NON-TIME-CRITICAL REMOVAL ACTION NO. 1 DEMONSTRATION OF COMPLIANCE PLAN

Solvents Recovery Service of New England, Inc.
Superfund Site

Southington, Connecticut

Prepared For:
SRSNE PRP Group

June 1995

BLASLAND, BOUCK & LEE, INC.
ENGINEERS & SCIENTISTS

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Table of Contents

1.0 - Introduction

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1.1 General

This Demonstration of Compliance Plan (DCP) was prepared by Blasland, Bouck & Lee, Inc. (BB&L) on behalf of the Solvents Recovery Service of New England, Inc. Superfund Site (SRSNE Site) PRP Group to verify the effectiveness of the Non-Time-Critical Removal Action No. 1 (NTCRA 1) ground-water containment and treatment system at the SRSNE Site in Southington, Connecticut. The original DCP, described in detail in the "NTCRA 1 100% Ground-Water Containment and Treatment System Design Report" (100% Design Report, BB&L, December 1994), was revised pursuant to United States Environmental Protection Agency (USEPA) comments, as presented in a letter to the SRSNE PRP Group dated April 21, 1995. In accordance with the NTCRA 1 Statement of Work (SOW), the DCP provides specific performance standards for the ground-water containment and treatment system, and criteria that will be used to evaluate the effectiveness of the system.

The ground-water containment system will be installed in the Containment Area, which is defined in the SOW as the general area within the former Cianci Property that is downgradient (east) of the Operations Area, upgradient (west) of the Lower Till Window, north of the Town of Southington wellfield property, and south of a 36-inch-diameter underground pipeline that traverses the former Cianci Property (Figure 1). In vertical section, the Containment Area includes the saturated outwash deposits from the water table to the top of the glacial till. Based on available geologic data for the site, a layer of glacial till is laterally continuous immediately above the weathered top of bedrock throughout the Containment Area (HNUS, May 1994; ENSR, June 1994; BB&L, December 1994). The thickness of the saturated outwash deposits above the till ranges from approximately 13 feet in the west-central portion of the Containment Area to approximately 24 feet along the eastern edge of the Containment Area.

The ground water extracted by the containment system will be pumped to the ground-water treatment system located in the treatment system building (Figure 1). Treated effluent from the treatment system will be discharged into the Quinnipiac River.

1.2 Ground-Water Containment System Design

The proposed design for the ground-water containment system includes an array of ground-water extraction wells and a downgradient hydraulic barrier (steel sheetpiling) wall that will hydraulically and physically contain overburden ground water entering the Containment Area from the SRSNE Operations Area (Figure 2). The overburden ground-water extraction wells will extract overburden ground water on the upgradient (west) side of the hydraulic barrier wall, establishing an inward hydraulic gradient across the hydraulic barrier wall. The design of the hydraulic barrier wall and the ground-water extraction wells are described in detail in the 100% Design Report.

The results of numerical ground-water flow (MODFLOW) simulations, presented in Appendix B of the 100% Design Report (BB&L, December 1994) and the Addendum to Appendix B (BB&L, March 1995), predict that a hydraulic divide will be established downgradient of the hydraulic barrier wall during the implementation of the ground-water containment system. The overburden ground-water elevation (head) immediately inside (west of) the hydraulic barrier wall will be lower than the head outside (east of) the hydraulic barrier wall. The hydraulic divide (stagnation point) is expected to be situated approximately 100 feet downgradient of the hydraulic barrier wall during operation of the NTCRA 1 ground-water containment system. The hydraulic gradient will be generally inward toward the containment system, creating a continuum of hydraulic control in the overburden. East of the hydraulic divide, the hydraulic gradient will be eastward toward the river. West of the two ends of the hydraulic barrier wall, ground-water flow will converge into the hydraulic barrier wall.

1.3 Ground-Water Containment and Treatment System Performance Standards

This DCP describes the acquisition and interpretation of field data that will be used to verify that the ground-water containment and treatment systems comply with the performance standards specified in the SOW. The performance standards for the containment system are to:

- Prevent the migration of all contaminated overburden ground water from the Operations Area of the SRSNE Site; and

- Prevent the migration of all contaminated overburden ground water from the Operations Area into the bedrock aquifer through the lower till window that forms the eastern boundary of the Containment Area.

The containment system performance standards will be evaluated based on the Reversal of Gradient Test, as presented in the SOW. The acquisition and analysis of field data for the Reversal of Gradient Test are described in Section 2.0 of this DCP.

The treatment system performance standards require that the system treat the impacted ground water pumped from the containment system to concentrations that meet all applicable or relevant and appropriate requirements (ARARs) prior to discharge to the Quinnipiac River. The treatment system effluent limits will be developed by the Connecticut Department of Environmental Protection (CT DEP).

1.4 Plan Organization

The remaining sections of this DCP describe:

- The acquisition of field data that will be used to evaluate the effectiveness of the ground-water containment and treatment system (Section 2.0);
- Data interpretation and reporting (Section 3.0); and
- Adjustments to the ground-water containment and treatment system (Section 4.0).

2.0 - Field Data Acquisition

2.1 General

The data required to demonstrate compliance with the ground-water containment and treatment system performance standards will be obtained in the form of head measurements from wells and piezometers installed in the area of the containment system, flow measurements from the containment system recovery well array, and treatment system effluent pumping rates and analytical data. Field methods used to obtain the necessary data to demonstrate compliance will be performed in general accordance with the relevant standard operating procedures presented in the "Final Soil, Groundwater, and Additional Studies Workplan for the SRSNE Superfund Site" (ENSR, March 1994), which are included in Appendix A.

As specified in the SOW, the effectiveness of the ground-water containment system at achieving the performance standards will be evaluated based on the results of a Reversal of Gradient Test. The successful Reversal of Gradient Test will show that the following two requirements are achieved during operation of the ground-water containment system:

1. Within the Containment Area, overburden ground water east and downgradient of the Operations Area is flowing in the direction of the ground-water extraction wells; and

2. Overburden ground-water flow is reversed and maintained in the direction of the ground-water extraction wells within the area defined by (west of) the interpreted hydraulic divide that forms east of the ground-water containment system.

The Reversal of Gradient Test is to be demonstrated within a 30-day Compliance Period, which begins at the initiation of full-scale operation of the ground-water containment and treatment system, and during the entire operation of the system thereafter. The Reversal of Gradient Test results will be evaluated based on field measurements of hydraulic heads at a specified array of monitoring locations installed within the saturated outwash. To verify that each of the two requirements of the Reversal of Gradient Test are satisfied during operation of the ground-water containment system, two different groups of wells and piezometers will be monitored, as described below.

2.2 Reversal of Gradient Test - Requirement #1

To confirm that overburden ground water east and downgradient of the Operations Area within the Containment Area is flowing in the direction of the ground-water extraction wells (Reversal of Gradient Test Requirement #1), hydraulic head measurements will be obtained at the following wells/piezometers installed within the overburden in the general vicinity of the ground-water containment system: RW-1, RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, RW-8, RW-9, RW-10, RW-11, MW-409, MW-415, MWL-301, MWL-304, MWL-305, MWL-307, MWL-308, MWL-310, P-16, P-2B, PZO-1, PZO-2, and PZ0-3. Data will also be obtained at wells MWL-302, MWL-306, MWL-309, MWL-311, and TW-7A to assess the hydraulic response in the area between the hydraulic barrier wall and the Quinnipiac River. Also, to evaluate the vertical hydraulic gradient between the outwash deposits and the underlying till or bedrock during operation of the overburden ground-water containment system, comparative hydraulic head data will be measured at the following wells and piezometers installed in the till or bedrock: MW-408, MW-414, MW-416, PZR-1, PZR-2, and PZR-4. Ground-water elevations will be measured weekly at the locations listed above during the Compliance Period and the first 12 months of operation of the containment system.

2.3 Reversal of Gradient Test - Requirement #2

To verify that overburden ground-water flow is reversed and maintained in the direction of the ground-water extraction wells within the area defined by (west of) the interpreted hydraulic divide that forms east of the containment system (Reversal of Gradient Test Requirement #2), five pairs of compliance piezometers, CPZ-1 through CPZ-10, will be installed at the locations shown on Figure 2. The SOW, which was prepared under the assumption that the containment system would consist of only extraction wells and/or trenches, indicated that separate compliance piezometers should be installed in the shallow, middle, and deep outwash at each compliance monitoring location. The use of an essentially impermeable hydraulic barrier, however, renders separate piezometers unnecessary.

The NTCRA 1 compliance monitoring network includes one fully penetrating overburden piezometer at each compliance piezometer location. This design modification was approved by USEPA at a meeting with the SRSNE PRP Group on January 10, 1995 and documented in a letter from BB&L to USEPA dated January 12, 1995. At each compliance piezometer location, an overburden piezometer screened throughout the shallow, intermediate, and deep portions of the saturated outwash will be installed within a borehole drilled to the top of till. Each overburden piezometer will be constructed using Schedule 40 PVC and will include a 0.010-inch-slot screen installed within a Morie #0 or equivalent sand filter pack. A minimum one-foot-thick, hydrated bentonite seal will be placed above the filter pack, and the remainder of the borehole will be grouted to ground surface. In addition, a bedrock piezometer will be installed adjacent to each overburden compliance piezometer to allow an assessment of the hydraulic influence of NTCRA 1 on the bedrock flow system (Figure 2). Each piezometer will be developed to enhance the hydraulic connection between the piezometer and the surrounding formation.

Hydraulic head data, as well as the appropriate overburden hydraulic head data, will be measured at these bedrock piezometers on the last day of the Compliance Period. Hydraulic head data will be obtained from the overburden compliance piezometers on the same schedule as described for the bedrock piezometers.

The hydraulic gradient will be considered reversed, and inward toward the Containment Area when the hydraulic head data measured at the overburden compliance piezometers inside the hydraulic barrier wall (at locations CPZ-1, CPZ-3, CPZ-5, CPZ-7, and CPZ-9) are at least 0.3 feet lower than the heads measured at the corresponding overburden compliance piezometers located immediately opposite the wall. For example, hydraulic head data will be compared between the following pairs of overburden piezometers: CPZ-1 and CPZ-2; CPZ-3 and CPZ-4; CPZ-5 and CPZ-6; CPZ-7 and CPZ-8; CPZ-9 and CPZ-10.

As specified in the SOW, to verify the continuity of the reversal of the hydraulic gradient across the hydraulic barrier wall, relatively continuous hydraulic head measurements will be recorded at piezometers CPZ-5 and CPZ-6. These data will be obtained every four hours during the Compliance Period and the first 30 days thereafter, and on a daily basis during the remaining 11 months of the first year of containment-system operation.

2.4 Flow Rate Data

In addition to the hydraulic head measurements described above, the flow rate from the containment system will be recorded continuously using an in-line totalizing flow meter and a strip chart recorder (located in the treatment system building) throughout the Compliance Period and the first 12 months thereafter. The cumulative volume of ground water pumped by the containment-system extraction wells will be documented daily during the first week of the Compliance Period, and on a weekly basis for the remainder of the Compliance Period and the first 12 months of system operation. The effluent from the treatment system will also be monitored to determine flow rate and water-quality characteristics, as required by the terms of the effluent limits to be established by the CT DEP.

3.0 - Demonstration of Compliance Reports

3.1 General

The results of the ground-water containment and treatment system monitoring activities described above will be presented in Demonstration of Compliance Reports, which will be submitted for USEPA review and approval within seven days of the end of the Compliance Period, and monthly thereafter. These reports will contain the information necessary to demonstrate compliance with the performance standards for the ground-water containment and treatment system, descriptions of adjustments made to the system, and conclusions regarding compliance, as well as the basis for these conclusions. If compliance is not demonstrated, based on the data acquired under the DCP, a plan and schedule will be presented describing the actions that will be undertaken to establish compliance with the performance standards in the SOW.

3.2 Ground-Water Containment System

To demonstrate the effectiveness of the ground-water containment system, Demonstration of Compliance Reports will include:

- A table of hydraulic head data measured each week during the Compliance Period, on the last day of the Compliance Period (in the first Compliance Report submittal) and every 30th day thereafter (in subsequent reports);

- Contour maps created using hydraulic head data measured on the last day of the Compliance Period in the first Compliance Report submittal and, in subsequent reports, every 30th day thereafter, which will show the hydraulic gradient and the location of the hydraulic divide within the saturated outwash; and

- Hydrographs created using hydraulic head data from compliance piezometers CPZ-5 and CPZ-6, which will verify the temporal continuity of the gradient reversal across the hydraulic barrier wall.

The hydraulic head contours will be used to interpret the location of the hydraulic divide and to verify that all overburden ground water between the Operations Area and the extraction wells, and between the extraction wells and the interpreted hydraulic divide, is flowing in the direction of the extraction wells. The tabulated hydraulic head data measured at pairs of compliance piezometers situated at the same depth interval on either side of the hydraulic barrier wall will be used to verify that the hydraulic gradient across the wall is inward (toward the west), based on a minimum hydraulic head differential of 0.3 feet as measured on either side of the wall. Also, tabulated hydraulic head data from wells/piezometers installed in the bedrock will be compared to the hydraulic head data from nearby wells/piezometers installed in the outwash to verify that the vertical gradient is upward in the vicinity of the containment system. The hydrographs created from data measured at compliance piezometers CPZ-5 and CPZ-6 will be used to verify that the gradient reversal at the hydraulic barrier wall is continuous through time. These hydrographs will also be compared to the hydraulic head contours, and a description of this comparison will be provided in the Demonstration of Compliance Reports.

Area(s) not in compliance with the performance standards and the location of the hydraulic divide will be identified based on the hydraulic head contour map presented in each Demonstration of Compliance Report. If the containment system performance standards are not demonstrated based on the compliance monitoring data, a plan and schedule will be presented in the same Demonstration of Compliance Report describing actions that will be taken to achieve the containment system performance standards.

3.3 Ground-Water Treatment System

The Demonstration of Compliance Reports will also present the following information pertinent to the ground-water treatment system operation:

- Tabulated summary of the total volume of water pumped from the Containment Area and discharged to the Quinnipiac River;

- Tabulated summary of the analytical results from discharge monitoring specified by the CT DEP; and

- Tabulated comparison of the discharge monitoring analytical results to the effluent limits established by the CT DEP.

If the CT DEP effluent limits are not demonstrated by the compliance monitoring data for the treatment system, a plan and schedule will be presented in the Demonstration of Compliance Report describing modifications to the operation or design of the treatment system necessary to achieve the ground-water treatment system performance standards. Each Demonstration of Compliance Report will present a concluding statement addressing the status of compliance with the performance standards, as well as the other ARARs specified in the SOW. The current status of potential ARARs for NTCRA 1 is summarized on Table 1 of this document.

4.0 - System Adjustments

4.0 - System Adjustments

If, based on the review of hydraulic head data measured at the site during the ground-water containment system operation, the system does not appear to satisfy the containment-system performance standards, adjustments will be made to the containment system to establish and maintain hydraulic containment. These adjustments may include modification of ground-water extraction rates at the extraction wells or installation of additional extraction wells, if necessary. Similarly, if the analytical results of samples from treatment system discharge do not meet the effluent limits established by the CT DEP, the treatment system will be modified, as necessary, to attain the requirements for discharge.

5.0 - References

5.0 - References

Blasland, Bouck & Lee, Inc. "Ground-Water Containment System Modeling Results for Bedrock Ground-Water Extraction," Addendum to Appendix B of "Non-Time-Critical Removal Action 100% Ground-Water Containment and Treatment System Design Report," March 1995.

