TO pH<2	6 MONTHS

*In the October 26, 1984 (40 CFR 136), Federal Register, the EPA proposed these holding times for preserved samples.

Toxicity Leaching Tests

Methods used to perform EP toxicity tests correspond directly with EPA Method 1310 contained in SW-846. Quality control procedures which require duplicate and blank analysis every 20 samples are used. In addition, spiked and duplicate samples of the leachates are analyzed as required in RMT's quality control program.

The USEPA's new proposed Toxicity Characteristic Leaching Procedure or TCLP can be performed by the Laboratory. The procedures, equipment and analyses outlined in the June 13, 1986 Federal Register are followed. A quality control program of duplicates and blanks has been established to monitor the leaching procedure and USEPA methods are used in the analysis of all leachates.

VII. QUALITY CONTROL

The following quality control techniques are used to insure accurate results. All quality control data are documented and kept on file for inspection. More detailed information on each technique is found in the EPA Handbook for Analytical Quality Control in Water and Wastewater Labs, 1979.

REFERENCE SAMPLES

Quality control samples from the EPA are analyzed twelve times per year. The correct results are sent in sealed envelopes with the samples. The envelopes are opened only after the analysis is complete. The laboratory results are compared with the correct results and are available for inspection. The performance of the laboratory is reviewed after the analyses and any problem areas are defined and corrected.

STANDARD CURVES

With each new batch of reagents, a new standard curve is established using at least seven concentration levels and a blank. The new standard curve is compared to the existing curve and must agree within ±10%. The curve is kept on file for verification until a new curve is required. In each subsequent analysis run, the standard curve must be verified by a blank and two standards. The acceptance criteria for standard curve verification is ±10% for both standards.

The only exception to the above is atomic absorption work which uses three standards and a blank each time an analysis is run.

SPIKED ANALYSIS

Spikes are used to determine the accuracy of a given analysis. For each ten or less analyses performed, one sample is spiked and the percent recovery determined. The percent recovery data are compared to the quality control chart developed for each analysis (see below). The acceptance criteria for percent recovery is ± one standard deviation. The percent recovery is calculated as follows:

STANDARDS) $$\text{PERCENT RECOVERY} = 100 \frac{\text{OBSERVED VALUE}}{\text{KNOWN VALUE}}$$

SPIKES) $$\text{PERCENT RECOVERY} = 100 \frac{\text{OBSERVED VALUE-BACKGROUND VALUE}}{\text{SPIKE VALUE}}$$

DUPLICATE ANALYSIS

Duplicate analyses are used to determine the precision of each analysis. For each ten or less samples, one duplicate is run. The range between the duplicates is compared to the critical range value. The range must be below or equal to the critical range for acceptance. The critical range value is concentration dependent and determined by a large number of duplicate analyses.

STANDARD ADDITIONS

The method of standard additions is used primarily in furnace atomic absorption to determine interferences in different sample matrixes. Known amounts of a metal are added to the unknown sample at zero, one, two, and three times the expected amount. The results are plotted on a graph of absorbance vs. concentration and the value of the point of interception of the abscissa is the unknown concentration.

All furnace work requires the verification of matrix interferences before the need for standard additions can be determined. The unknown is spiked at a 1:4 dilution and compared to the unspiked result. If agreement is ±10%, then no interference exists, If it is greater than ±10%, then standard additions is required.

EP LEACH TEST

One out of every ten EP leach tests will have one duplicate and one blank analysis. The duplicate and blank data will be kept on file for inspection. It is difficult to establish acceptance criteria. A criteria of ±20% will be used until enough data is generated to determine higher or lower limits.

QUALITY CONTROL CHARTS

Charts are kept on each parameter and analyst. Accuracy and precision charts are available for inspection.

ACCURACY

When the results fall outside ±1 standard deviation or seven consecutive results are on the same side of the average percent recovery line, then the analysis is stopped and problem corrected. Then, the number of checks is doubled and all analyses in question are repeated or discarded.

PRECISION

When the precision of duplicate analyses is outside the critical range, the analysis is stopped and the problem corrected. The number of checks is doubled and all analyses in question are repeated or discarded.

Precision and accuracy data will be recorded daily on quality control charts. These charts will provide an easy evaluation of our work. We will use two types of charts for both precision and accuracy: cusum charts and Shewhart charts. One duplicate and spike should be run for each set of ten samples or less. The data will be recorded immediately after finishing the analyses in both a table (see examples) and on the four quality control charts. Initially the data will have to be recorded in the table alone until there is sufficient data to prepare the charts, about 20 to 25 sets.

Cusum charts are based on a cumulative sum of the square of the difference between duplicates or the known and observed values of a spiked sample. The following equations are needed to prepare the charts for both precision and accuracy:

Where di = the difference between the ith set of duplicates or spiked samples

N = the total number of sets of duplicates or spiked samples used to construct the chart

S_d^2 = the variance of the differences

S_d = the standard deviation

S_o^2 = the minimum amount of variation allowed in the system

S_1^2 = the maximum amount of variation allowed in the system

= the percent (in decimal fraction) of time we are willing to judge the procedure out of control when it is in control

= the precent (in decimal fraction) of time we are willing to judge the precedure in control when it is out of control. The parameters and should be set between 0.05 and 0.15. A value of 0.05 gives a wide allowable range while a value of 0.15 gives a smaller range.

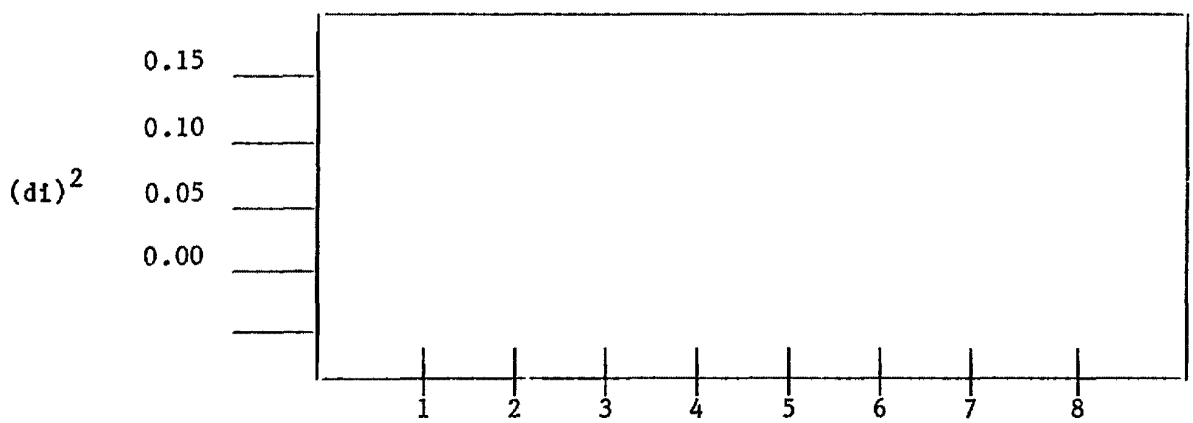
M = the number of sets of duplicates or spikes used in calculating the value to be plotted on the chart

UL (M) = the upper limit at M sets of samples

LL (M) = the lower limit at M sets of samples

The following is an example of the daily calculations used for precision data. For accuracy charts the same procedure is used except di is the difference between the known value of the spike and the observed value.