Blasland, Bouck & Lee, Inc. "Non-Time-Critical Removal Action 100% Ground-Water Containment and Treatment System Design Report." Solvents Recovery Service of New England, Inc. Site, December 1994.

ENSR Consulting & Engineering. "Groundwater Technical Memorandum, Soils Study Report, and Additional Studies Report for the SRSNE Superfund Site, Volume III - Additional Studies Report." Draft, June 1994.

Halliburton NUS Environmental Corporation. "Final Remedial Investigation Report." Solvents Recovery Service of New England, Inc. Site, May 1994.

Table

Table 1

SRSNE, Inc. Superfund Site
Southington, Connecticut

<u>NTCRA 1 Potential ARARs</u>

Authority	Requirement	Requirement Synopsis	Action to be Taken to Achieve ARAR	ARAR Status
Federal Regulatory Requirement	National Emissions Standards for Hazardous Air Pollutants (NESHAPS) (40 CFR 61)	These standards regulate emissions of hazardous air pollutants from specific manufacturing plants.	Air emissions from air strippers or other vapor control devices shall meet the requirements of these standards.	All tanks covered and vented to vapor-phase carbon.
Federal Criteria, Advisories, Guidance	EPA Carcinogen Assessment Group Potency Factors	EPA Carcinogenic Potency Factors are used to compute the individual incremental cancer risk resulting from exposure to carcinogens.	These factors were used to assess health risks from VOC carcinogens in soil.	N/A
Federal Criteria, Advisories, Guidance	EPA Risk Reference Doses (RfDs)	RfDs are dose levels developed by EPA for non-carcinogenic effects.	EPA RfDs were used to characterize risks due to exposure to VOCs in soil.	N/A
Federal Regulatory Requirements	Wetlands Executive Order (E.O. 11988), 40 CFR Part 6, Appendix A	Federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands.	It is anticipated that the dewatering will not impact the wetlands. If wetlands are impacted, there is no practical alternative to in-situ soil treatment because of health risk from excavation of the soil. If wetlands are impacted, all alternatives shall include all practicable means of minimizing harm to wetlands.	Conceptual Wetlands Mitigation Plan submitted to USEPA on 4/28/95. USEPA approved on 6/9/95. Detailed mitigation design due on 9/30/95.
State Regulatory Requirements	Connecticut Inland Wetlands and Water Courses Regulations (Title 22a)	The regulations limit activities that deposit material in, alter, or pollute inland wetlands and water courses.	These regulations shall be met when water is discharged to the river.	Substantive requirement for water discharge to be issued by CT DEP. Draft issued 2/16/95.
Federal Regulatory Requirements	CWA-National Pollutant Discharge Elimination Systems (NPDES) (40 CFR 122, 125)	Any point-source discharge must meet substantive NPDES requirements which include meeting discharge limitations.	Treated ground water discharged to the Quinnipiac River shall comply with these requirements.	Substantive requirement for water discharge to be issued by CT DEP. Draft issued 2/16/95.
Federal Regulatory Requirements	National Ambient Air Quality Standards for Particulates (40 CFR 50)	This regulation sets standards for particulate matter.	Emissions of dust shall be controlled to ensure that standards are met during construction and operation of NTCRA.	N/A

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Table 1
(Cont'd)
SRSNE, Inc. Superfund Site
Southington, Connecticut

NTCRA 1 Potential ARARs

Authority	Requirement	Requirement Synopsis	Action to be Taken to Achieve ARAR	ARAR Status
Federal Regulatory Requirements	Resource Conservation and Recovery Act (40 CFR 264, Subpart A)	Regulations contain air emission standards for process vents, closed-vent systems and control devices at hazardous waste treatment, storage, or disposal facilities.	The air sparging/vapor extraction alternative shall meet the requirements of these regulations these regulations apply to.	N/A
Federal Regulatory Requirements	Resource Conservation and Recovery Act (40 CFR 265, Subpart P)	Regulations contain requirements for air emissions from thermal units.	The catalytic oxidation unit shall meet the requirements of these regulations as well as other alternatives these regulations apply to.	N/A
Federal Regulatory Requirements	Resource Conservation and Recovery Act (40 CFR 264, Subpart B)	Regulations contain general requirements for facilities.	The NTCRA shall meet these requirements.	NTCRA 1 facilities have been designed to meet substantive requirements of RCRA.
Federal Criteria, Advisories Guidance	Control of Air Emissions from Superfund Ground-Water Sites, (OSWER Directive 9355.0-28)	Guidance on the control of air emissions from CERCLA air strippers for ground-water treatment.	Any alternative involving use of an air stripper shall meet these requirements.	N/A
State Regulatory Requirements	Connecticut Water Quality Standards (Sec. 22a-426)	These requirements consist of surface water classifications which apply to certain waters within the state.	Discharges to surface waters shall be treated to ensure that there are no violations to water quality standards.	Substantive requirement for water discharge to be issued by CT DEP. Draft issued 2/16/95.
State Regulatory Requirements	Connecticut Discharge Permit Regulations (Sec. 22a-430)	These requirements supplement the CWS NPDES permit requirements for discharges to surface waters.	Ground water treated on site and discharged to the Quinnipiac River shall comply with the substantive standards contained in these regulations.	Substantive requirement for water discharge to be issued by CT DEP. Draft issued 2/16/95.
State Regulatory Requirements	Connecticut Air Pollution Control Regulations (Sec. 2a-174-29)	The regulations limit emissions from source. Hazardous air pollutant compounds have been identified under these regulations. Standards or thresholds have been developed.	Emissions from all components of the selected NTCRA treatment alternative shall meet these substantive requirements in these regulations.	All tanks covered and vented to vapor-phase carbon.

Table 1
(Cont'd)
SRSNE, Inc. Superfund Site
Southington, Connecticut

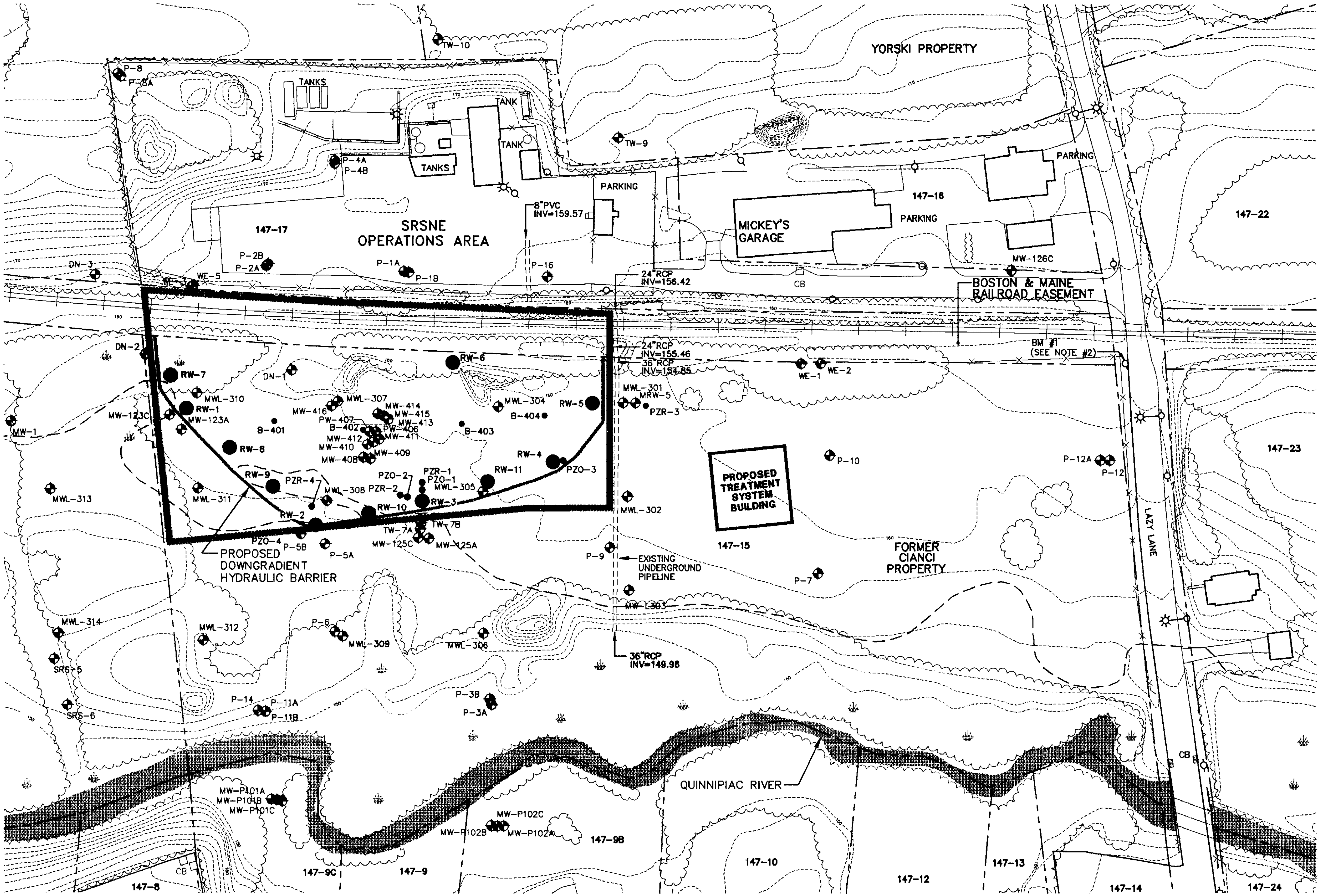
<u>NTCRA 1 Potential ARARs</u>

Authority	Requirement	Requirement Synopsis	Action to be Taken to Achieve ARAR	ARAR Status
State Regulatory Requirements	Connecticut Primary Ambient Air Quality Standards for Particulates (Sec. 22a-174-24)	This regulation sets standards for emissions of particulate matter.	Emissions of dust shall be controlled to ensure that standards are met during construction and operations of NTCRA.	N/A

Notes:

1. This table adapted from NTCRA 1 Statement of Work.
2. NA = Not applicable.

Figures



LEGEND

- PROPERTY LINE
- 100-YEAR FLOOD LIMIT
- WATER
- RIVER
- WETLAND
- RW-1 OVERBURDEN EXTRACTION WELL
- P-10 MONITORING WELL
- PZR-3 PIEZOMETER
- CONTAINMENT AREA
- 147-15 TAX MAP NUMBER
- EXISTING STRUCTURE
- VEGETATION
- EXISTING CONTOUR
- FENCE
- UTILITY POLE
- LIGHTING

NOTES

1. SITE PLAN TAKEN FROM DIVERSIFIED TECHNOLOGIES CORP., 556 WASHINGTON AVE., NORTH HAVEN, CT, DATED 6/93. TOPOGRAPHY REPORTED TO HAVE BEEN DIGITIZED FROM TOWN OF SOUTHINGTON TOPOGRAPH MAPS G-7, G-8, G-9; PHOTOGRAPHY DATED NOV. 1978, SCALE: 1"=100'. PROPERTY LINES REPORTED TO HAVE BEEN DIGITIZED AND LOT NUMBERS TAKEN FROM "PROPERTY MAP, TOWN OF SOUTHINGTON" MAPS 134 & 147, SCALE: 1"=100' BY DIVERSIFIED TECHNOLOGIES CORPORATION.
2. BENCHMARK #1 IS AT ELEVATION 164.03. PK NAIL; S'LY SIDE; POLE #9049.
3. THE 100-YEAR FLOOD LIMIT AND WETLAND AREAS WERE TAKEN FROM THE FINAL REMEDIAL INVESTIGATION REPORT (HNUS, MAY 1994).
4. THE LOCATION OF EXISTING WELLS AND PIEZOMETERS ARE APPROXIMATE ONLY.

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NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

No.	Date	Revisions	Init

In charge of ________
Designed by ________
Drawn by ________
Checked by ________

BLASLAND, BOUCK & LEE, INC.
ENGINEERS & SCIENTISTS
SYRACUSE, NEW YORK

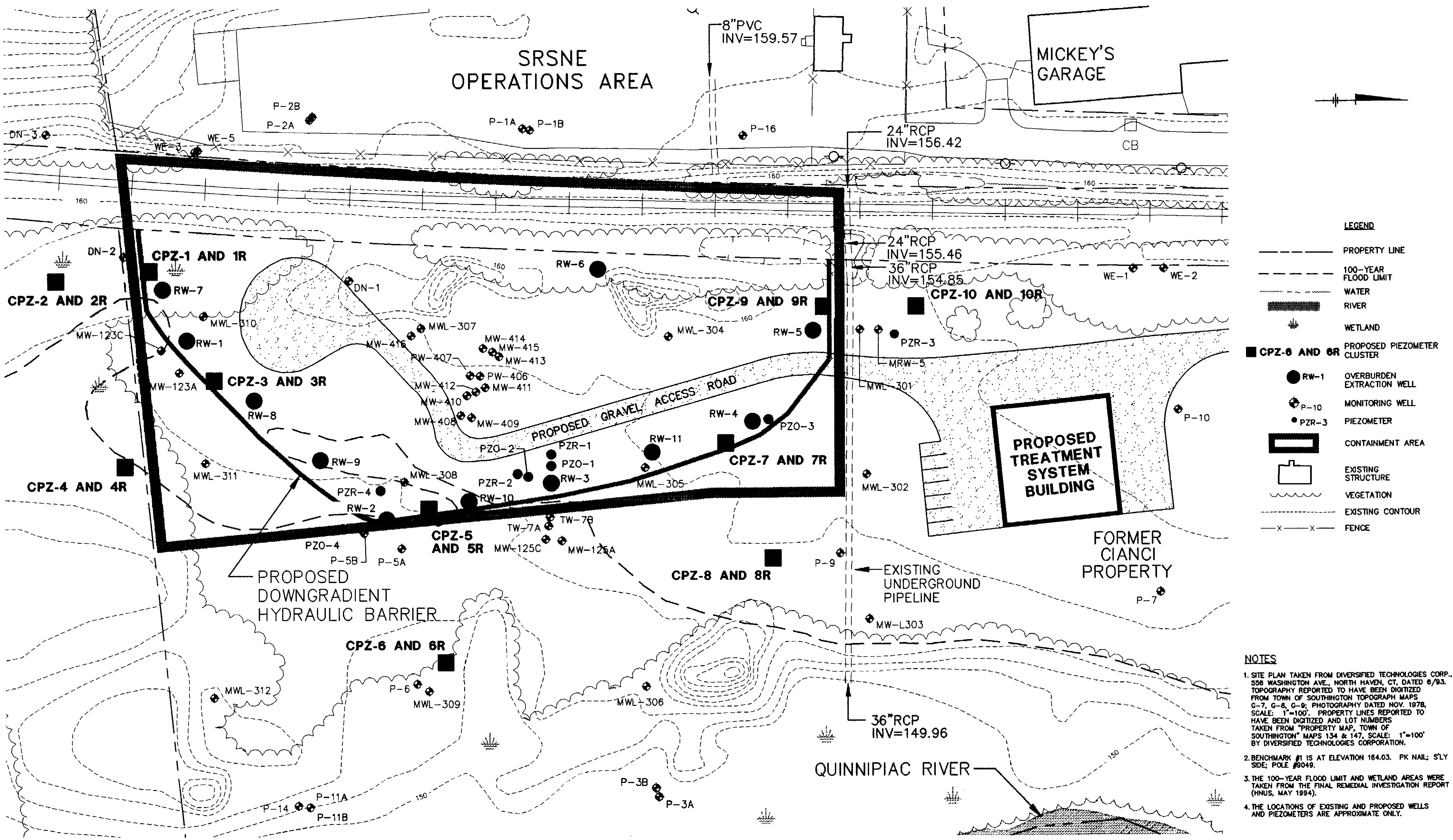
SRSNE PRP GROUP • SOUTHINGTON, CONNECTICUT

DEMONSTRATION OF COMPLIANCE PLAN
SRSNE SITE

SITE PLAN

File Number 083.25
Date JUNE 1995

FIGURE **1**



NOTES

1. SITE PLAN TAKEN FROM DIVERSIFIED TECHNOLOGIES CORP., 558 WASHINGTON AVE., NORTH HAVEN, CT, DATED 6/93. TOPOGRAPHY REPORTED TO HAVE BEEN DIGITIZED FROM TOWN OF SOUTHINGTON TOPOGRAPH MAPS G-7, G-8, G-9; PHOTOGRAPHY DATED NOV. 1978, SCALE: 1"=100'. PROPERTY LINES REPORTED TO HAVE BEEN DIGITIZED AND LOT NUMBERS TAKEN FROM "PROPERTY MAP, TOWN OF SOUTHINGTON" MAPS 134 & 147, SCALE: 1"=100' BY DIVERSIFIED TECHNOLOGIES CORPORATION.
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3. THE 100-YEAR FLOOD LIMIT AND WETLAND AREAS WERE TAKEN FROM THE FINAL REMEDIAL INVESTIGATION REPORT (HNUS, MAY 1994).
4. THE LOCATIONS OF EXISTING AND PROPOSED WELLS AND PIEZOMETERS ARE APPROXIMATE ONLY.

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6/22/95-54 PMC DMW
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NO ALTERATIONS PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW

No.	Date	Revisions	Init

In charge of ________
Designed by ________
Drawn by ________
Checked by ________

BLASLAND, BOUCK & LEE, INC.
ENGINEERS & SCIENTISTS
SYRACUSE, NEW YORK

SRSNE PRP GROUP • SOUTHINGTON, CONNECTICUT
DEMONSTRATION OF COMPLIANCE PLAN
SRSNE SITE

PROPOSED HEAD MONITORING LOCATIONS

File Number 083.25
Date JUNE 1995
FIGURE 2

Appendix

Appendix A
Standard Operating Procedures
Index

Number	Title
7115	Subsurface Soil Sampling, Rev. 3
7130	Ground-Water Sample Collection from Monitoring Wells, Rev. 2
7220	Monitoring Well Construction and Installation, Rev. 3
7221	Monitoring Well Development, Rev. 1
7315	Operation/Calibration of HNU Photoionization Analyzer, Rev. 2
7510	Packaging and Shipment of Samples, Rev. 2
7600	Decontamination of Field Equipment, Rev. 3

Source: "Final Soil, Groundwater, and Additional Studies Workplan for the SRSNE Superfund Site" (ENSR, March 1994).

ENSR STANDARD OPERATING PROCEDURE

Number: 7115 Date of Issue: 2nd Qtr.1993

Revision: 3

Title: Subsurface Soil Sampling (Split-Spoon)

Organizational Acceptance	Authorization	Date
Originator	Charles Martin	3/2/84
Technical Reviewer	Arthur Lazarus	3/2/84
Technical Reviewer	Elaine Moore	3/2/84
Technical Reviewer		
Quality Assurance	Scott Whittemore	3/2/84

Revision #	Changes	Authorization	Date
1	• Update	Scott Whittemore Charles Martin Arthur Lazarus Elaine Moore	3/2/84 3/2/84 3/2/84 3/2/84
2	• Use of recirculated water must be documented in Field Log Books • All field documentation must be completed ASAP to ensure traceability • Miscellaneous rewording	Scott Whittemore Elaine Moore Charles Martin	10/15/86 10/15/86 10/16/86
3	• Format update • Boring Log update	Mike Dobrowolski	4/27/93

Organizational acceptance signatures are maintained on file with the original document in the Quality Assurance Library in Acton, MA.

Subsurface Soil Sampling (Split-Spoon)

Date:	2nd Qtr. 1993
Revision No:	3
Author:	Charles Martin
Discipline:	Geosciences

1.0 PURPOSE AND APPLICABILITY

This SOP describes the methods used in obtaining subsurface soil samples for identification of soil grain-size distributions, stratigraphic correlations, and chemical analysis (if required). Subsurface soil samples are obtained in conjunction with soil boring and monitoring-well installation programs and provide direct information as to the physical makeup of the subsurface environment. This SOP covers subsurface soil sampling by split-spoon only, as this is the means most often used for obtaining samples from unconsolidated deposits. (See also. ENSR SOP 7220 - Monitoring Well Construction).

2.0 RESPONSIBILITIES

2.1 Project Geologist/Engineer

It shall be the responsibility of the project geologist/engineer to observe all activities pertaining to subsurface soil sampling to ensure that all the standard procedures are followed properly, and to record all pertinent data on a boring log. It is also the geologist/engineer's responsibility to indicate to the contract driller at what specific depth samples shall be collected. The geologist/engineer will maintain custody of all samples until they are shipped or delivered to their appropriate destination.

2.2 Driller

It shall be the responsibility of the contract driller to provide the necessary materials for obtaining subsurface soil samples including the split-spoon sampler. Standard Penetration Tests (SPT) (ASTM: 1586-67) will be conducted by the contract driller if required by the project. Equipment decontamination shall also be the responsibility of the driller.

3.0 REQUIRED MATERIALS

In addition to those materials provided by the contract driller, the geologist/engineer will provide:

- sample bottles and labels
- boring logs
- field notebook
- chain-of-custody forms and tape
- ENSR SOP 7210, Rock Core Drilling
- ENSR SOP 7220, monitoring Well Installation
- ENSR SOP 7510, Packaging and Shipment of Samples
- ENSR SOP 7600, Decontamination of Equipment

4.0 METHOD

4.1 General Procedures

The sampling depth interval is typically one (1) sample per every five (5) vertical feet with additional samples taken, at the discretion of the project geologist/engineer, when significant textural, visual or odor changes are encountered.

Specific requirements described in a project's task plan may call for deviations from the standard procedures but these will be taken into account on a project by project basis. Any deviations from specified procedures will be recorded on the boring log and the Field Log Book with rationale.

4.2 Advancing Casing

4.2.1 The casing shall be advanced to the required depth. All loose material within the casing shall be removed prior to sampling. The casing shall be advanced according to project requirements. Borings are typically advanced by two methods, drive-and-wash casing, and hollow-stem augering. The casing shall be of the flush joint or flush couple type and of sufficient size to allow for soil sampling, coring, and/or well installation. All casing sections shall be straight and free of any obstructions. Hollow-stem augers or solid flight augers with casing may be used according to specific project requirements as described in the project task plan. If hollow-stem augers are to be used, the bit shall be equipped with a plug device to be removed at the required sampling depth.

4.2.2 For those borings which encounter obstructions, the casing shall be advanced either past or through the obstruction by drilling, mechanically fracturing, or blasting (if required). If the obstruction is bedrock, a rock core shall be taken according to project requirement and following the standard procedures for rock coring (ENSR SOP # 7210 Rock Core Drilling).

4.2.3 The use of recirculated water shall not be permitted when casing is being driven, unless specified in the project task plan, directed and properly documented (in field notebook, logs) by the geologist/engineer.

4.2.4 If recirculated water is used all loose material within the casing shall be removed by washing to the required sampling depth using a minimum amount of water. Care shall be taken to limit recirculation of the wash water to those times when the water supply is extremely limited or unavailable.

4.3 Standard Procedures - Soil Sampling

4.3.1 Subsurface soil samples shall be obtained using a split-tube type similar (split spoon) having a 2-inch O.D. with a corresponding 1 3/8-inch I.D. and a 18- or 24-inch long sample capacity. It shall be equipped with a ball check valve and may require a flap valve or basket-type retainer for loose-soil sampling. Sampling frequency will be as stated in Section 4.1, or as otherwise specified in the project task plan.

4.3.2 Sampling depth shall be independently determined by the inspecting geologist, and any discrepancies shall be resolved prior to obtaining the sample.

4.3.3 Samples shall be obtained using the standard penetration test (SPT), which allows for determination of resistance within the deposits. The sampler shall be driven using a 140-pound hammer with a vertical drop of 30-inches using 1 to 2 turns of the rope on the cathead. A certificate indicating exact weight may be required for documentation purposes. The number of hammer blows required for every 6 inches of penetration shall be recorded on the boring log.

4.3.4 The sampler shall be immediately opened upon removal from the casing. If the recovery is inadequate, another attempt shall be made before drilling progresses. Adequate recovery should be no less than 12 inches, not including any residual wash material brought up with the sample.

4.3.5 The sample shall be split if necessary, placed in the appropriate container, labelled, and placed in the storage box. The boring log and the sample container/label should contain the following information for each sample: site name, boring location, depth, blow counts, recovery, sample number and collection date. The type of material shall be indicated in the boring logs and will be described using the Unified Soil Classification System (ASTM: D2487-69 and D2488-69).

4.3.6 The sampler shall be cleaned with water between attempts in order to prevent cross-contamination. If further decontamination is required it will be conducted in accordance with ENSR SOP 7600, Decontamination of Equipment.

4.3.7 Proper procedures for delivery to the designated laboratory shall be initiated when all samples are collected. This includes packaging, shipping with sample logs, analysis request forms, and chain of custody forms. Refer to ENSR SOP 7510, Packaging and Shipment of Samples.

5.0 QUALITY CONTROL

Quality control requirements are dependent on project-specific circumstances and objectives. These requirements should be described in the Project Quality Assurance Plan.

6.0 DOCUMENTATION

Various forms are required to ensure that adequate documentation of each sample is followed and will include:

- Sample logs
- Boring logs
- Field Log Book entries
- Chain of custody forms
- Shipping forms

The Field Log Book will be kept as an overall log of all samples collected throughout the study. All documents are retained in the appropriate project files indefinitely. It is important that all field documentation be as complete as possible to ensure traceability (QA/QC requirements).

7.0 REFERENCES

Not applicable.

ENSR

BORING LOG

Sheet 1 of

Project No. ____ Date - Start ____ Finish ____ Boring ____

Project Name ____ Drilling Co. ____

Location ____ Drilling Method ____

Total Depth ____ Inspector ____ Reviewer ____

Remarks ____

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 In.	Depth Range	Rec.			

M890278

ENSR **STANDARD OPERATING PROCEDURE**

Number: 7130 **Date of Issue:** 2nd Qtr.1993

Revision: 2

Title: Ground-Water Sample Collection from Monitoring Wells

Organizational Acceptance	Authorization	Date
Originator	Christopher Carlio	3/13/84
Technical Reviewer	Arthur Lazarus	3/13/84
Technical Reviewer	Elaine Moore	3/13/84
Technical Reviewer		
Quality Assurance	Scott Whittemore	3/13/84

Revision #	Changes	Authorization	Date
1	• Addition of Equipment Checklists	Scott Whittemore	9/5/86
		Charles Martin	9/11/86
	• The use of electronic sounding devices for water-level measurements has been removed	Elaine Moore	9/10/86
	• Unnecessary steps have been deleted from decontamination procedures		
	• Volume requirements for ground-water purging has been changed from 4 - 10 to 3 - 10 volumes		
	• Additional bailing details added		
	• Additonal figures were added		
	• Miscellaneous rewording		
2	• Ground-Water Sample Collection Record, Chain-of-Custody and Sample Label form updates	Mike Dobrowolski	4/27/93
	• Format update		

Organizational acceptance signatures are maintained on file with the original document in the Quality Assurance Library in Acton, MA.

Ground-Water Sample Collection from Monitoring Wells

Date: 2nd Qtr. 1993
Revision No: 2
Author: Christopher Carlio
Discipline: Geosciences

1.0 PURPOSE AND APPLICABILITY

This standard operating procedures (SOP) is concerned with the collection of valid and representative samples from ground-water monitoring wells. The scope of this document is limited to field operations and protocols applicable during ground-water sample collection.

2.0 RESPONSIBILITIES

The site coordinator or designee will have the responsibility to oversee and ensure that all ground-water sampling is performed in accordance with the project-specific sampling program and this SOP. In addition, the site coordinator must ensure that all field workers are fully apprised of this SOP. The field team is responsible for proper sample handling as specified in SOP 7510, Packaging and Shipment of Samples.

3.0 REQUIRED MATERIALS

The list below identifies the types of equipment which may be used for a range of ground water-sampling applications. From this list, a project-specific equipment list will be selected based upon project objectives, the depth to ground-water, purge volumes, analytical parameters and well construction. The types of sampling equipment are as follows:

- Purging/Sample Collection

  Bailers
  Centrifugal Pump
  Submersible Pump
  Peristaltic Pump

- Sample Preparation/Field Measurement

  pH Meter
  Specific Conductance Meter
  Filtration Apparatus

Water-Level Measurement Equipment

Additional equipment to support sample collection and provide baseline worker safety will be required to some extent for each sampling task. The additional material are separated into two primary groups: general equipment which is reusable for several samplings, and materials which are expendable.

- General

  Project-specific Sampling Plan
  Deionized-water dispenser bottle
  Decontamination Solvent-dispenser bottle
  Site-specific Health & Safety equipment (gloves, respirators, goggles)
  Field data sheets and/or log book
  Preservation solutions
  Sample containers
  Buckets and intermediate containers
  Coolers
  First-Aid kits

- Expendable Materials

  Bailer Cord
  Respirator Cartridges
  Gloves
  Water Filters
  Chemical-free paper towels
  Plastic sheets

Equipment checklists have been developed to aid in field trip organization and should be used in preparation for each trip.

- ENSR SOP 7131. Field Filtration of Water Samples for Inorganics

- ENSR SOP 7510, Packaging and Shipment of Samples

- ENSR SOP 7600, Decontamination of Equipment

4.0 METHOD

4.1 Water-Level Measurement

4.1.1 Prior to obtaining a water-level measurement, cut a slit in one side of a plastic sheet and slip it over and around the well, creating a clean surface onto which the sampling equipment can be positioned. This clean working area should be a minimum of eight feet square. Care will be taken not to kick, transfer, drop, or in any way let soil or other materials fall onto this sheet unless it comes from inside the well. Do not place meters, tools, equipment, etc. on the sheet unless they have been decontaminated.

4.1.2 Unlock and/or open the monitoring well. Enter a description of condition of the security system and protective casing on the Ground-Water Sample Collection Record shown in Figure 1.

4.1.3 Check for the measuring point for the well. The measuring point location should be clearly marked on the outermost casing or identified in previous sample collection records. If no measuring point can be determined, a measuring point should be established. Typically, the top (highest point) of the protective or outermost well casing will be used as the measuring point. The measuring point location should be described on the Ground-Water Sample Collection Record and should be the same point used for all subsequent sampling efforts.

4.1.4 To obtain a water-level measurement lower a decontaminated steel or fiberglass tape into the monitoring well. Care must be taken to assure that the water-level measurement device hangs freely in the monitoring well and is not adhering to the wall of the well casing. The water-level measuring tape will be lowered into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined (to hundredth of a foot) by repeatedly raising and lowering the tape to converge on the exact measurement. The water-level measurement as well as the point of measurement should be entered on the Ground-Water Sample Collection Record.