No. of duplicates (M)	Value 1	Value 2	di	di^2	$(di)^2$
1	5.4	5.2	0.2	0.04	0.04
2	4.8	4.7	0.1	0.01	0.05
3	6.1	5.8	0.3	0.09	0.14



If a di^2 value falls out of control by the upper limit, the analysis will be stopped, the problem corrected, and the samples represented by the out of control value rerun sum. Data that falls out of control on the lower limit may be due to false reporting or an increase in precision. Analyses will be continued unless the trend changes. New control charts will be constructed based on recent data.

Shewhart charts use different calculations for accuracy and precision. The accuracy charts are based on percent recovery data. Percent recovery is calculated as

$$P = 100 \frac{\text{observed value}}{\text{known value}} \quad \text{for standards}$$

and

$$P = 100 \frac{\text{observed} - \text{background}}{\text{spike}} \quad \text{for spikes of real samples}$$

The standard deviation for percent recovery is then calculated:

where N = the number of standards or spikes used

$\bar{P}$ = the average percent recovery

Sp = the standard deviation

Upper and lower control limits can be calculated from the following equations:

$$UCL = \bar{P} + xS_p \quad \text{for the upper limit}$$

$$LCL = \bar{P} - xS_p \quad \text{for the lower limit}$$

The value x determines how many standard deviations from the mean we are willing to call in control. To start our charts will have two sets of limits:

$$UCL = \bar{P} + 1S_p$$

$$UCL = \bar{P} - 1S_p$$

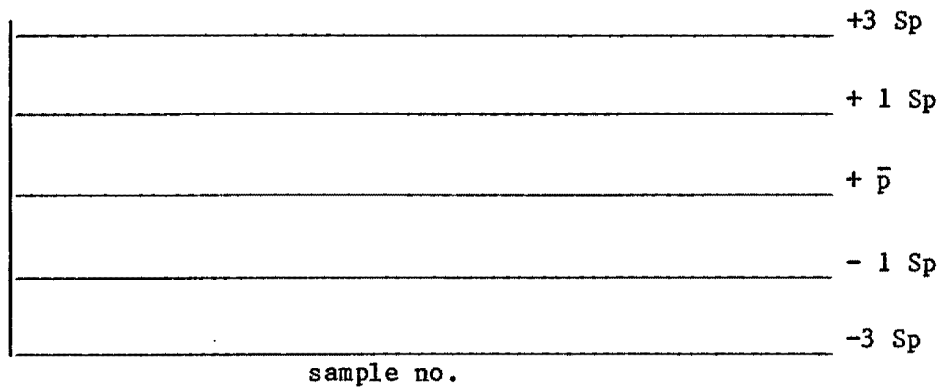
and

$$UCL = \bar{P} + 3S_p$$

$$LCL = \bar{P} - 3S_p$$

On a daily basis the percent recovery of each spike is calculated and plotted on the chart.

PERCENT RECOVERY



The inside control limits (± 1Sp) will be used as a warning line. If data falls outside the outer control lines, the analyses will be stopped until the problem is corrected and the samples under question rerun.

The Shewhart chart for precision is based on the absolute value of the difference between each set of duplicate samples or their range. The average of a group of duplicates is calculated by

where N = the number of duplicates
R = the range of each set of duplicates (R is equal to di on the cusum charts)

The upper control limit can then be calculated

$$UCL_R = D_4\bar{R}$$

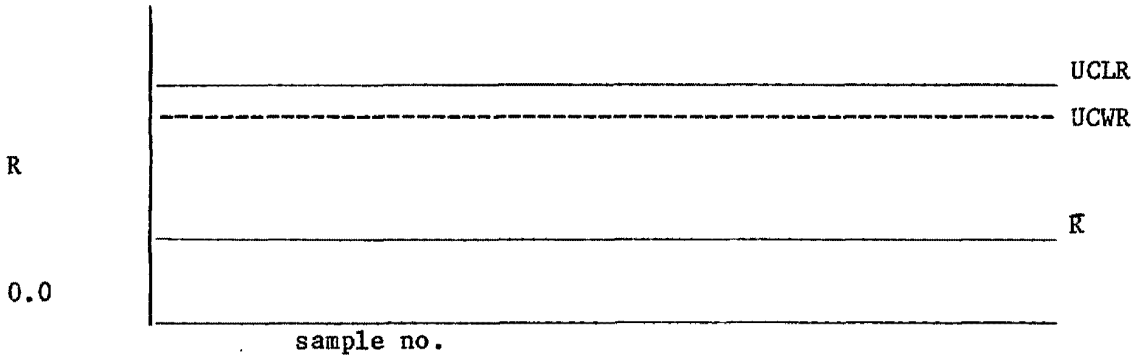
and the upper warning limit

$$UWL_R = 2/3\ (D_4\bar{R} - \bar{R}) + \bar{R}$$

where D4 is a constant dependent on the number of units in the subgroup. For duplicate samples there are two units, so D4 is equal to 3.27.

The upper warning limit (UWL_R) corresponds to the 95% confident level.

After the chart has been prepared, the range of each set of duplicates is calculated and plotted after every analysis.



The analysis will be stopped if the range of a set of duplicates exceeds the upper control limit

Precision For

Test: _____

Method: _____

Date	Set No. M	Value 1	Value 2	Range R or di	di^2	$(di)^2$	Analyst	Comments

Accuracy For

Test: _____

Method: _____

Date	Set No. M	Conc. Added	Obs. Value	Backgrd Value	Obs.- Backgrd	% Recovery P	di	di^2	$(di)^2$	Analyst	Comments

VIII. DATA HANDLING

All samples are recorded when they arrive at the laboratory. Samples are numbered and dated, and the required analyses are listed. Samples collected by RMT are labelled in the field. The labels contain the following information.

COLLECTION DATE:
COLLECTION TIME:
PLACE:
COLLECTOR:
SAMPLE DESCRIPTION:

A data sheet is written for each laboratory analysis. These data sheets contain the following information:

ANALYST:
ANALYTICAL METHOD:
RESULTS AND DATA:

All data and reports are kept on file for a minimum of three years. The data collected from quality control checks for each parameter are kept in a separate file.

CHAIN OF CUSTODY

All samples received in the lab must be accompanied by a sample record form (copy attached). This form is sent to the sampling site and is completed by sample collector. The chain of custody form is sealed inside the box containing the samples. The box is then shipped to the lab. All individuals who handle samples before shipment must sign off on a custody form. The sample shipper (UPS, etc.) does not sign the chain of custody. When the samples are received in the lab, the shipping container is inspected for signs of a broken seal. If a sample container has been opened before receipt by the lab, the sample will be refused and the chain of custody broken. If a sample container is still sealed, the chain of custody form will be completed by the lab and kept on permanent file.

APPENDIX B

SOIL-GAS SAMPLING PROCEDURES

FIELD METHODS - SOIL GAS SAMPLING AND ANALYSIS

The field methods described below are those that will be used in Phase I. The methods may be modified, based on site-specific conditions encountered in Phase I, to optimize each method. Any modifications made in the field will be noted in the field data sheets. It is anticipated that only one of the methods will be used in Phase II. The quality control procedures will remain the same in both phases of work unless unanticipated difficulties indicate a change is warranted.

Decontamination

Soil augers should be carefully cleaned with soapy water, rinsed with clean water, and dried before each sampling session. Between samples, the augers should be wiped clean with a wet paper towel. If organic residue appears to be adhering to the auger, then an HNU reading should be taken. If the reading indicates organic contamination, then the auger should be cleaned with soapy water and rinsed with clean water.

The plastic sheet used during soil boring should be shaken clean between sample locations, with visual inspection to ensure that no soil is stuck to the sheet.

New Ball jars and 40-ml VOA vials are preferred for both methods. If used Ball jars or vials are used, at least 10 percent will be checked for cleanliness with the HNU.

The stainless steel probes used for soil pore gas analysis should be checked for cleanliness prior to use with the HNU meter. If the probes show residual contamination, they should be cleaned with a

propane torch to drive off volatile compounds. If a probe is still not free of volatiles when tested with the HNU meter, then the probe should be rinsed with acetone and heated until clean, or the probe should be discarded and a new probe substituted.

Calibration

The HNU meter should be calibrated using the calibrant gas supplied by HNU Systems, Inc., prior to taking the instrument into the field. During use, the battery should be kept charged and the zero reading checked each time the instrument is turned on. Before each sampling episode, the HNU should be checked for response using an available VOC source (e.g., felt tip marker).

Calibration of the portable GC is done by making up a standard gas containing the compounds of interest at known concentrations in the range corresponding to sample concentrations. The instrument is calibrated in the lab prior to its use in the field. Instrument settings for analyzing the parameters of interest are also set in the lab prior to taking the instrument into the field.

The instrument being used (a Photovac, Inc., portable GC) has an internal calibration curve that identifies and quantifies compound peaks based on the stored standard curve. Each time the portable GC is turned on, blanks are run to ensure that there is no background contamination in the instrument. Then, a standard is run and the internal standard curve calibrated for site-specific operating conditions (especially temperature). Following this, samples are run. During routine operation, blanks and standards are run after every 8 to 10 samples. If

a sample with a particularly high VOC concentration has been injected, then the instrument is cleaned by running blanks until the baseline returns to background.

A. Soil Pore Gas Analysis

Soil pore gas will be collected using stainless steel probes in the following manner:

1. Four-foot stainless steel hollow probes will be used for collecting samples. The probe has a tapered hose attachment tube at one end and an open downhole end.

2. Prior to installing the probes, the cleanliness of the probe will be checked by drawing air through the probe and monitoring VOCs in the gas with an HNU meter. If the HNU reading is greater than 1 ppm over background, then the cleaning procedure specified above, under Decontamination, will be initiated. If the probe cannot be cleaned, then another probe will be used.

3. Once a sampling location has been chosen, a loose-fitting screw is placed in the open end of the tube. The tube is then placed vertically on the ground. A special sleeve is placed over the tapered hose attachment, and the probe is hammered into the ground to the 3.5-foot mark. The tube is withdrawn one foot from the bottom of the hole. The screw stays at the bottom of the hole, and the tube can draw soil gas from a one-foot vertical section of exposed soil in the 2.5- to 3.5-foot interval.

4. A vacuum is applied to the probe to determine if gas can be withdrawn from the soil. If gas can be withdrawn, then the gas is extracted for approximately one minute, and an HNU reading of the pore gas taken by attaching the HNU meter to the probe. The reading is noted, and the meter is then taken off the probe and a vacuum is reapplied. After another minute evacuation, a second HNU reading is taken. If a constant HNU reading is obtained, then a sample is taken for final HNU analysis and for portable GC analysis. If the reading is not steady, then the process is repeated until a steady reading is obtained. If no steady reading is obtained after 15 minutes of evacuation and if gas is being removed, then a sample is taken and the unsteady HNU reading noted on the Field Data Form.

5. A gas sample is taken by placing a deflated Tedlar® bag in a wide-mouth plastic bottle. The top is screwed on the bottle. Ports in the top allow a tube to be connected to the Tedlar® bag and allow evacuation of gas from the area between the bag and the bottle wall. Gas is withdrawn from the bottle with a vacuum pump, causing the Tedlar® bag to draw in air from the soil probe and inflate. Once the bag has inflated, the vacuum pump is turned off and the Tedlar® bag sealed. The bottle is then marked with the sample identification (sample number, sampling location, time, date, field staff initials, project number), and saved for analysis.

6. Samples are taken directly from the bag for both HNU and portable GC analysis. Portable GC analysis should be conducted first, using the field HNU readings as a guide for injection volumes, as follows:

HNU Reading (ppm)	Injection Volume (uL)
0 - 5	250
5 - 25	100
25 - 100	50
100 - 200	25
> 200	10

7. Data is collected on the form shown in Table B-1.

8. The stainless steel probe assembly should be checked for leaks following removal from the ground after each sampling episode. This is accomplished by applying a passive vacuum (pipet bulb) to the gas extraction end of the probe and sealing the other end by finger pressure. If the bulb maintains its vacuum, then the probe is still sealed.

B. Soil Headspace Analysis

1. The soil auger (a bucket auger) should be cleaned initially with soapy water, rinsed with clean water, wiped off with a paper towel, and then air dried prior to use.

2. Once the sample location is identified, the surface litter is scraped off the soil and a plastic sheet spread near the boring site. The top 2.5 feet of soil is removed with the auger and placed on one side of the plastic sheet. The next foot of soil (2.5 to 3.5 feet) is removed, placed on the plastic sheet, and quickly homogenized on the sheet. Sub-samples are taken for both HNU and portable GC analysis.

TABLE B-1

FIELD DATA FORM
SOIL GAS INVESTIGATION

DATE:

PROJECT:

FIELD STAFF:

PROBE/HEADSPACE:

Sample Identification			HNU Reading (ppm)		Portable G C Results			Comments
					TCE	DCE		
#	Location	Depth	Probe	Bag		cis	trans	

3. For HNU analysis, a one-quart Ball jar is filled approximately 1/2 full with soil. Any large chunks (greater than 1/2 inch) of soil should be broken up. The top of the Ball jar is covered with aluminum foil (shiney side up). The screw ring is then placed on the jar. The jar is marked with sample information (sample number, sampling location, time, date, field staff initials, and project number), and then placed in an area at room temperature to equilibrate. During equilibration, Ball jars are maintained in an inverted position.

4. For the portable GC analysis, a 40-ml VOA vial is filled approximately 1/2 full of soil. The top is covered with aluminum foil (shiney side up), and the cap and septum are then put on the vial. The vial is marked with the same sample information as the Ball jar. As with Ball jars, vials must equilibrate to room temperature while in an inverted position. Duplicate vials should be taken for all samples. Samples should be taken for both HNU and field GC analysis as quickly as possible to minimize volatilization.