4.1.5 Decontamination

The measurement device shall be decontaminated prior to and immediately after use in accordance with ENSR SOP 7600. Decontamination of Equipment. Generally, only that portion of the tape which enters the water table should be cleaned. It is important that the measuring tape is never placed directly on the ground surface.

4.2 Purge-Volume Computation

All monitoring wells to be purged prior to sample collection. Depending upon the ease of purging, 3 to 10 volumes of ground water present in a well shall be withdrawn prior to sample collection or one volume if the well can be purged dry. The volume of water present in each well shall be computed based on the length of water column and well casing diameter. The water volume shall be computed using the volume factors or graph presented in Figure 2.

4.3 Well Purging

Purging must be performed for all ground-water monitoring wells prior to sample collection in order to remove stagnant water from within the well casing and ensure that a representative sample is obtained. The following sections explain the proper procedures for purging and collecting water samples from monitoring wells.

Three general types of equipment are used for well purging: bailers, surface pumps, or down-well submersible pumps.

In all cases pH and/or specific conductance will be monitored during purging. Field parameter values will be entered on the Ground-Water Sample Collection Record along with the corresponding purge volume.

4.3.1 Bailing

In many cases bailing is the most convenient method for well purging. Bailers are constructed using a variety of material: generally, PVC stainless steel, and Teflon®. Care must be taken to select a specific type of bailer that suits a study's particular needs. Teflon® bailers are generally most "inert" and are used most frequently. Keep in mind the diameter of each monitoring well so that the correct size bailers are taken to the site. It is preferable to use one bailer per well: however. field decontamination is a relatively simple task if required.

Bailing presents two potential problems with well purging. First. increased suspended solids may be present in samples as a result of the turbulence caused by raising and lowering the bailer through the water column. High solids concentrations may require that total suspended solids (TDS) and the chemical character of solids be evaluated during sample analyses. Second. bailing may not be feasible for wells which require that greater than twenty (20) gallons be removed during purging. Such bailing conditions mandate that long periods be spent during purging and sample collection or that centrifugal pumps be used. All ground-water collected from monitoring wells for subsequent volatile organic compounds analyses shall be collected using bailers. regardless of the purge method.

4.3.2 Surface Pumping

Ground-water withdrawal using pumps located at the ground surface is commonly performed with centrifugal or peristaltic pumps.

All applications of surface pumping will be governed by the depth to the ground-water surface. Peristaltic and centrifugal pumps are limited to conditions where ground water need only be raised through approximately 20 feet of vertical distance. The lift potential of a surface pumping system will depend upon the net positive suction head of the pump and the friction losses associated with the particular suction line, as well as the relative percentage of suspended particulates.

Surface pumping can be used for many applications of well purging and ground-water sample collection. In all cases, pumping cannot be used for the collection of samples to be analyzed for volatile organic compounds (VOCs).

- Peristaltic Pump

  Peristaltic pumps provide a low rate of flow typically in the range of 0.02-0.2 gallons/min (75-750 ml/min). For this reason, peristaltic pumps are not particularly effective for well purging. Peristaltic pumps are suitable for purging situations where disturbance of the water column must be kept minimal for particularly sensitive analyses. Peristaltic pumps are most often used in conjunction with field filtering of samples and therefore can be used to obtain water samples for direct filtration at the wellhead.

- Centrifugal Pump

  Centrifugal pumps are designed to provide a high rate of pumping, in the range of 10-40 gallons per minute (gpm), depending on pump capacity. Discharge rates can also be regulated somewhat provided the pump has an adjustable throttle.

  When centrifugal pumps are used, samples should be obtained from the suction (influent) line during pumping by an entrapment scheme (Figure 3). Construction of this sampling scheme is relatively simple and will not be explained as part of this SOP. It is suggested that if samples cannot be obtained before going through the pump, that samples be obtained by using a bailer once pumping has ceased. Collecting samples from the pump discharge is not recommended.

4.3.3 Submersible Pump

Submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than twenty (20-30) feet and the depth or diameter of the well requires that a large purge volume be removed during purging.

ENSR uses the Johnson-Keck pump model SP-81 which has a 1.75 inch diameter pump unit. The pump diameter restricts use to monitoring wells which have inside diameters equal to or greater than two (2) inches. As with other pump-type purge/sample collection methods. submersible pumps will not be used for the collection of samples for analyses of volatile organic compounds. Submersible pumps should never be used for well development as this will seriously damage the pump.

4.4 Sample Collection Procedures

4.4.1 Bailing

Obtain a clean/decontaminated bailer and a spool of polypropylene rope or equivalent bailer cord. Using the cord at the end of the spool, tie a bowline knot or equivalent through the bailer loop. Test the knot for security and the bailer itself to ensure that all parts are intact prior to inserting the bailer into the well.

Remove the protective foil wrapping from the bailer, and lower the bailer to the bottom of the monitoring well and cut the cord at a proper length. Boiler rope should never touch the ground surface at any time during the purge routine.

Raise the bailer by grasping a section of cord using each hand alternately in a "rocking" action. This method requires that the samplers' hands be kept approximately 2-3 feet apart and that the bailer rope is alternately looped onto or off each hand as the bailer is raised and lowered.

Bailed ground water is poured from the bailer into a graduated bucket to measure the purged water volume.

For slowly recharging wells, the bailer is generally lowered to the bottom of the monitoring well and withdrawn slowly through the entire water column. Rapidly recharging wells should be purged by varying the level of bailer insertion to ensure that all stagnant water is removed. The water column should be allowed to recover to 70-90% of its static volume prior to collecting a sample. Water samples should be obtained from midpoint or lower within the water column.

Samples collected by bailing will be poured directly into sample containers from bailers which are full of fresh ground water. During sample collection. bailers will not be allowed to contact the sample containers.

4.4.2 Peristaltic Pump

Place a new suction and discharge line to the peristaltic pump. Silicon tubing must be used through the pump head. A second type of tubing may be attached to the silicon tubing to create the suction and discharge lines. Such connection is advantageous for the purpose of reducing tubing costs. but can only be done if airtight connections can be made. Tygon tubing will not be used when performing well purging or collecting samples for organic analysis. The suction line must be long enough to extend to the static ground-water surface and reach further should drawdown occur during pumping.

Measure the length of the suction line and lower it down the monitoring well until the end is in the upper 2-5 inches of the water column present in the well. Start the pump and direct the discharge into a graduated bucket.

Measure the pumping rate in gallons per minute by recording the time required to fill a selected volume of a bucket. Flow measurement shall be performed three times to obtain an average rate.

The pumping shall be monitored to assure continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts.

Measurements of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record.

Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and specific conductance) have stabilized.

When the sample bottles are prepared, each shall be filled directly from the discharge line of the peristaltic pump. Care will be taken to keep the pump discharge line from contacting the sample bottles. Ground-water samples requiring filtration prior to placement in sample containers, will be placed in intermediate containers for subsequent filtration or filtered directly using the peristaltic pump.

At each monitoring point when use of the peristaltic pump is complete, all tubing including the suction line, pump head and discharge line must be disposed of. In some cases where sampling will be performed frequently at the same point, the peristaltic pump tubing may be retained between each use in a clean zip-lock plastic bag.

4.4.3 Centrifugal Pump

- Direct Connection Method (Note: This method requires that the well casing be threaded at the top.)

  Establish direct connection to the top of the monitoring well if possible using pipe connections, extensions, and elbows, with Teflon® tape wrapping on all threaded connections. If the centrifugal pump will subsequently be used for sample collection, a sample isolation chamber will be placed in the suction line configuration as shown in Figure 3.

  Prime the pump by adding tap water to the pump housing until the housing begins to overflow.

  Start the pump and direct the discharge into a graduated bucket or a bucket of known capacity (>2.5 gallons).

  Start the pump and measure the pumping rate in gallons per minute by recording the time required to fill the graduated bucket. Flow measurement should be checked periodically to determine if pumping rates are continuous, fluctuating, or diminishing. If discharge stops, the pump will be throttled back to determine if pumping will restart at a lower rate. If pumping does not restart, the pump should be shut off to allow the well to recharge.

Measurements of pH and specific conductance will be made periodically during well purging. All readings will be entered on the Ground-Water Sample Collection Record. Samples will be collected after the required purge volume has been withdrawn and the field parameters (pH and specific conductance) have stabilized. Samples should be collected from an in-line discharge valve or with a bailer. The pump should be properly decontaminated between wells.

- Down-Well Suction-Line Method

  Lower a new suction line into the well. The suction line will have a total length great enough to extend to the water table and account for a minimum of five (5) feet of drawdown. Note should be made that drawdown may exceed the depth where pumping will terminate as a result of a limitation derived from suction-line conditions and the lift potential of the pump. All connections should be made using Teflon® ferrules and Teflon® thread wrapping tape. Run the pump as per Section 4.4.3.

  At each monitoring well when use of a centrifugal pump is complete, all suction line tubing should be disposed of properly.

4.4.4 Submersible Pump

Prior to using a submersible pump, a check will be made of well diameter and alignment. A 1.75 inch diameter decontaminated cylindrical tube should be lowered to the bottom of each monitoring well to determine if the alignment or plumbness of a well is adequate to accommodate the submersible pump. All observations will be entered in the Ground-Water Sample Coilection Record.

Slowly lower the submersible pump into the monitoring well taking notice of any roughness or restrictions within the riser.

Count the graduations on the pump discharge line and stop lowering when the stainless steel portion is below the uppermost section of the static water column within monitoring well. Secure the discharge line and power cord to the well casing.

Connect the power cord to the power source (i.e., rechargeable battery pack or auto battery) and turn the pump on (forward mode). When running, the pump can usually be heard by listening near the well head.

Voltage and amperage meter readings on the pump discharge must be checked continuously. The voltage reading will decline slowly during the course of a field day representing the use of power from the battery. Amperage readings will vary depending upon the depth to water table. Amperage readings greater than 10 amps usually indicate a high solids content in the ground water which may cause pump clogging and serious damage. If a steady increase in amperage is observed, the pump should be shut off, allowed to stop, switched to the reverse mode, stopped again and then placed in forward mode. If high amperage readings persist, the pump should be withdrawn and checked using the large upright cylinder and tap water. Ground-water conditions such as high solids may require that an alternate purge/sample method be used.

Drawdown must also be monitored continuously by remaining near the well at all times and listening to the pump. When drawdown occurs, a metallic rotary sound will be heard as the pump intake becomes exposed and ceases to discharge water, but continues to run. The pump should be lowered immediately to continue pumping water within the uppermost section of the static water column.

NOTE: The submersible pump cannot be allowed to run while not pumping water for more than five seconds or the pump motor will burn out.

If drawdown continues to the extent that the well is pumped dry, the pump should be shut off and the well allowed to recharge. This on/off cycle may need to be repeated several times in order to purge the well properly.

Measurements of the pumping rate, pH, and specific conductance should be made periodically during well purging.

All readings and respective purge volumes should be entered on the Ground-Water Sample Collection Record.

While pumping is on-going and when sample bottles are prepared, bottles will be filled directly from the discharge line of the pump taking care not to touch sample bottles to the discharge line.

At each monitoring well when use of the submersible pump is complete, the pump, discharge line and power cord shall be decontaminated according to the procedures contained ENSR SOP 7600 Decontamination of Equipment.

4.5 Sample Preparation

4.5.1 Prior to sample collection or shipment, ground-water samples may require filtration and/or preservation dependent on the specific type of analysis required.

4.5.2 Specific preservation techniques are described in the EPA document, Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA-600/4-82-029). The EPA manual and laboratory manager should be consulted during the planning stage of the project. Project-specific sampling plans shall be assembled using the approved procedures obtained from the EPA manual.

4.5.3 Filtration

Ground-water samples collected for dissolved metals analyses will be filtered prior to being placed in sample containers in accordance with ENSR SOP 7131, Field Filtration of Water Samples for Inorganics.

Ground-water filtration will be performed using a peristaltic pump and a 0.45 micron, water filter. Typically the water filters are 142 mm in diameter and are usually placed in 142 mm polycarbonate housings.

The filtration of ground-water samples shall be performed either directly from the monitoring well or from intermediate sample containers such as decontaminated buckets. In either case. well purging shall be performed first. Fresh ground water shall then be filtered and discharged from the filtration apparatus directly into sample containers.

For most dissolved metal analyses. pH adjustment of the sample is also required and shall be performed after filling the sample bottles. This is generally accomplished using laboratory supplied compounds such as sulfuric or nitric acid and sodium hydroxide. The preservative shall be identified in the Quality Assurance or Sampling Plan.

5.0 QUALITY CONTROL

Quality control requirements depend on project-specific circumstances and objectives and should be addressed in the Quality Assurance Project Plan (QAPP).

6.0 DOCUMENTATION

A number of different documents must be completed and maintained as a part of ground-water sampling effort. The documents provide a summary of the sample-collection procedures and conditions, shipment method, the analyses requested and the custody history. The list of documents is:

- Ground-water sample collection record
- Sample labels
- Chain of custody forms and tape
- Shipping receipts

Sample labels shall be completed at the time each sample is collected and will include the information listed below. A sample label is shown in Figure 4.

- Client or project name
- Sample number
- Designation (i.e., identification of sample point no.)
- Analysis

- Preservative (e.g., filtration, acidified pH<2 HNO_3)

- Sample-collection date

- Sampler's name

Figure 5 displays the chain of custody record used by ENSR. The chain of custody form is the record of sample collection and transfer of custody. Information such as the sample collection date and time of collection, sample identification and origination, client or project name shall be entered on each chain of custody record. In accordance with 40 CFR 261.4(d) the following information must accompany all ground water samples which are known to be non-hazardous and to which U.S. Department of Transportation and U.S. Post Office regulations do not apply. Such information is:

- sample collector's name, mailing address and telephone number,

- analytical laboratory's name, mailing address and telephone number,

- quantity of each sample,

- date of shipment, and

- description of sample.

The chain of custody forms provide a location for entry of the above-listed information.

7.0 REFERENCES

EPA. Handbook for Sampling and Sample Preservation of Water and Wastewater EPA-600/4-82-029, September 1982.

Geotrans, Inc. RCRA Permit Writer's Manual, Ground-Water Protection prepared for U.S. EPA. Contract No. 68-01-6464, October 1983.

Code of Federal Regulations, Chapter 40 (Section 261.4(d).

ENSR

WELL NO.