5. The excavated soil is returned to the boring and tapped down with a steel bar. Extra dirt is then added to fill the hole. The auger and spatulas used for taking the soil samples should be washed with soapy water, rinsed with clean water, wiped with a paper towel, and then air dried.

6. The soil headspace sample for HNU analysis should be equilibrated at room temperature for between 1.5 and 2 hours before taking the HNU reading. The sample should be shaken prior to analysis. The HNU probe should be gently inserted through the aluminum foil, making as small a hole as possible. The probe should be lowered to approximately halfway down the bottle (making sure the probe does not touch the soil). The meter reading should be carefully monitored as the probe is pushed through the foil and into the jar, because a rapid rise and fall in concentration may indicate very high VOC concentrations in the bottle. If there is no large spike in the HNU reading, then the highest and stable reading are both recorded. The probe often takes 10 to 15 seconds to approach a stable reading, which is maintained for 20 to 30 seconds (or more) until the reading starts to fall as incoming air dilutes the headspace air.

7. Samples in VOA vials are equilibrated for at least one hour. Analysis should be run within 6 to 8 hours of sample collection if possible. The injection volume to be used is based on the soil headspace HNU reading, using the guide given for the soil pore gas analysis.

8. Portable GC and HNU analysis should be recorded on Field Data Forms (Table B-1). The presence of major unidentified peaks

should be noted on the data sheet. If a tentative identification can be made based on relative retention time, then the identification should be noted in parentheses with a question mark (e.g., PCE ?).

9. If the results of portable GC analysis are off-scale or questionable for some reason, the duplicate soil sample should be run, adjusting the injection volume as appropriate. Duplicates should be run in any case on every fifth sample as part of the quality control program.

10. The chromatograms for the day or work period should be marked with the date, project name and number, and analyst's initials and saved for future reference.

11. All Ball jars and VOA vials should be returned to the RMT Laboratories for cleaning or disposal. Tedlar® bags will be cleaned by filling and emptying the bag several times with clean air.

C. Additional Data Recording and Storage Requirements

1. HNU - All HNU readings are recorded on duplicate data sheets. One of these sheets is kept in a 3-ring binder at the site. The other sheet is sent to the location where the portable GC is being operated.

2. GC - Portable GC results are also recorded in two places (in addition to the chromatogram itself). First, portable GC results are recorded on the Field Data Form accompanying the samples, and stored in a 3-ring binder which is kept with the instrument. Second, the results are stored in the portable GC log book. All field GC runs - blanks, standards, samples, and replicates - are recorded in the log book so that a complete record of all analyses is maintained. The 3-ring binders become part of the project file maintained in the RMT office. The log book is kept with the instrument in the field. Results from previous projects are stored in the laboratory. All chromatograms are marked with the sample information (e.g., sample identification number, injection volume) on the chromatogram itself. The instrument records sample date and time of analysis.

Each day's or work period's output is marked with the date and project number, and then stored in the laboratory for future reference. Thus, if there is any question about whether a sample was run and what the results were, the log book will provide information on what samples were run, and, if necessary, the actual chromatogram can be retrieved to review the results.

APPENDIX C

RESUMES OF KEY PERSONNEL

THOMAS P. KUNES, P.E.
President, Northern Region

Role at RMT: Directs and supervises RMT's solid and hazardous waste management, environmental audit and landfill development projects, which include: industrial waste characterization, analysis and testing; environmental compliance audits; evaluation of waste handling alternatives; landfill site selection, design, and monitoring; economic analysis; assistance in expediting approvals and permits from state regulatory agencies; expert testimony.

Mr. Kunes has provided technical consultation to Cast Metals Federation, and several state foundry industry organizations.

At RMT, Mr. Kunes was an appointed member of The Wisconsin Legislative Council's Special Committee on Groundwater Management which has drafted AB595, the major groundwater bill which was introduced in the Legislature's Spring 1984 Session.

Experience: As Assistant Chief of the Solid Waste Management Section at the Wisconsin Department of Natural Resources, Mr. Kunes served as an advisor to the Wisconsin Legislative Council Committees and helped draft revisions to new state solid and hazardous waste laws (Chapter 377), including:

- regulations for closure and long-term care of waste disposal sites,
- a complete revision of the landfill siting and approval process,
- a program for the regulation of toxic and hazardous wastes.

Mr. Kunes also spent a year at the University of Wisconsin-Extension where he provided technical assistance and training in solid waste management to engineers and representatives of industry, and local and county governments.

Education: Master of Science in civil and environmental engineering from the University of Wisconsin-Madison. Mr. Kunes' thesis project on foundry waste leachability was conducted under the sponsorship of the American Foundrymen's Society. It addresses the environmental aspects of foundry waste

RES:kunes

Education (Continued):

disposal and represents the first major work on foundry solid wastes available nationally.

Bachelor of Science in civil engineering from the University of Wisconsin-Madison.

Other:

- Member of American Foundrymen's Society Water Quality and Waste Disposal Committee and Sand Reclamation Committee; National Solid Waste Management Association; American Society of Civil Engineers; American Society for Testing and Materials, Solid Waste Committee; National Society of Professional Engineers; Chi Epsilon Civil Engineering Honor Fraternity. Member of Wisconsin Legislative Council Special Committee on Ground Water Management.

- Registered Professional Engineer in Wisconsin, Minnesota, Tennessee, Michigan, Oklahoma, Washington, Mississippi, Oregon, and New Jersey.

- Published many articles and technical papers and lectured in University Solid Waste Engineering Courses at the University of Wisconsin-Madison.

- Completed graduate research at the University of Wisconsin-Madison which resulted in the development of a foundry waste leaching test procedure for the American Foundrymen's Society.

- Southwest Chapter Wisconsin Society of Professional Engineers 1981 recipient of Young Engineer of the Year award.

RES:kunes

MARK E. SMITH, P.E.
Director of Technical Operations

Role at RMT: Responsible for day-to-day direction and coordination of technical operations, including:

- Project management and coordination.
- Work production and QA/QC.
- Work planning and scheduling, scoping, and pricing; resource allocation and general supervision of technical staff; and business development and marketing by technical staff.

Responsible for quality control/quality assurance company-wide in the following areas:

- Land disposal field investigations and soil testing programs.
- Land disposal facility design.
- Landfill leachate and gas management design.
- Contract documents, plans, and specifications for construction projects.
- Hazardous waste land disposal remedial engineering.

Experience: Preliminary Assessments of Waste Disposal Facilities and Remedial Action Sites

Mr. Smith has worked as part of RMT's engineering and hydrogeological teams assigned to perform preliminary investigations of the environmental impact of existing hazardous, industrial and municipal waste disposal sites. These investigations include:

- Initial site surveys/problem definition
- Development of site investigation program
- Data analysis and development of remedial action programs.

Waste Characterization and Analysis

Part of Mr. Smith's experience with land disposal projects includes designing and supervising waste sampling and testing programs to identify the types of waste to manage in order to identify and assess waste. Mr. Smith has designed waste handling and disposal systems for both industrial and municipal clients.