GROUND WATER SAMPLE COLLECTION RECORD

Project No. ______________ Date __________ Time: Start __________ am/pm

Project Name ______________________________ Finish __________ am/pm

Location ______________________________

Weather Conds.: ______________ Collector ______________

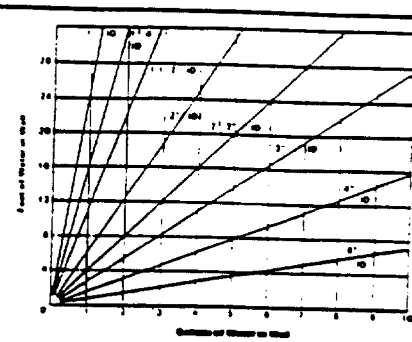
1. WATER LEVEL DATA: (measured from ToC)

a. Total Well Length __________ Well Casing Type __________

b. Water Table Depth __________ Casing Diameter __________

c. Length of Water Column __________ (a-b)

d. Calculated Purgeable Volume __________



2. WELL PURGEABLE DATA

a. Purge Method ______________________________

b. Required Purge Volume (@ ______ well volumes) ______________________________

c. Field Testing: Equipment Used ______________________________

Volume Removed	T°	PH	Spec. Cond.	Color	Other

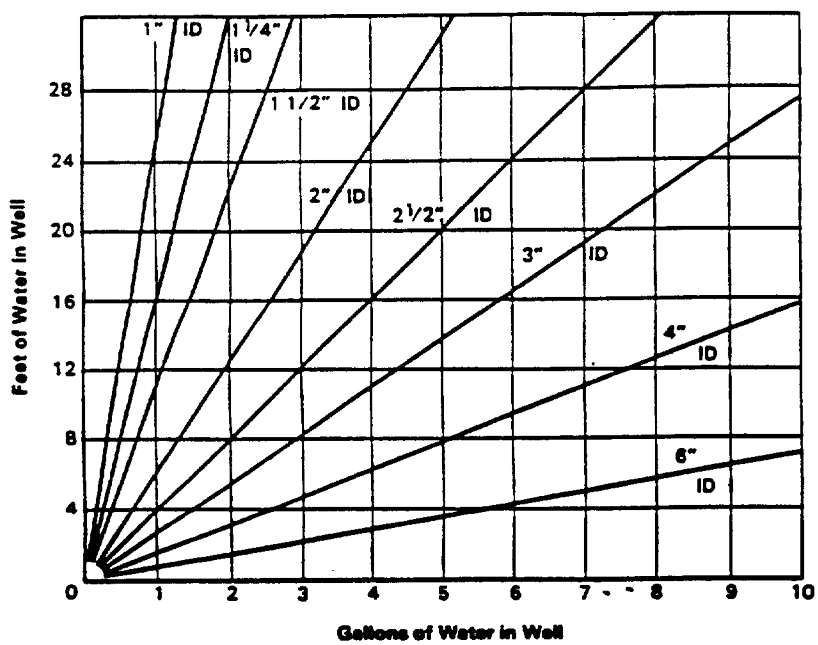
3. SAMPLE COLLECTION: Method ______________________________

Container Type	Preservation	Analysis Req.

Comments ______________________________

M880844

Figure 1



(a) Graphical Explanation

Volume/Linear Ft. of Pipe		
ID(in)	Gal	Liter
1/4	0.003	0.010
3/8	0.006	0.022
1/2	0.010	0.039
3/4	0.023	0.087
1	0.041	0.154
2	0.163	0.618
3	0.367	1.39
4	0.653	2.47
6	1.47	5.56

(b) Volume Factors

Figure 2 Purge Volume Computation

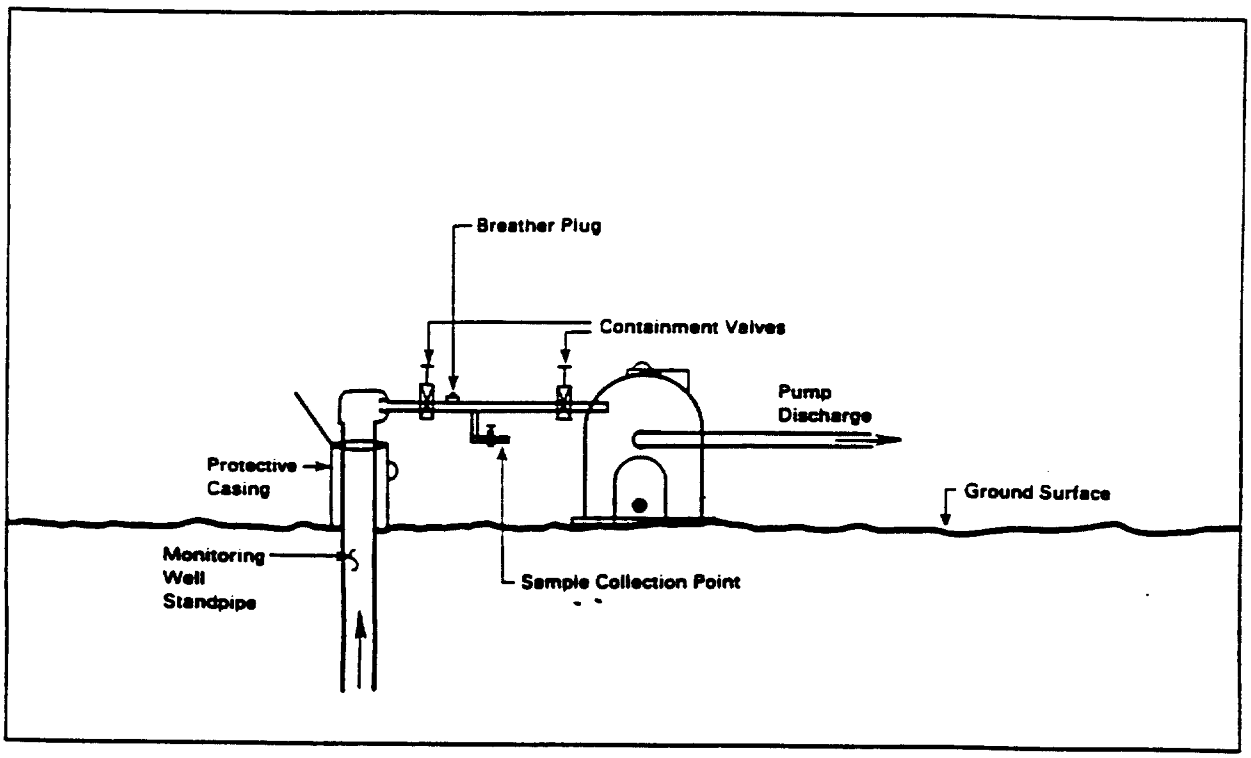


Figure 3 Down Well Suction Line Configuration

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ENSR Consulting and Engineering

SITE ________________ PROJECT# ______________

SAMPLE ID# ______________________________

ANALYSIS ________________________________

PRESERVATIVE: HNO_3, H_2SO_4, OTHER ____________

DATE ___________________ TIME ______________

SAMPLER ________________________________

OTHER __________________________________

Figure 4 Sample Container Label

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CHAIN OF CUSTODY RECORD

Page ___ of ___

Client/Project Name:	Project Location:
Project Number:	Field Logbook No.:
Sampler: (Print Name) /Affiliation:	Chain of Custody Tape No.:
Signature	Send Results/Report to:

Field Sample No./ Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered	Analysis Requested						Lab I.D.	Remarks

Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Analytical Laboratory (Destination):
Relinquished by: (Print Name) Signature	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	
Relinquished by: (Print Name) Signature	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Serial No 6118

Figure 5 Sample Chain-of-Custody Record

ENSR STANDARD OPERATING PROCEDURE

Number: 7220 **Date of Issue:** 2nd Qtr.1993

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Title: Monitoring Well Construction and Installation

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Originator	Tim Cosgrave	3/23/89
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Technical Reviewer	Maury Veatch	5/2/89
Technical Reviewer		
Quality Assurance	Scott Whittemore	5/12/89

Revision #	Changes	Authorization	Date
2	Complete re-write	Tim Cosgrave	3/23/89
		William Gregg	4/18/89
		Maury Veatch	5/2/89
		Scott Whittemore	5/12/89
3	Format update	Mike Dobrowolski	4/27/93

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Monitoring Well Construction and Installation

Date:	2nd Qtr. 1993
Revision No:	3
Author:	Tim Cosgrave
Discipline:	Geosciences

1.0 PURPOSE AND APPLICABILITY

This SOP establishes the method for installing ground water monitoring wells. These wells will be installed to monitor the depth to ground water, to measure aquifer properties and to obtain samples of ground water for chemical analysis.

1.1 Quality Assurance Planning Considerations

The following aspects of monitoring well design and installation procedures will depend on project-specific objectives and circumstances and should be addressed in the Quality Assurance Project Plan (QAPP).

- Construction materials for well screen, riser, filter pack and seals;
- Borehole drilling method;
- Depth and length of screen;
- Location and composition of seals; and
- Well head completion and protection.

Some states and EPA Regions have promulgated comprehensive guidelines for monitoring well configuration and for subsurface investigation procedures. These guidelines will be followed as applicable and deviations from this SOP to accommodate those requirements will be explained in the QAPP.

1.2 Health and Safety Considerations

Monitoring well installation may involve chemical hazards associated with materials in the soil or aquifer being explored; and always involves physical hazards associated with the drill rig and well construction methods. When wells are to be installed in locations where the aquifer and/or overlying materials may contain chemical hazards, a Health and

Safety Plan must be prepared and approved by the Health and Safety Officer before field work commences.

In addition, the following protective measures are required:

- all persons within 50 feet of the drill rig must wear hard hats and safety shoes. Hearing protection must be provided during periods of excessive noise; and

- personnel who are not directly involved in overseeing, inspecting or performing the drilling and well installation will remain at least 100 feet away from the drill rig.

2.0 RESPONSIBILITIES

2.1 Project Manager

2.1.1 It is the responsibility of the Project Manager to ensure that each project involving monitoring well installation is properly planned and executed, and that the safety of personnel from chemical and physical hazards associated with drilling and well installation is protected.

2.1.2 Some states have specific requirements regarding the construction of monitoring wells. It is the responsibility of the Project Manager to understand these regulations and any permitting requirements that may be necessary, and to ensure that the well installation program complies with all state and local requirements.

2.2 Project Geologist/Engineer

It is the responsibility of the Project Geologist or Engineer to directly oversee the construction and installation of the monitoring well by the subcontract driller to ensure that the well-installation specifications defined in the project work plan are adhered to and that all pertinent data are recorded on the appropriate forms.

3.0 REQUIRED MATERIALS

3.1 The monitoring well shall consist of a commercially available well screen constructed of PVC, stainless steel, teflon, or fiberglass pipe of minimum

2-inch nominal diameter. The length of the screen and the size of the screen slots shall be determined by the inspecting geologist or specified in the project work plan depending upon the grain-size distribution of the aquifer materials. PVC, stainless steel, steel, teflon.or fiberglass riser pipe of minimum 2-inch nominal diameter shall be used to complete the monitoring well to ground surface. The riser pipe shall be connected by flush-threaded, coupled or welded watertight joints. No solvent or anti-seize compound shall be used on the joints.

3.2 The section of riser pipe that sticks up above ground shall be protected by a steel guard pipe set at least 2 feet into a concrete surface seal. The top of the guard pipe shall have a vented lockable cap. Alternatively, a road box may be installed, if it satisfies the security requirements of the project. Road-box installations must use a watertight seal inside of the riser pipe to prevent surface water from entering the well.

3.3 Other materials used for well construction include silica sand, bentonite, cement, and a calibrated tape for length measurements and water-level measurements. Construction materials are generally provided by the drilling subcontractor.

3.4 ENSR SOP 7221, Monitoring Well Development

4.0 METHOD

4.1 Borehole Requirements

The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals.

Rotary drilling methods requiring bentonite-based drilling fluids should be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, significantly reducing the permeability of the material adjacent to the well screen.

If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site.

4.2 Procedure for Construction

4.2.1 After drilling and soil sampling have been completed. total open depth of the borehole shall be measured with a weighted, calibrated tape measure.

4.2.2 If the borehole has been advanced to a depth greater than that of the bottom of the well to be installed, bottom grouting, or bentonite pellet sealing, of the borehole will be required. A heavy plumb bob on a calibrated tape shall be used to determine the total depth of the boring. This depth measurement shall be used with the required bottom elevation of the well screen to calculate the thickness of the grout plug. If bottom grouting is necessary, then provisions should be made to support the screen and riser pipe to prevent them from sinking into the grout. The depth to the top of the grout should be checked often with a weighted tape measure.

4.2.3 The assembled screen and riser or its constituent parts shall be decontaminated with a detergent and water wash and triple deionized water rinse. Steam-cleaning also can be done to decontaminate the well materials. Decontaminated well components should be wrapped in plastic until installed in the boring. All personnel handling the decontaminated well components should exercise great care not to contaminate these components as they are installed in the borehole.

4.2.4 The well screen and riser pipe generally are assembled as they are lowered into the borehole. As the assembled well is lowered, care shall be taken to ensure that it is centered in the hole. In boreholes which are determined to be not plumb, centralizers should be used on the tail pipe below the screen and/or the midpoint and top of the screen. This will assure that the screened portion of the well is centrally located in the borehole with a uniform thickness of sand or filter pack between the screen and the borehole wall. In all holes greater than 25 feet in depth, centralizers should be used.

4.2.5 The annular space surrounding the screened section of the monitoring well and at least 1 foot above the top of the screen shall be filled with an appropriately graded, clean sand or gravel. In no case shall the sand pack be longer than 1.5

times the length of the screen. A minimum 1-foot thick layer of very fine sand (i.e.. sand-blasting sand) should be placed immediately above the well screen sand pack. This layer is designed to prevent the infiltration of sealing components (bentonite or grout) into the sand pack. As each layer is placed. a weighted tape should be lowered in the annular space to verify the depth to the top of the layer.

Depending on the depth of the well, the diameters of the borehole and well materials. and the depth to the static water level, satisfactory placement of the sand pack may require the use of a tremie pipe.

4.2.6 Bentonite seals, either pellets or slurry, a minimum of 2 feet thick shall be installed immediately above the artificial gravel pack in all monitoring wells. The purpose of the seal is to provide a barrier to vertical flow of water in the annular space between the borehole and the well. Bentonite is used because it swells significantly upon contact with water. Pellets generally can be installed in shallow boreholes by pouring them very slowly from the surface. If they are poured too quickly, they may bridge at some shallow, undesired depth. Powdered bentonite shall be installed by mixing a very thick slurry and using a tremie pipe to inject the seal material at the desired depth in the borehole. Bentonite slurry should be pumped into the annular space using a side-discharge tremie pipe located about 2 feet above the fine-sand pack. Side discharge will ensure the integrity of the sand pack.

In situations where the monitoring well screen straddles the water table, the seal will be in the unsaturated zone and pure bentonites (pellets or powder) will not work effectively as seals due to dessication. Seals in this situation should be a cement/bentonite mixture containing 2 to 10 percent bentonite by weight. This type of mixture shall be tremied to the desired depth in the borehole.

4.2.7 The remaining length of borehole shall be backfilled with grout to within 2 feet of the ground surface. This grouting will consist of a cement/bentonite mixture. A tremie pipe shall be used to install the grout. Drill cuttings, even those known not to be contaminated, shall not be used as backfill material.

4.2.8 The steel guard-pipe shall be placed around the riser. and the borehole around the guard pipe shall be dug out to approximately a 1-foot radius to a depth of 2 feet. and filled with concrete. The concrete pad shall be sloped so that drainage occurs away from the well. All completed wells will have identification numbers clearly painted on the cap and guard pipe with bright colored paint.

Generally, the protective guard pipe will be lockable. A point on the top of the riser pipe will be marked (paint spot or cut notch) to indicate the surveyed elevation position, known as the "measuring Point" (MP).

A vent hole must be installed in the protective casing in an area that is protected from precipitation. Road box installations should not be vented.

4.2.9 Measure the depth to the stabilized water level and record on the ground water monitoring well detail report (Figure 1).

4.2.10 At some point after installation of a well and prior to use of the well for water level measurements or water quality samples, development of the well shall be undertaken in accordance with ENSR SOP 7221, Monitoring Well Development.

5.0 QUALITY CONTROL

5.1 The borehole will be checked for total open depth, and extended by further drilling or shortened with a grout plug, if necessary, before any well construction materials are placed.

5.2 Water level will be checked repeatedly during well installation to ensure that the positions of well screen, sand pack and seal, relative to water level, conform to project requirements.

5.3 The depth to the top of each layer of packing (i.e., sand, bentonite, grout, etc.) will be verified and adjusted if necessary to conform to the requirements of this SOP and the QAPP before the next layer is placed.

5.4 If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of fluids should be obtained and analyzed for chemical constituents that may be of interest at the site.

6.0 DOCUMENTATION

During installation of each monitoring well, a series of measurements shall be taken and recorded. These measurements shall include:

- length of tail pipe (if used)
- length of screen
- length of riser pipe
- total length of well
- depth to stabilized water level

Other data include the screen and riser pipe materials, diameters of the respective components, screen slot size, type and thickness of the sand pack, thicknesses and different types of grouting materials, and elevation of the top of the guard pipe, established measuring point, and ground surface after surveying is complete.

All data shall be recorded on site onto the ground water monitoring well detail report (Figure 1) and all wells shall be referenced onto the appropriate site map. A Field Log Book and/or boring log can be used as additional means of recording data. In no case shall the Field Log Book or boring log take the place of the ground water monitoring well detail report. All documentation shall remain in the project files indefinitely.

7.0 REFERENCES

Not applicable.

APPENDIX

Annulus: The space between the borehole wall and the outside of the well screen or riser pipe.

Filter Pack: A well-graded, clean sand or gravel placed around the well screen to prevent the entry of very fine soil particles.

Grout Plug: A cement/bentonite mixture use to seal a borehole that has been drilled to a depth greater than the final depth at which the monitoring well is to be installed.

Guard Pipe: A pipe, usually made of steel, placed around that portion of the well riser pipe that extends above the ground surface. As well as providing security to a well, it may provide a fixed elevation for surveying.

Riser Pipe: The section of unperforated well construction material used to connect the well screen with the ground surface. Frequently it is made of the same material and has the same diameter as the well screen.

Road Box: A man-hole set into the ground around a well installation. Usually constructed in areas where the monitoring well cannot extend above the ground surface for traffic or security reasons.

Tremie Pipe: A small diameter pipe that will fit in the annulus and is used to inject filter sands, seal materials, or cement/bentonite grout under pressure.

Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. Typically a well screen has slots but holes, slits, louvers, and other perforations can, in some situations, be used.

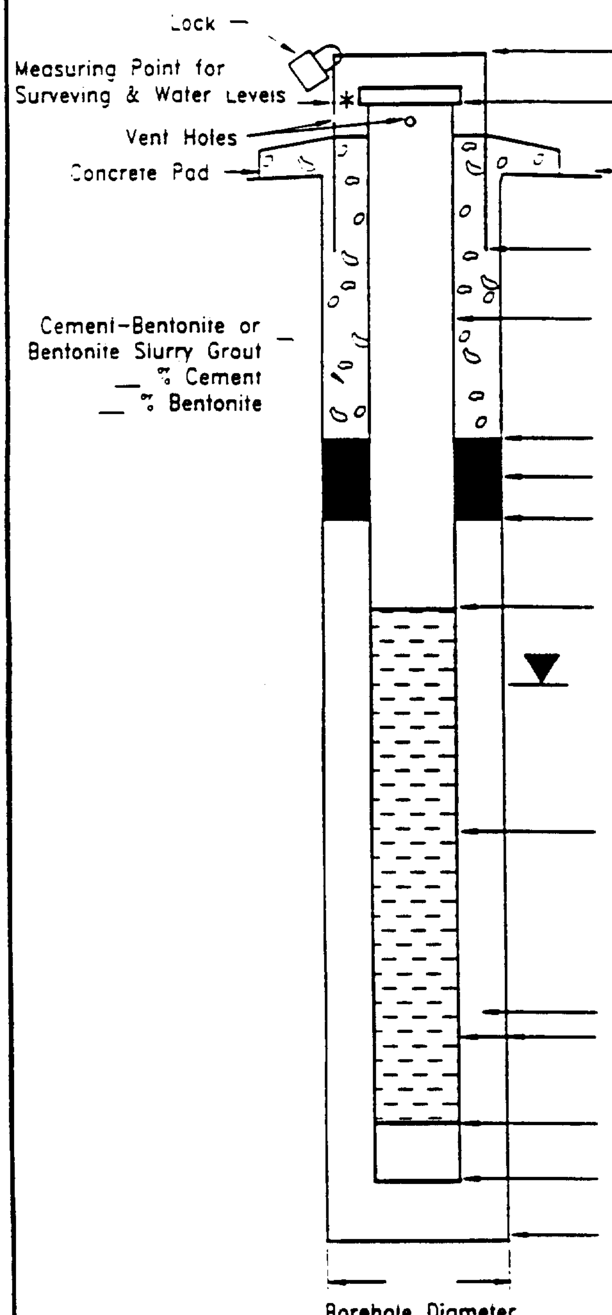
Project No: ______ Client: ______ Site: ______

WELL No:

Well Location: ______ Date Installed: ______

Contractor: ______ Method: ______ Inspector: ______

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		______	______
Top of Riser Pipe		______	______
Ground Surface (G.S.)		0.00	______
Bottom of Steel Guard Pipe		______	______
Riser Pipe:			
Length	______		
Inside Diameter (ID)	______		
Type of Material	______		
Top of Bentonite Seal		______	______
Bentonite Seal Thickness	______		
Top of Sand		______	______
Top of Screen		______	______
Stabilized Water Level		______	______
Screen:			
Length	______		
Inside Diameter (ID)	______		
Slot Size	______		
Type of Material	______		
Type/Size of Sand	______		
Sand Pack Thickness	______		
Bottom of Screen		______	______
Bottom of Tail Pipe:		______	______
Length	______		
Bottom of Borehole		______	______

Approved:

* Describe Measuring Point: ______

______ Signature ______ Date

ENSR.

ENSR STANDARD OPERATING PROCEDURE

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Organizational Acceptance	Authorization	Date
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Technical Reviewer		
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SOP NO: 7221

ENSR ENSR Consulting and Engineering

Monitoring Well Development

Date: 2nd Qtr. 1993
Revision No: 1
Author: Tim Cosgrave
Discipline: Geosciences

1.0 PURPOSE AND APPLICABILITY

1.1 This SOP describes the methods used for developing monitoring wells after original installation and prior to use of the well for obtaining water level measurements or water quality samples. Development should not be confused with purging, the purpose of which is to evacuate the monitoring well system of stagnant water which may not be representative of the aquifer. For purging procedures refer to ENSR SOP 7130, Ground-Water Sample Collection from Monitoring Wells.

1.2 Monitoring well development and/or rehabilitation are necessary to ensure that complete hydraulic connection is made and maintained between the well and the aquifer material surrounding the well screen and packing materials. Development is necessary after original installation of a monitoring well to (1) reduce the compaction and inter-mixing of grain sizes produced during drilling; (2) to increase the porosity and permeability of the artificial filter pack by removing the finer grain-size fraction introduced near the screen by drilling and well installation; and (3) to remove any foreign drilling fluids that coat the borehole or that may have invaded the adjacent natural formation.

1.3 This procedure applies to monitoring wells in which siltation has been determined to have occurred. After a well has been installed for some period of time (ranging from months to years), siltation of the well may occur and rehabilitation will be necessary to re-establish complete hydraulic connection with the aquifer.

1.4 Health and Safety Considerations

Monitoring well development may involve chemical hazards associated with materials in the soil or aquifer being explored; and always involves physical hazards associated with the heavy equipment that may be used for various development techniques. When wells are to be installed and developed in locations where the aquifer and/or overlying materials may contain chemical hazards, a Health and Safety Plan must be prepared and approved by the Health and Safety Officer before field work commences.

1.5 Method Selection

The appropriate development method will be selected for each project on the basis of the circumstances. objectives and requirements of that project. Further. some states and EPA regions have promulgated comprehensive guidelines for ground water monitoring and subsurface investigation procedures. The provisions of this SOP will be adapted to these project-specific requirements in the Quality Assurance Project Plan (QAPP). Each QAPP will describe the specific method(s) to be used and the rationale, including trade-offs associated with the nature of the aquifer formation, chemical analytical objectives. and client or agency requirements.

1.6 Purge Water and Sediment Disposal

The QAPP must specify the means for disposing of purged sediment-laden water. In most cases. disposal of this material will follow the methods used in the original installation of the borehole. If soil and/or ground water contamination conditions in a well have changed, it may be necessary to specify new disposal methods for wells that are being re-developed.

2.0 RESPONSIBILITIES

Development of new monitoring wells is the responsibility of the geologist or hydrogeologist involved in the original installation of the well. The geologist may, in fact, contract with the well driller to develop new wells under the geologist's guidance and oversight. Records of well development methods and results are to be kept by the geologist.

Any person using existing monitoring wells for any purpose is responsible for verifying the original well construction details and determining if a well requires rehabilitation.

3.0 REQUIRED MATERIALS

The following list identifies the types of equipment which may be used to develop monitoring wells. Exact equipment needs will be well-specific and will depend upon the diameter of the well, the depth to the static water level and other factors such as project objectives.

3.1 Surge Block

A surge block consists of a rubber (or leather) and metal plunger attached to rod or pipe of sufficient length to reach the bottom of the well. Well drillers usually can provide surge blocks for large diameter wells (greater than 6 inches). Surge blocks for smaller diameter wells can be constructed easily of materials readily accessible in any hardware store. A recommended design is shown in Figure 1. To reduce cross-contamination of monitoring wells, a new plunger generally is used in each well to be developed and the rod is decontaminated in accordance with procedures in ENSR SOP 7600, Decontamination of Equipment.

3.2 Pump

A pump is necessary to remove large quantities of silt-laden ground water from a well after using the surge block. In some situations, the pump alone is used to both surge the well and remove the fines. Since the purpose of well development is to remove suspended solids from a well, the pump must be capable of moving some solids without damage. The preferred pump is a centrifugal because of its ability to pump solids, but a centrifugal pump will work only where the depth to static ground water is less than approximately 25 feet. In deep ground water situations, a positive-displacement pump such as a submersible or bladder pump will be necessary.

3.3 Bailer

A bailer is to be used to purge silt-laden water from wells after using the surge block. In some situations, the bailer can be used to surge a well but the use of a bailer for surging is not recommended. The bailer is to be used for purging in situations where the depth to static water is greater than 25 feet and the silt loading is greater than that which can be handled by positive-displacement pumps.

3.4 Compressed Gas

Compressed gas, generally nitrogen, can be used to both surge and purge a monitoring well. A nitrogen tank is used to inject gas at the bottom of the water column, driving sediment-laden water to the surface. Compressed gas can also be used for "jetting" - a process by which the gas is directed at the slots in the well screen to cause turbulence (thereby disturbing fine materials in the adjacent filter pack). Compressed gas is not limited to any depth range.

The hose or pipe which will be installed in the well for jetting should be equipped with a horizontal (side) discharge nozzle and one or more small holes in the bottom of the hose to enhance the lifting of sediment during jetting.

Since the compressed gas will be used to "lift" water from the monitoring well, provisions must be made for controlling the discharge from contaminated wells. This is generally accomplished by attaching a "tee" discharge to the top of the casing and providing drums to contain the discharged water. Gas-lifting must never be done in contaminated wells without providing discharge control apparatus.

3.5 Decontamination Equipment

Standard equipment for decontaminating field apparatus in accordance with ENSR SOP 7600 will be used to decontaminate all equipment used to develop monitoring wells.

3.6 Monitoring Well Construction Details

A copy of the original Monitoring Well Construction Detail form for the well to be developed must be obtained from the project manager. This form provides critical information regarding the construction of the monitoring well and must be in the possession of the well development crew so that pertinent well construction details, such as total depth, are known.

3.7 Supporting ENSR SOPs

- 7130 - Ground-Water Sample Collection from Monitoring Wells
- 7220 - Monitoring Well Construction and Installation
- 7600 - Decontamination of Equipment

- 7720 - Rising-Head/Falling-Head Permeability Testing

4.0 METHOD

4.1 General Procedure

4.1.1 Conduct a permeability test as described in ENSR SOP 7720 to determine the hydraulic conductivity of the screened interval. The results of this test, along with other tests conducted during the development process, will be used to evaluate the success of the development.

4.1.2 Water is caused to move in and out through the monitoring well screen to move silt and clay particles out of the filter pack around the well screen and into suspension within the well. Water movement is effected using a surge block, bailer, or a compressed gas. In some situations, pumping water may effect satisfactory development, but pumping alone is not generally recommended.

4.1.3 The sediment-laden water is removed from the monitoring well using a pump, bailer, or air compressor.

4.1.4 Surging of the well is continued until the water removed is essentially free of suspended silt and clay particles. During the surging/purging cycles, a permeability test should be performed as described in ENSR SOP 7720 to monitor and evaluate the development process.

4.1.5 Generally, a permeability test as described in ENSR SOP 7720 is used to confirm that a reliable hydraulic connection has been established (or re-established) between the well and the surrounding aquifer material.

4.2 Selection of a Specific Procedure

The construction details of the well can be used to initially define the method of purging a well with due consideration being given to the level of contamination.

The criteria for selecting a well development method include well diameter, total well depth, static water depth, screen length, the likelihood and level of contamination, and the type of geologic formation adjacent to the screened interval.

The limitations, if any, of a specific procedure are discussed within each of the following procedures.

Methods that involve placing water into the well may be objectionable to some state and federal agencies. In such cases the surge block procedure may be preferable over the pumping procedure.

4.3 Specific Procedure: Surge Block

4.3.1 A surge block effectively develops most monitoring wells. If the geologic layering in the screened interval includes permeable and impermeable layers (e.g., gravels and clays), it is possible that surging could remove fines from the impermeable layers and force them into the permeable layers. This problem can be minimized by using fewer surging cycles, using a surge block which is looser fitting and/or increasing the purging volume or time of development.

4.3.2 Construct a surge block using the design in Figure 1 as a guide. Specific materials will depend upon the diameter of well to be developed. The diameter of the flexible rings must be sufficient to cause a tight seal within the well casing, and the rods must be of sufficient length to reach to the bottom of the monitoring well.

4.3.3 Insert the surge block into the well and lower it slowly to the level of static water. Start the surge action slowly and gently above the well screen using the water column to transmit the surge action to the screened interval. A slow initial surging, using plunger strokes of 3 to 5 feet, will allow material which is blocking the screen to separate and become suspended.

4.3.4 After a number (5 to 10) of plunger strokes, remove the surge block and purge the well using a pump or bailer. The returned water should be heavily laden with suspended silt and clay particles. As development continues, slowly increase the depth of surging to the bottom of the well screen. For monitoring wells with long screens (greater than 10 feet) surging should be undertaken along the entire screen length in short intervals (2 to 3 feet) at a time.

4.3.5 Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material.

4.4 Specific Procedure: Pump

4.4.1 Well development using only a pump is most effective in those monitoring wells that will yield water continuously. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge.

4.4.2 Set the intake of the pump in the center of the screened interval of the monitoring well.

4.4.3 Pump a minimum of three well volumes of water from the well while using the intake hose of the pump as a plunger. The motion of the intake hose will act to a limited extent as a surge block.

4.4.4 Occasionally, where appropriate, use the pump to fill the monitoring well to the top of the casing and allow the water level to decline to the static level, thereby forcing water back into the formation. This action will cause water to exit the well screen and reduce the bridging of materials caused by water flowing in one direction through the well screen while pumping.