RES:smith

Experience (Continued):

Design of Industrial and Municipal Waste Land Disposal Facility

Mr. Smith has prepared engineering designs for new land disposal facilities and surface impoundments and the expansion or improvement projects at existing sites. Special projects have included the preparation of state of the art leachate collection and liner system designs. Other design specialties include drainage control, gas control, and long-term care and closure plans.

Design and Construction Supervision of Remedial Action Programs at Waste Disposal Sites

Mr. Smith's staff at RMT, performs construction observation of disposal facility construction projects to insure that they are being completed according to the engineer's specifications and in keeping with applicable permit conditions.

RMT staff engineers under the direction of Mr. Smith have performed on-site construction, land based industrial wastewater treatment and settling facility construction and remedial action construction including hazardous waste disposal impoundment and removal.

Contract Preparation

Contract and technical specification preparation and review for potential liability are a part of Mr. Smith's expertise in land disposal facility design and remedial action work.

Regulatory Liaison and Public Relations

As engineering manager, Mr. Smith is responsible for large land disposal facility design and remedial action projects. Mr. Smith reviews design and construction procedures for compliance with federal, state, and local regulations. He also assists clients with negotiations with regulatory agencies and public information programs.

Education: Bachelor of Science in civil and environmental engineering from the University of Wisconsin - Madison. Registered Professional Engineer in the State of Wisconsin.

RES:smith

ERIC GREDELL, P.E.
Project Manager

Role at RMT: Responsible for management of projects in the areas of industrial water supply and wastewater treatment, and RCRA/CERCLA - related projects.

Experience: Managed and coordinated design, installation, and start up activities on a turnkey basis for wastewater pretreatment and demineralizer system for an electronic components manufacturing client.

Directed preparation of specifications for client to procure a long-term operating and maintenance contractor for well field and ground water pretreatment facilities at a hazardous waste site.

Supervised a study of wastewater treatment and metal recovery alternatives for achieving compliance with elecroplating and metal finishing regulations. Study included a field sampling program and laboratory treatability tests.

Developed process design for a complex, seven-month pilot test of a high strength coke plant wastewater. Directed detail design of all treatment system components including an ammonia stripping tower, numerous chemical feed systems, various pump systems, steam supply and other utilities, and several automatic control and monitoring systems. Project also involved organizing field operating personnel and evaluating and summarizing test results in a report that included preliminary design and cost estimates for a full-scale treatment facility patterned after the pilot test system.

Conducted field investigation to identify problems with a chrome recovery system at a large leather tannery. Directed final process and detail design for recommended improvements, including new grease collection and refining equipment.

Directed project design for improvements to a blast furnace gas scrubber wastewater system. Facility included a 110-foot diameter thickener, 24-inch diameter screw classifier, 8-foot diameter rotary drum vacuum filter, filter cake conveyor, polymer feed system, and a 24-inch diameter overhead gravity slurry pipeline. Construction cost was $5.3 million.

Prepared a report defining current deficiencies and giving recommendations for improvements with cost estimates for plating wastewater treatment facilities at a large household appliance manufacturing company. Organized wastewater sampling, treatability testing program, and investigated existing plating and treatment facilities. Improvements included modifications to piping and controls, a new pH control system a new gravity upflow sand filter, and new pump systems for reuse of treated wastewater.

RES:gredell

Experience (Continued): Managed project for dewatering of 390,000 gallons of anaerobic sludge using portable belt filter press. Approximately 100,000 lbs of dry sludge solids were produced during the one month field operation. The dewatered sludge was used by the client for subsequent tests to determine feasibility of recovering cobalt from the solids.

Directed field inspection and trouble shooting program for a sludge dewatering system at a national airport's industrial waste treatment plant.

Coordinated and directed design team for major new wastewater pretreatment facilities at two large automobile assembly plants to comply with the electroplating and metal finishing regulations. Facilities included a new pretreatment building at each assembly plant and other major equipment including clarifiers, thickeners, and 750,000 gallon equalization tanks. Also managed "emergency" engineering effort for both assembly plants to design, procure equipment, install, and startup 200 GPM pretreatment systems to meet the federal deadline for compliance with the electroplating regulations. The facilities were on-line within 3 1/2 weeks after work began.

Coordinated a testing and data acquisition program for development of a new coke plant preheater charging liquor treatment and recirculation system. Participated in field investigations and troubleshooting for a seamless pipe mill, and conceptual design of treatment facilities for a cold rolling mill. Conducted field sampling program and treatability tests, and prepared report with preliminary design and cost estimates for new hot strip mill treatment and recirculation facilities. Participated in design and operation of a pilot testing system for tertiary treatment of coke plant wastewater; prepared preliminary design and cost estimates for recommended full-scale facilities.

Assisted with design of a treatment pond and collection system for SO_2 scrubber blowdown for a new coal-fired power plant. Also designed and specified over 2 million square feet of synthetic liner for plant's evaporation ponds.

Directed field efforts for collection of data to prepare a heat balance for an existing water supply reservoir at a steel plant. Prepared report including data evaluation and temperature projections for several future operating conditions. Directed design efforts for a new pump station (three 7,100 GPM pumps) and 20-inch and 24-inch diameter force mains to supply reservoir water to two blast furnace gas scrubbers.

RES:gredell

Education: Master of Science degree in environmental engineering from the University of Illinois-Urbana. Bachelor of Science degree in civil engineering from the University of Missouri-Rolla.

Registration: Registered Professional Engineer (in the states of Wisconsin and Missouri).

Organizations: National Society of Professional Engineers Water Pollution Control Federation.

RES:gredell

RICHARD P. FISH
Manager of Technical Services

Role at RMT: Directs and supervises RMT's technical services in the preparation of plans and graphics for regulatory approvals and the construction of solid and hazardous waste landfills, and the preparation of process flow diagrams, plant and process layouts, and other graphics as required to meet clients' needs. Administers subcontracts for subsurface investigations, monitoring well construction, aerial photography and topographic mapping. Coordinates management information systems to provide project managers with information to schedule resources and monitor project schedules and budgets to insure that projects are completed on time and within authorized funding.

Project-Related Experience: Before joining RMT, Mr. Fish was Engineering Development Coordinator for the City of Madison and has experience in the following areas:

- Coordinated the design, approval, and preparation of construction plans for public works projects, and coordinated the construction of these projects with consulting engineers, utility companies, sewerage districts, and city, county, and state agencies.

- Prepared master plans, preliminary plats, final plats, and certified surveys for the development of industrial parks and surplus city lands. Provided technical assistance to developers in the formulation of master plans, rezonings, Planned Unit Developments, and subdivisions for industrial, commercial and residential developments; and during the approval/development process acted as liaison between developers and city, county, and state agencies.

- Scheduled and administered contracts for public works improvement, aerial photography, topographic mapping, and consulting services for the City of Madison Department of Public Works.

- Prepared and administered capital improvement and operating budgets.