The water used to fill the monitoring well should be the same water removed from the well during the previous pumping cycle. The sediment previously pumped from the well must be removed from the water prior to re-introduction to the well. A steel drum can be used as a sediment-settling vessel.

4.4.5 Continue pumping water into and out from the well until sediment-free water is obtained.

4.5 Specific Procedure: Bailer

4.5.1 Lower the bailer into the screened interval of the monitoring well.

4.5.2 Using long, slow strokes, raise and lower the bailer in the screened interval simulating the action of a surge block.

4.5.3 Periodically bail standing water from the well to remove silt and clay particles drawn into the well.

4.5.4 Continue surging the well using the bailer and bailing water from the well until sediment-free water is obtained.

4.6 Specific Procedure: Compressed Gas (Nitrogen)

4.6.1 Although the equipment used to develop a well using this method is more difficult to handle and use, well development using compressed gas for jetting is considered to be a very effective method. This method also is the most generally applicable because it is not limited by well depth, well diameter or depth to static water, but caution must be exercised in highly permeable formations not to inject gas into the formation.

4.6.2 Lower the gas line from the gas cylinder into the well, setting it near the bottom of the screened interval. Install the discharge control equipment at the well head.

4.6.3 Set the gas flow rate to allow continuous discharge of water from the well. The discharge will contain suspended clay and silt material.

4.6.4 At intervals during gas-lifting, especially when the discharge begins to contain less suspended material, shut off the air flow and allow the water in the well to flow out through the screened interval to disturb any bridging that may have occurred. Re-establish the gas flow when the water level in the well has returned to the pre-development level.

4.6.5 Jetting of the screened interval also can be done during gas-lifting of water and sediment from the well. This is accomplished by using a lateral-discharge nozzle on the gas pipe or hose and slowly moving the nozzle along the length of the screened interval. Jetting should be done beginning at the bottom of the well screen and moving slowly upwards along the screened interval. To enhance gas lifting of sediment.

occasionally raise the discharge nozzle into the cased portion of the well and discharge sediment-laden water.

4.6.6 Continue gas-lifting and/or jetting until the water returned in the air stream is free from suspended material.

5.0 QUALITY CONTROL CHECKS

A well has been successfully developed when one or more of the following criteria are met:

- the well yields only clear, sediment-free water.
- two or more permeability tests in accordance with ENSR SOP 7720 yield repeatable hydraulic conductivity values.
- the original depth of the well, as described on the Monitoring Well Construction Detail form in ENSR SOP 7220, is clear of sediment and that depth is maintained for some period of time (longer than hours, probably less than one year).

6.0 DOCUMENTATION

The Monitoring Well Development Record (Figure 2) will be completed by the geologist or hydrogeologist conducting the development. In addition, a Field Log Book should be maintained detailing any problems or unusual conditions which may have occurred during the development process. Any in ability to return the well to the original specifications will be noted on the original copy of the Monitoring Well Construction Detail form and on the Monitoring Well Development Record.

All documentation will be retained in the project files following completion of the project.

7.0 REFERENCES

Not applicable.

APPENDIX

Bridging: A condition within the filter pack outside the well screen whereby the smaller particles are wedged together in a manner that causes blockage of pore spaces.

Hydraulic Conductivity: a characteristic property of aquifer materials which describes the permeability of the material to a particular fluid (usually water).

Hydraulic Connection: A properly installed and developed monitoring well should have a complete hydraulic connection with the aquifer. The well screen and filter material should not provide any restriction to the flow of water from the aquifer to the well.

Permeability Test: Used to determine the hydraulic conductivity of the aquifer formation near a well screen. Generally conducted by displacing the water level in a well and monitoring the rate of recovery of the water level as it returns to equilibrium. Various methods of analysis are available to calculate the hydraulic conductivity from these data.

Screened Interval: That portion of a monitoring well that is open to the aquifer.

Static Water Level: The water level in a well that represents an equilibrium condition when the aquifer is not being stressed (no nearby withdrawal or injection of water). Since the ground water conditions are generally dynamic, static is a condition that holds true only for short periods of time (anywhere from minutes to years depending on cultural and climatic influences).

Well Surging: That process of moving water in and out of a well screen to remove fine sand, silt and clay size particles from the adjacent formation.

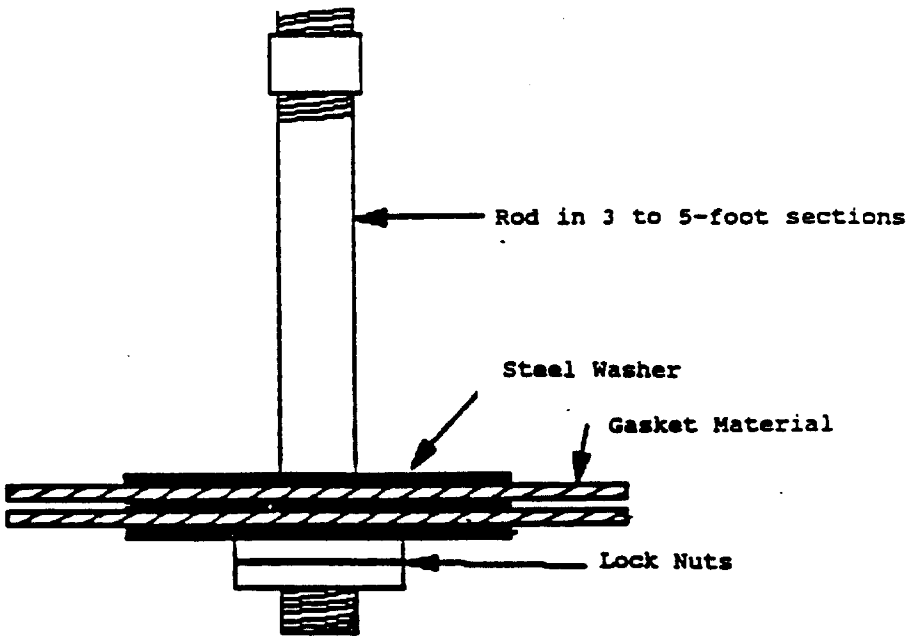
Well Purging: The process of removing water from a well to allow in situ formation water to enter the well. Generally thought of in terms of removing standing water from a well prior to the collection of water samples for quality determination, the process also is conducted to remove suspended particles from the well after well surging.

Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. Typically a well screen has slots but holes. slits. louvers. and other perforations can. in some situations. be used.

Figure 1

SURGE BLOCK DESIGN

Steel washers should be 1/2" to 3/4" smaller diameter than the well ID. Gasket can be rubber or leather and should be the same diameter or 1/8" smaller than the well diameter to compensate for swelling of the leather. Rod can be steel, fiberglass, or plastic but must be strong and lightweight.



NOT TO SCALE

ENSR CONSULTING & ENGINEERING		
Figure 1 Surge Block Design		
TMC	11/10/88	SOP 7221

Figure 2

ENSR

MONITORING WELL DEVELOPMENT RECORD

DATE: ______ WELL I.D.: ______

PROJECT NAME: ______ LOCATION: ______

PROJECT NUMBER: ______ DEVELOPER: ______

☐ ORIGINAL DEVELOPMENT ☐ REDEVELOPMENT ORIGINAL DEVELOPMENT DATE: ______

WELL DATA

Well Diameter	
Total Well Depth	
Depth to Top of Screen	
Depth to Bottom of Screen	
Depth to Static Water Level	

Geology at Screened Interval	
Likely Contaminants	
Purge Water and Sediment Disposal Method	

DEVELOPMENT METHOD	PURGING METHOD	PERMEABILITY TEST RESULTS

ACCEPTANCE CRITERIA

Signature ______ Date ______

M890322

ENSR # STANDARD OPERATING PROCEDURE

Number: 7315 **Date of Issue:** 2nd Qtr.1993

Revision: 2

Title: Operation/Calibration of the HNU Photoionization Analyzer

Organizational Acceptance	Authorization	Date
Originator	Charles Martin	3/13/84
Technical Reviewer	Arthur Lazarus	3/13/84
Technical Reviewer	Elaine Moore	3/13/84
Technical Reviewer		
Quality Assurance	Scott Whittemore	3/13/84

Revision #	Changes	Authorization	Date
1	Complete re-write	Scott Whittemore	5/1/87
		Charles Martin	5/6/87
		Elaine Moore	5/6/87
2	Format update	Mike Dobrowolski	4/27/93

Organizational acceptance signatures are maintained on file with the original document in the Quality Assurance Library in Acton, MA.

Operation/Calibration of HNU Photoionization Analyzer

Date: 2nd Qtr. 1993
Revision No: 2
Author: Charles Martin
Discipline: Geosciences

1.0 PURPOSE AND APPLICABILITY

1.1 This document describes the procedures necessary for operation and calibration of the HNU Photoionization Analyzer. The HNU is primarily used by ENSR personnel for safety and survey monitoring of ambient air. determining the presence of volatiles in soil and water, and detecting leakage of volatiles.

Personnel responsible for using the HNU should first read and thoroughly familiarize themselves with the instrument instruction manual.

1.2 Principle of Operation

The HNU is a non-specific vapor/gas detector. The hand-held probe houses a photoionization detector (PID), consisting of an ultraviolet (UV) lamp and two electrodes, and a small fan which pulls ambient air into the probe inlet tube. All organic and inorganic vapor/gas compounds having ionization potentials (IP) lower than the energy output of the UV lamp are ionized; and the resulting potentiometric change is seen as a needle deflection, proportional to vapor concentration, on the potentiometer of the readout/control box.

1.3 Specifications

Detection range*:	0.1 to 2,000 ppm.
Linear range*:	0.1 to 400 ppm.
Response time:	3 seconds to 90% full scale deflection.
Operating temperature:	-10°C to 40°C.
Operating time on battery. continuous use, without recorder:	approximately 10 hours: at lower temperatures time is reduced.

Recharge from full discharge: full recharge 12-14 hours.

*When equipped with 10.2 eV probe with SPAN set at 9.8 and measuring benzene. Values may vary for other compounds and conditions.

1.4 Health and Safety Considerations

Only photoionization analyzers stamped Division I Class I may be used in explosive atmospheres. Refer to the project Health & Safety plan for instructions pertaining to instrument use in explosive atmospheres.

2.0 RESPONSIBILITIES

2.1 It is the responsibility of the Project Manager to ensure that the necessary equipment is available and that field personnel are adequately trained in its use.

2.2 It is the responsibility of the field operator to calibrate and operate the HNU in accordance with the requirements of this procedure.

3.0 REQUIRED MATERIALS

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated.
- Regulator for calibration gas cylinder
- Approximately 3-4 feet of teflon tubing
- "Magic Marker"

4.0 METHOD

4.1 Preliminary Steps

4.1.1 Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

4.1.2 The sensor probe is carried separately in the instrument carrying case. For most safety and survey work, the 10.2 eV probe is used, as it detects more compounds than the 9.5 eV probe and is more durable than the 11.7 eV probe. Unclamp the cover from the readout/control box and remove the inner lid from the cover. Screw the inlet tube onto the sensor probe. Attach the probe cable plug to the 12 pin keyed socket on the readout panel by matching the alignment slot in the plug to the key in the connector, and screwing down the probe connector until a distinct snap and lock is felt.

4.1.3 Turn the function switch to the BATT (battery check) position. The meter needle will deflect to the green zone if the battery is fully charged. If the needle is below the green arc or if the low battery indictor comes on, the battery must be recharged (Section 4.5) before the analyzer is used.

4.2 Operation

4.2.1 Turn the function switch to the appropriate range. Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify that the UV lamp is on by briefly looking into the probe from a distance greater than six inches to observe a purple glow.

WARNING:Continued exposure to ultraviolet energy generated by the light source can be harmful to eyesight.

4.2.2 At the beginning of each day, check the calibration (Section 4.3) and make adjustments if necessary. Record the calibration information in the Field Log Book.

4.2.3 The instrument is now operational. Readings should be taken on the lowest possible scale and recorded in the Field Log Book.

4.2.4 When the HNU is not being used or between monitoring intervals, the function switch should be set on the STANDBY position to conserve battery power and UV lamp life.

4.2.5 At the end of each day, recheck calibration (Section 4.3) and record the information in the Field Log Book.

4.2.6 To shutdown the HNU, turn the function switch to OFF.

4.2.7 Recharge the battery after each use (Section 4.5).

4.2.8 When transporting, disconnect the probe cable connector from the control panel and return the instrument to its stored condition.

4.3 Calibration Procedures

4.3.1 For measurement on the 0-20 ppm or 0-200 ppm ranges only one calibration gas standard is required. Calibration on the 0-200 ppm range will provide accurate values on the 0-20 ppm range as well.

4.3.2 Connect the probe tip to the gas cylinder regulator, observing safety precautions. A t-fitting and plastic tubing can be used to ensure that the gas is delivered to the probe at atmospheric pressure (Figure 1). Adjust the regulator so that the gas is delivered at 150-200 cubic centimeters per minute. The fan inside the probe draws approximately 100 cc/min.

4.3.3 Set the function switch to the proper range setting, based on the calibration gas used, and record the meter reading in the Field Log Book. Also record the calibration gas composition and concentration, the date and the time.

4.3.4 If the adjustment is necessary, turn the span as required to read the ppm concentration of the gas standard, or the equivalent concentration of benzene if the HNU is being calibrated to benzene.

4.3.5 Recheck the zero setting. If readjustment of the zero setting is necessary, repeat the span adjustment. Record the span setting and the new meter reading. Whenever the span is changed, the zeroing procedure should be repeated.

4.3.6 If the calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Section 4.4).

4.3.7 Alternate Calibration Technique. It may be more convenient in certain circumstances to employ the use of a Tedlar bag filled with calibrant instead of a calibration cylinder. In that case, the bag (usually 3-10 liter capacity) should be filled with the appropriate calibrant and brought to the HNU. The HNU probe should be connected to the discharge fitting on the bag using a piece of flexible tubing. Allow the HNU to draw the calibrant from the bag and follow the instructions as indicated in 4.3.3 and 4.3.4.

4.4 Probe Cleaning

4.4.1 During periods of operation, moisture, dust, or other foreign matter can be drawn into the probe and form deposits on the surface of the UV lamp and ion chamber. This causes interference with the ionization process and produces erroneous readings. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, or drifting. In most cases, the following field cleaning procedure is sufficient to correct this condition.

4.4.2 Turn the function switch to the OFF position. Disconnect the probe cable connector at the readout panel. Unscrew the probe inlet tube from the end cap and clean the inside of the tube making sure that the tube is dry and lint-free when finished. A pipe cleaner or a kim-wipe and piece of wire can be used. Keeping the probe upright, remove the two screws holding the end clamp in place and remove the cap and ion chamber. Place one hand over the top of the lamp housing and tilt slightly. The light source will slide out of the housing. Take care not to lose or misplace o-rings or other parts. Do not touch the internal parts of the probe, particularly the UV lamp, with the bare hand during cleaning or reassembly. Surgical gloves are recommended. Clean the internal parts with a non-abrasive, lint-free paper towel (e.g., kim-wipe) and reassemble the probe.

4.5 Battery Charging

4.5.1 The battery charger is stored inside the instrument cover. To charge the battery, first insert the mini plug of the charger into the jack on the side of the meter, with the function switch in the OFF position. Next, insert the charger plug into a 120VAC single phase, 50-60 HZ outlet.