- Directed the preparation of utility and highway "as-built" records and official maps and assisted the City of Madison Planning and Development Department in the formulation of master plans for the development of lands within the City and its extra territorial limits.

RES:fish

Professional Affiliations: Registered Land Surveyor in the State of Wisconsin, Certified Engineering Technical, Notary Public, Member of Wisconsin Society of Land Surveyors.

Education: Associate degree - Civil Highway Technology. Additional course work at the University of Wisconsin - Madison in land surveying, computer applications in engineering, land use planning, and public works management.

RES:fish

STEPHEN D. JOHANNSEN
Hydrogeology Manager

Role at RMT: Directs the hydrogeology group at RMT's Madison office. Responsible for management of staff work load and quality control/quality assurance for group outputs. Group projects include ground water monitoring research, ground water quality sampling, Remedial Investigation/Feasibility Studies, geophysical investigations, regulatory strategy and permitting, disposal facility siting and feasibility investigations, pump tests and ground water quality assessments.

Project management liaison with clients and regulatory agencies, and project budgeting and scheduling. Manages comprehensive RI/FS, ground water, hazardous waste and land disposal projects.

Experience: Installation of ground and surface water monitoring systems to evaluate the environmental impact of landfilling and surface disposal of wastes; design of borings and piezometer layout; supervision of geologic borings and installation of monitoring equipment; analysis of boring logs, results from soil samples analyses, and piezometer data. Design of water quality monitoring programs and evaluation of existing programs. Collection of water quality samples, analysis of water quality data, and site selection studies for expanding old landfills and developing new ones.

Representative projects involved in Quality Assurance review of hydrogeological and geological investigations for RI/FS projects in New York and Indiana.

Ground water and surface water quality consulting, research, presentations, and papers. This water quality monitoring experience includes sampling and interpretation of data for inorganic and organic contaminants on industrial spill sites and hazardous waste landfills, and planning for and use of safety equipment in potentially dangerous investigations.

Hydrogeologic project planning, supervision, and technical review. Experienced in use and interpretation of ground water models. Also experienced in interpretation of maps, air photos, remote sensing data, and glacial stratigraphy. Other related environmental investigation work has included wetland assessment, water balances, ecological evaluations and the interpretation of regulations.

RES:johannsen

Education: M.S. Soil Science, University of Wisconsin - Madison.

M.S. Water Resources Management, University of Wisconsin - Madison.

B.S. Biology, University of Minnesota.

Publications: Johannsen, S.D. 1979. Ground water quality beneath two sandy barnyards in Wisconsin. M.S. Thesis, Department of Soils Science, University of Wisconsin - Madison.

RES:johannsen

DANIEL E. OMAN, P.E.
Manager, Engineering

Role at RMT:

Manages the Environmental Process Engineering Department of RMT's Madison office.

Conducts feasibility studies for Superfund and RCRA corrective action projects.

Conducts waste characterization and analysis of industrial facilities.

Designs and implements bench-scale testing programs.

Develops and evaluates engineering alternatives for remedial action projects.

Develops and evaluates engineering alternatives for underground storage tank abandonment.

Responsible for QA/QC on waste characterization studies, feasibility studies, hazardous waste projects, wastewater projects, Superfund projects, and underground storage tank projects.

Experience:

In addition to his role as Manager of Engineering. Mr. Oman manages a number of large projects for major industrial clients involving solid and hazardous waste management.

Prior to joining RMT, Mr. Oman worked as a project manager for an environmental consulting firm and as an environmental engineer with the Wisconsin DNR.

Representative Projects:

As feasibility study task leader for RI/FS project for New York client, in charge of directing engineering and drafting efforts, and preparing Feasibility Report, conceptual remedial design and plans, and a public health and environmental assessment feasibility study involved review and screening of remedial action alternatives, including waste treatment options.

Developed and evaluated engineering remedial alternatives for a PCB disposal site.

Designed and implemented a bench-scale testing program to evaluate the effectiveness of different filtration media in removing asbestos fibers from simulated stormwater runoff. Results of the bench-scale testing program were incorporated into the design of filtration berms which were constructed at an asbestos waste landfill to minimize the migration of asbestos in stormwater runoff off-site.

RES:oman

Representative Projects:

Implemented a charge modification program to reduce lead concentration in an industrial sludge. Developed alternatives for management and disposal of hazardous and non-hazardous sludges.

Developed interim operations and closure plan for a landfill receiving waste from two industries and a municipality.

Developed feasibility studies and engineering plans for solid waste landfill permits.

Conducted numerous waste characterization studies for industrial clients in more than 10 different states.

Education:

M.S. Civil and Environmental Engineering. University of Wisconsin - Madison. Thesis: "A Comparison Between Two Laboratory Batch Leaching Procedures and In-Field Leachate Quality at Foundry Waste Landfills."
B.S. Civil Engineering. University of Delaware.

Professional Associations:

Member of American Society of Civil Engineers, Technical Association of the Pulp and Paper Industry, and The Hazardous Materials Control Research Institute.

Presentations:

Oman, D.E. 1986. Design and operation of pulp and paper mill sludge landfills. Presented at Central-Lake States Regional Meeting of the National Council of the paper industry for Air and Stream Improvement, September 18, 1986.

Oman, D.E. 1986. Important considerations when characterizing foundry wastes. Presented at Using Foundry Sand in Highway Construction. April 23-24, 1986.

Oman, D.E. 1985. Effective industrial waste management: case studies. Presented at Effective Management of Industrial Wastes at the University of Minnesota, June 18, 1985.

Oman, D.E. 1985. Waste characterization and analysis: a key to waste management alternatives. Presented at American Foundrymen's Society, Wisconsin Chapter Meeting, March 18, 1985.

RES:oman

JITENDRA T. RADIA, P.E., CIH
Chief, Industrial Hygiene and Air Pollution Control Engineering

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Role at RMT: Directs RMT's industrial hygiene, and air pollution control engineering. Areas of expertise include: environmental audits, airborne toxic dust, fume, and gas sampling surveys; noise surveys; asbestos abatement projects including building surveys, air sampling, preparation of specifications for asbestos removal and encapsulation, contractor liaison, on-site review, and regulatory assistance on asbestos; hazardous waste site surveys; emergency spill response; personal protection programs; exhaust ventilation surveys; energy audits; neighborhood noise surveys; design of engineering control systems for toxic dust, fumes, gases odors and noise; assistance with air emission problems including air dispersion modeling, VOC, particulate and toxic substance emissions, air permits and equipment specification; preparation of bid specifications and bid evaluation for environmental control equipment; contract administration; training programs; programs aimed at achieving compliance with OSHA, EPA and state regulations.

Mr. Radia has an understanding of a wide range of industrial processes and has worked on design and testing of cupola and electric furnace gas cleaning systems and other air pollution control systems, stack sampling, waste heat recovery, energy auditing and computer-aided mathematical modeling of industrial processes.

A representative project involved providing Quality Assurance Review of Health and Safety procedures developed for RMT and subcontractor personnel involved in a Remedial Investigation/Feasibility Study for a CERCLA site in New York.

Education: Master of Science in industrial metallurgy and management, University of Aston, Birmingham, England. Bachelor of Technology, metallurgical engineering, Indian Institute of Technology, Bombay, India.

Experience: August 1975 to July 1980: BCIRA, Birmingham, England Principal Officer - Environmental & Industrial Hygiene Department.

Responsible for providing consulting and advisory services on all aspects of industrial hygiene and air pollution control to the foundry industry for achieving compliance with applicable regulations. Duties included assessment of environmental and industrial hygiene problems for member foundries, specifying suitable remedial control measures;

RES:radia

Experience (Continued):

preparing outline design schemes, specifications and management reports; advising on the design of environmental control equipment, liaison with vendors and Health and Safety Executive officials (equivalent to OSHA); assessing and advising management on capital project schemes and quotations from vendors; responsible for specific research and development projects on the assessment of organic contaminants in foundry atmospheres and on gas cleaning system design including planning, progress, completion, and reporting.

Main areas of activity cover all foundry operations ranging from melting through finishing and include in-plant dust and fume hazard assessment and control, waste disposal, in-plant and external noise assessment and control, odor control, design and testing of cupola and electric furnace gas cleaning systems and other dust/fume control systems, stack sampling and emission control, computer-aided mathematical modeling of foundry processes, and waste heat recovery.

November 1973 to July 1975: Steel Castings Research & Trade Association, Sheffield, England. Senior Investigator - Plant Engineering and Industrial Health Department.

Responsible for advisory services and specific research and development projects related to industrial hygiene and environmental problems in the steel foundry industry. Duties included visiting member foundries to assist with in-plant and external environmental problems; advising management on suitable control measures required to meet regulations; preparing technical reports and outline drawings and specifications for management; financial and technical evaluation of capital project schemes; and liaison with Health and Safety Executive officials and vendors; and specific research and development projects on the improvement of environmental conditions in foundries. Briefly, the main areas of activity included in-plant and external dust, fume and noise surveying and control; waste disposal; design and testing of foundry extraction systems; and industrial safety.

Certification and Professional Affiliations:

Registered as a Professional Engineer in the State of Wisconsin; certified in comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene; Chartered Engineer (UK); member, Occupational Health Committee of the American Foundrymen's Society, the American Industrial Hygiene Association, the Institution of Metallurgists (UK).

RES:radia

BERND W. REHM
Hydrogeologist

Role at RMT:

Group Leader for hydrogeologic services in RCRA and CERCLA progams. His primary responsibilities in this role include project scoping and planning, management and QC review of technical outputs, and RMT program development.

Conducts hydrogeologic investigations for solid and hazardous waste site selection and engineering projects, designs and directs remedial action programs at waste disposal and spill sites, and designs ground water monitoring programs.

Experience:

Mr. Rehm conducted hydrogeologic assessments of solid and liquid waste disposal sites, prepared hazardous waste site assessments, and assisted clients with RCRA Part B permits and RCRA monitoring programs. He has also served as the on-site coordinator and RI Task Leader on several CERCLA investigations. Mr. Rehm was involved in a study conducted on the impact of coal surface mining reclamation, and utility waste disposal on ground water flow and quality. He also participated in a hydrogeologic assessment of a radioactive waste site.

Representative Projects:

Remedial Investigation Task Leader for CERCLA investigations in New York and Minnesota. Also served as on-site coordintor for New York site.

Hydrogeological investigations under RCRA for industrial and waste disposal facilities in Wisconsin, Ohio, Indiana, Illinois, Michigan, and Arkansas (including design, implementation, data anaylsis, and reporting).

Geophysical investigations for the identification of buried waste. Design, implementation, and analysis of materials (drums and solid waste) in Ohio and South Carolina; and ground water contamination in Ohio, Michigan, and South Carolina.

Design, implementation and analysis of aquifer pumping test as part of a ground water supply development.

Evaluation (literature review) of geophysical techniques, solid waste sampling methods and unsaturated zone measurement devices for the Electric Power Research Institute.

RES:rehm

Representative Projects (Continued): Field testing of unsaturated zone measurement devices in fly ash disposal site monitoring program for the Electric Power Research Institute.

Education: Bachelor of Science, 1974, Allegheny College, Meadville, Pennsylvania.
Master of Science, University of Waterloo, Ontario. 1977.

Professional Registration: Professional Geologist, Indiana

Professional Organizations: American Geophysical Union, Association of Ground Water Scientists and Engineers (NWWA)

RES:rehm

THOMAS R. STOLZENBURG, Ph.D.
Group Leader of Applied Chemistry

Role at RMT: Directs research involving ground water sampling and unsaturated zone sampling. Designs waste treatability testing programs for hazardous wastes. Participates in research of leaching of utility solid residue and industrial waste.

Experience: Provided Quality Assurance review of laboratory procedures for analysis of water and soil samples collected as part of a RI/FS field investigation for a New York site, CERCLA.

Designed and conducted an evaluation of ground water sampling devices in a controlled laboratory experiment. Both sampling mechanisms and sample handling procedures were studied for their effects on the chemistry of ground water samples. Potential effects were quantified and samplers were ranked by measurement accuracy. This project was funded by the Electric Power Research Institute.

Studied leaching patterns of chemical constituents from four fly ash types in a project for Wisconsin Power and Light Company. Compared batch leach test results with column methods. Determined primary physical and chemical mechanisms controlling leachate and extrapolated to field conditions.

Designed and directed several hazardous waste treatment testing programs. Identified chemical treatment alternatives to render both solid waste and wastewater nonhazardous.

Developed a procedure and apparatus for evaluating reactivity of wastes to water. A standard method has been proposed and used for wastes from foundries.

Conducted research on the physical and chemical processes which determine the fate of persistent organic chemicals in aqueous environments, and the structural characteristics of organic molecules which favor bioaccumulation. This project was funded by the University of Wisconsin Sea Grant Institute.

Developed a technique for measuring the aqueous solubility of persistent organic compounds (e.g., PCBs, dioxins, etc.).

Prepared an air monitoring program on the Menomonee River Watershed to study the atmospheric deposition of lead and phosphorus. This project was funded by the USEPA and the International Joint Commission on Pollution from Land Use Activities Reference Group.

RES:stolzenbur

Experience (Continued): Developed a simple acid digestion method for the determination of ten elements in ambient aerosols by flame atomic absorption spectrometry.

Education: Doctor of Philosophy in water chemistry from the University of Wisconsin - Madison. Thesis: Metallic Composition of Aerosols over the Menomonee River Watershed.

Bachelor of Science degrees in biology and resource management from the University of Wisconsin, Stevens Point.

RES:stolzenbur

CHRIS HANSEN, CIHT
Industrial Hygienist

Role at RMT: Conduct asbestos abatement projects, develops health and safety plans for industrial, municipal and RMT employees. Conducts airborne toxic dust, fume, and gas sampling surveys; noise surveys; and develops personal protection programs.

Experience: Asbestos Abatement Projects - Conducts asbestos building evaluation surveys, labeling, air sampling; develops operations and maintenance programs for asbestos, develops health and safety specifications for asbestos abatement projects and provides regulatory assistance on asbesots.

Health and Safety Plan Development - served as on-site health and safety officer for a major RI/FS project in New York. Conducted training on the use of respirators and SCBA equipment for personnel involved in the clean up of PCB and organic waste. Evaluates employee exposure to chemical contaminants, noise, and heat stress to determine compliance with OSHA standards.

Air Pollution - conducts surveys for indoor air pollution including monitoring for formaldehyde, carbon monoxide, carbon dioxide, and organics. Performs maintenance and calibration of equipment used for air monitoring, noise monitoring, and ventilation measurements.

Chemical Handling - recommends control methods, ventilation systems, personal protection equipment, and routine and emergency procedures.

Health Hazards - develops promotional programs for target health hazards including hazard communication and asbestos exposure.

Education: Associate degree in applied sciences-industrial hygiene. Extensive course work in the field of industrial hygiene.

Other: Certified Industrial Hygiene Technologist (CIHT) by the American Board of Industrial Hygiene.

Member of American Conference of Governmental Industrial Hygienists and the American Industrial Hygiene Association (AIHA). Serves as Secretary of the Wisconsin Chapter of AIHA.

RES:hansen1

JOEL L. LUNDGREN
Assistant Laboratory Director

Role at RMT: Manage the daily operation of the laboratory. Assist in the development of the laboratory capital budget, manage the expenses of the overall operation and coordinate the development of support programs internal to the operation.

Experience: Have been with RMT for 1.5 years as Assistant Laboratory Director. Before joining RMT, was employed as laboratory supervisor with General Electric Company where was responsible for a comprehensive analytical services operation providing problem solving efforts to a manufacturing and technology site plant (5 years). Employed with General Electric Company for 5 years as an analytical chemist. Primary experience was developing test methods for a production plant and training quality control personnel in test performance. Equipped and staffed an analytical test method development laboratory.

Representative Projects: Development of an environmental laboratory services unit including speficiation and purchase of lab equipment and maintaining section performance to EPA and state specifications; organized a problem solving task force of members from a multidivision operation to resolve critical manufacturing technical problems; development of a cost reduction program for a laboratory to reduce operating expenses of lab testing; preparation and researching the operating cost of an environmental laboratory to assess the pricing structure of laboratory services.

Education: Received a B.S. in Chemistry, University of Wisconsin, June 1968 and a Ph.D. in Analytical Chemistry, Northern Illinois University, August 1976.

Professional Affiliations: Member of American Chemical Society. Past chairman of local section and held officer positions in several ACS section committees.

Publications: Application of Ferroin Type Chromugens Immobilized by Adsorption on Styrene Divinyl Benzene Copolymer, Analytical Chemistry, 1977.

RES:lundgren

JOHN P. HANSON
Soils Laboratory Supervisor

Role at RMT: Responsible for the day-to-day operations of the Soils Laboratory at RMT. This includes scheduling testing programs, coordinating priorities, supervising other soils technicians, subcontract arrangements for other physical soils work, inventory control, report preparation, budgeting and purchasing equipment and supplies, technical training, invoicing, sample analysis, lab maintenance, and QA/QC program and implementation. Also serve as Radiation Safety Officer.

Experience: As soils engineering technician at RMT, worked on physical analysis of soils and waste materials. Types of analysis include moisture content, grain size analysis, specific gravity, Atterberg limits, moisture density tests, organic contents, permeability tests, etc. Other than soils for site investigations and construction documentation, work on waste materials such as slag, foundry sand, foundry sludge, fly ash, papermill sludge, etc. Research projects such as leachate compatibility studies, soil and synthetic liners, revegetation analysis, calcium carbide treatment, weathering studies, etc. Field experience in water sampling, soil sampling, surveying, water levels, etc. Course work in repro-graphics, soil mechanics, and soil testing. Assisted in developing a revegetation program for foundry waste landfill sites.

Education: Bachelor of Science, Landscape Architecture, with business and industry option, University of Wisconsin-Madison. University soils courses and hands-on soils laboratory training.
Troxler Electronic Laboratories Certification.

Professional Affiliations: Member of ASTM

RES:hanson

THOMAS E. KOCH
Hydrogeologist

Role at RMT: Project manager for remedial investigation projects including hydrogeologic investigations, well installation, and soil sampling.

Experience: Mr. Koch's experience includes serving as a project manager for remedial investigation studies, including site inspection, coordination and ground water contamination studies. He has acted as team leader for many investigations involving site inspections, monitoring and private well sampling, soil sampling, and subsurface water sampling. Mr. Koch has also utilized and supervised the use of portable tripods, submersible pumps, field filters, air drive bailers, surveying equipment, conductivity meters, pH meters, hollow-stem drilling, self-contained breathing apparatuses, air compressors, respirators, HNU, explosimeters, radiation detectors, various surface water and bottom sediment sampling devices, and numerous other pieces of safety and work equipment.

As hydrogeologist for the United States Geological Survey, Mr. Koch collected and logged samples of well sites and observed well drilling operations, prepared graphic representations of hydrologic data, utilized and prepared standard computer programs, and utilized a variety of methods and equipment to collect hydrogeological data.

Education: Master of Science degree in natural environmental systems and a Bachelor of Science degree in environmental systems from Northern Illinois University.

Professional Affiliations: Member of the National Water Well Association.

RES:koch

SCOTT A. MILLER
Project Engineer

Role at RMT:

Senior level project engineer in the Environmental Process Engineering Department of RMT's Madison office.

Conducts feasibility studies for Superfund and RCRA corrective action projects.

Develops and evaluates engineering alternatives for remedial action projects.

Develops and evaluates engineering alternatives for ground water contamination and protection projects.

Develops and evaluates engineering alternatives for underground storage tank abandonment.

Experience:

Prior to joining RMT, Mr. Miller worked as a Project Manager and prinicipal Project Engineer for environmental and geotechnical engineering firms. In these capacities, Mr. Miller was involved in hazardous waste remediation projects, remedial and water supply investigations, landfill designs, aquifer protection projects, and surface water hydrology, and hydraulics projects.

Representative Projects:

Feasibility study task leader for RI/FS project for Minnesota client, directed engineering and drafting efforts, and prepared Feasibility Study Report, including conceptual remedial design and plans, a public health and environmental assessment, a cost evaluation, and a screening of remedial alternatives.

Developed, evaluated, and implemented remedial alternatives at oil and gasoline spill sites.

Developed expansion, interim operation, and closure plans for municipal waste landfills.

Developed aquifer protection plans for municipal ground water supplies.

Managed environmental audits and risk evaluations at industrial facilities.

Performed watershed studies for pollution abatement and flooding reduction.

Developed conceptual and final designs for hydraulic structures.

RES:millerS

Education:	M.S. Civil Engineering. Massachusetts Institute of Technology. B.S. Engineering, Swarthmore College.
Professional Registrations:	Registered Professional Engineer, State of Vermont.
Professional Affiliations:	Member of American Society of Civil Engineers American Geophysical Union and National Water Well Association

RES:millerS