4.5.2 To ensure that the charger is functioning, turn the function switch to BATT. The meter should deflect full scale. The sensor probe cable must be connected to the control panel for a battery check response. For normal battery charging, leave the function switch in the OFF position.

4.5.3 The battery is fully charged after 14 hours of charging. The charger can be left on indefinitely without damage. Disconnect the charger from the electrical outlet before disconnecting the mini plug from the instrument.

With the function switch turned to the appropriate range setting, the HNU may be operated while recharging.

4.6 Troubleshooting Tips

4.6.1 One convenient method for periodically confirming instrument response is to hold the sensor probe next to the tip of a magic marker. A significant needle deflection should be observed within 3 second with the function switch set a 0-20 (after shave lotion or cologne also will make the needle deflect).

4.6.2 Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.

4.6.3 A fogged or dirty lamp, due to operation in a humid or dusty environment, may cause erratic or fluctuating readings.

4.6.4 Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings.

4.6.5 A zero reading on the meter should not necessarily be interpreted as an abasence of air contaminants. The detection capabilities of the HNU are limited to those compounds which will be ionized by the particular probe used.

4.6.6 Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.

4.6.7 If a negative deflection of the HNU meter is noted the ion chamber is dirty and needs cleaning. The chamber may be soaked in a solvent such as methanol in a soil bath air dried and then baked for two to four hours at a temperature of 100°C and not exceeding 105°C.

4.6.8 When high concentrations of hydrocarbons enter the ionization chamber in the HNU a "quenching" effect takes place. Typically, it is noted by a sharp needle movement once the flow of gas is pierced by the HNU probe. Within one to two seconds the needle fades to zero point. To check whether or not the quenching effect is taking place, move the HNU probe to just outside the hole created in the foil. Get another reading after five to ten seconds. If quenching is taking place a very erratic needle movement will occur. Once an operator has seen this phenomena it is fairly easy to recognize.

5.0 QUALITY CONTROL

A calibration check of the HNU will be conducted once each day of sampling or whenever instrument operation is suspect. The HNU will sample a calibration gas of known concentration. The instrument must agree with the calibration gas within +/- 10.0%. If the instrument responds outside this tolerance, it must be recalibrated.

6.0 DOCUMENTATION

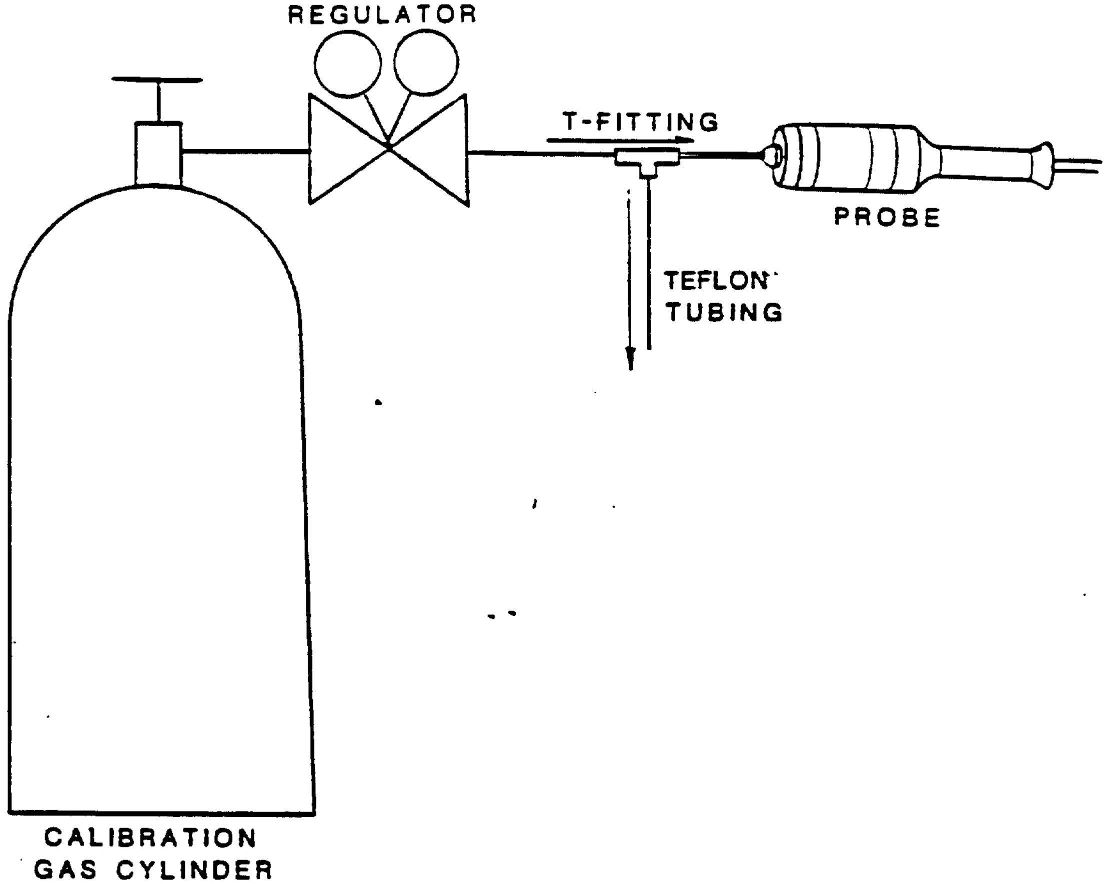
Safety and survey monitoring with the HNU will be documented in a bound Field Log Book and retained in the project files. The following information is to be recorded:

- Project name and number.
- Operator's signature.

- Date and time of operation.
- Calibration gas used.
- Calibration check at beginning and end of day (meter readings before adjustment).
- Span setting after calibration adjustment.
- Meter readings (monitoring data obtained).
- Instances of erratic or questionable meter readings and corrective actions taken.
- Instrument response verifications - magic marker (Section 4.6.1) or similar test.

7.0 REFERENCES

Not applicable.


REGULATOR
T-FITTING
PROBE
TEFLON
TUBING
CALIBRATION
GAS CYLINDER

ENSR STANDARD OPERATING PROCEDURE

Number: 7510 **Date of Issue:** 2nd Qtr.1993

Revision: 2

Title: Packaging and Shipment of Samples

Organizational Acceptance	Authorization	Date
Originator	Christopher Carlio	3/13/84
Technical Reviewer	Arthur Lazarus	3/13/84
Technical Reviewer	Elaine Moore	3/13/84
Technical Reviewer		
Quality Assurance	Scott Whittemore	3/13/84

Revision #	Changes	Authorization	Date
1	• Chain-of-Custody procedure for hinged coolers added • Miscellaneous rewording	Scott Whittemore Elaine Moore	9/19/86 10/13/86
2	• Format update • Chain-of-Custody form update	Mike Dobrowolski	4/27/93

Organizational acceptance signatures are maintained on file with the original document in the Quality Assurance Library in Acton, MA.

SOP NO: 7510

ENSR ENSR Consulting and Engineering

Packaging and Shipment of Samples

Date: 2nd Qtr. 1993
Revision No: 2
Author: Christopher Carlio
Discipline: Geosciences

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the procedures associated with the packaging and shipment of samples. Two general categories of samples exist: environmental samples consisting of air, water and soil; and waste samples which include non-hazardous solid wastes and hazardous wastes as defined by 40 CFR Part 261.

2.0 RESPONSIBILITIES

2.1 Project Manager

It is the responsibility of the project manager to assure that the proper packaging and shipping techniques are utilized for each project.

2.2 Field Team Leader

The field team leader shall be responsible for the enactment and completion of the packaging and shipping requirements outlined in the project specific sampling plan. The field team leader shall be responsible to research, identify and follow all applicable U.S. Department of Transportation (DOT) regulations regarding shipment of materials classified as waste.

3.0 REQUIRED MATERIALS

- Sample cooler
- Bubble wrap
- "Blue Ice" refreezable ice packs
- Fiber tape

- Zip lock plastic bags

4.0 METHOD

The objective of sample packaging and shipping protocol is to identify standard procedures which will minimize the potential for sample spillage or leakage and maintain field sampling program compliance with U.S. EPA and U.S. DOT regulations.

The extent and nature of sample containerization will be governed by the type of sample, and the most reasonable projection of the sample's hazardous nature and constituents. The EPA regulations (40 CFR Section 261.4(d)) specify that samples of solid waste, water, soil or air, collected for the sole purpose of testing, are exempt from regulation under the Resource Conservation and Recovery Act (RCRA) when all of the following conditions are applicable:

- Samples are being transported to a laboratory for analysis;
- Samples are being transported to the collector from the laboratory after analysis;
- Samples are being stored (1) by the collector prior to shipment for analyses, (2) by the analytical laboratory prior to analyses, (3) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

Qualification for transportation as described above require that sample collectors comply with U.S. DOT and U.S. Postal Service (USPS) regulations. If U.S. DOT and USPS regulations are found not to apply, the following information must accompany all samples and will be entered on a sample specific basis on chain of custody records:

- sample collector's name, mailing address and telephone number,
- analytical laboratory's name, mailing address and telephone number,
- quantity of sample,
- date of shipment,
- description of sample, and

In addition, all samples must be packaged so that they do not leak, spill or vaporize.

4.1 Place plastic bubble wrap matting over the base and bottom corners of each cooler or shipping container as needed to manifest each sample.

4.2 Obtain a chain of custody record as shown in Figure 1 and enter all the appropriate information as discussed above. Chain of custody records will include complete information for each sample. One or more chain of custody records shall be completed for each cooler or shipping container as needed to manifest each sample.

4.3 Wrap each sample bottle individually and place standing upright on the base of the appropriate cooler, taking care to leave room for some packing material and ice or equivalent. Rubber bands or tape should be used to secure wrapping, completely around each sample bottle.

4.4 Place additional bubble wrap and/or styrofoam pellet packing material throughout the voids between sample containers within each cooler.

4.5 Place ice or cold packs in heavy duty zip-lock type plastic bags, close the bags, and distribute such packages over the top of the samples. Add additional bubble wrap/styrofoam pellets or other packing materials to fill the balance of the cooler or container.

4.6 Obtain two pieces of chain of custody tape as shown in Figure 2 and enter the custody tape numbers in the appropriate place on the chain of custody form. Sign and date the chain of custody tape.

4.7 To complete the chain of custody form enter the type of analysis required for each sample, by container, under the "ANALYSES" section. Under the specific analysis enter the quantity/volume of sample collected for each corresponding analysis.

4.8 If shipping the samples where travel by air or other public transportation is to be undertaken, sign the chain of custody record thereby relinquishing custody of the samples. Relinquishing custody should only be performed when directly transmitting custody to a receiving party or when transmitting to a shipper for subsequent receipt by the analytical laboratory. Shippers should not be asked to sign chain of custody records.

4.9 Remove the last copy from the chain of custody record and retain with other field notes. Place the original and remaining copies in a zip-lock type plastic bag and place the bag on the top of the contents within the cooler or shipping container.

4.10 Close the top or lid of the cooler or shipping container and with another person rotate/shake the container to verify that the contents are packed so that they do not move. Improve the packaging if needed and reclose.

4.11 Place the chain of custody tape at two different locations on the cooler or container lid and overlap with transparent packaging tape. For coolers with hinged covers, if the hinges are attached with screws, chain of custody tape should also be used on the hinge side.

4.12 Packaging tape should be placed entirely around the sample shipment containers. A minimum of two full wraps of packaging tape will be placed at least two places on the cooler. Shake the cooler again to verify that the sample containers are well packed.

4.13 When transporting samples by automobile to the laboratory, and where periodic changes of ice are required, the cooler should only be temporarily closed so that reopening is simple. In these cases, chain of custody will be maintained by the person transporting the sample and chain of custody tape need not be used. If the cooler is to be left unattended, then chain of custody procedures should be enacted.

4.14 If shipment is required, transport the cooler to an overnight express package terminal or arrange for pickup. Obtain copies of all shipment records as provided by the shipper.

4.15 If the samples are to travel as luggage, check with regular baggage.

4.16 Upon receipt of the samples, the analytical laboratory will open the cooler or shipping container and will sign "received by laboratory" on each chain of custody form. The laboratory will verify that the chain of custody tape has not been broken previously and that the chain of custody tape number corresponds with the number on the chain of custody record. The analytical laboratory will then forward the back copy of the chain of custody record to the sample collector to indicate that sample transmittal is complete.

5.0 QUALITY CONTROL

Not Applicable

6.0 DOCUMENTATION

As discussed in Section 4.0 the documentation for supporting the sample packaging and shipping will consist of chain of custody records and shipper's records. In addition a description of sample packaging procedures will be written in the Field Log Book. All documentation will be retained in the project files following project completion.

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CHAIN OF CUSTODY RECORD

Page ____ of ____

Client/Project Name:	Project Location:
Project Number:	Field Logbook No.:
Sampler: (Print Name) /Affiliation:	Chain of Custody Tape No.:
Signature:	Send Results/Report to:

Field Sample No./ Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered	Analysis Requested						Lab I.D.	Remarks

Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Analytical Laboratory (Destination):
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Serial No. 6118

ENSR

Date ______________________

Sig. ______________________

№ 002233

STANDARD OPERATING PROCEDURE

Number: 7600 **Date of Issue:** 2nd Qtr.1993

Revision: 3

Title: Decontamination of Field Equipment

Organizational Acceptance	Authorization	Date
Originator	Charles Martin	3/2/84
Technical Reviewer	Arthur Lazarus	3/2/84
Technical Reviewer	Elaine Moore	3/2/84
Technical Reviewer		
Quality Assurance	Scott Whittemore	3/2/84

Revision #	Changes	Authorization	Date
1	Update	Charles Martin Arthur Lazarus Elaine Moore Scott Whittemore	3/2/84 3/2/84 3/2/84 3/2/84
2	• Addition of Health and Safety Considerations, Quality Assurance Planning Considerations, Training Requirements, QA/QC Checks, and Documentation sections • Addition of nitric acid wash for metals analyses • Addition of heavy equipment decontamination protocol • Miscellaneous edits and updates	Charles Martin Ken Fossey Mike Dobrowolski	3/12/90 4/3/90 5/3/90
3	Format update	Mike Dobrowolski	4/27/93

Organizational acceptance signatures are maintained on file with the original document in the Quality Assurance Library in Acton, MA.

Decontamination of Field Equipment

Date: 2nd Qtr. 1993
Revision No: 3
Author: Charles Martin
Discipline: Geosciences

1.0 PURPOSE AND APPLICABILITY

1.1 This SOP describes the methods to be used for the decontamination of all field equipment which may become contaminated or act as a contamination source during a sample collection task. The equipment may include split-spoon samplers, bailers, trowels, shipping coolers, drill rigs, backhoes, or any other type of equipment used during field activities.

Decontamination is performed as a quality assurance measure and a safety precaution.

- Improperly decontaminated sampling equipment can lead to misinterpretation of environmental data due to interference caused by cross-contamination.
- Decontamination protects field personnel from hazardous materials and protects the community by preventing uncontrolled transportation of contaminants at or from a site.

1.2 Decontamination is accomplished by manually scrubbing, washing, or spraying equipment with detergent solutions, tap water, distilled/deionized water, steam, or solvents. Equipment will be allowed to air dry after being decontaminated or may be wiped dry with chemical-free paper towels if immediate use is necessary.

The decontamination method and agents are to be determined on a project specific basis and must be stated in the Quality Assurance Project Plan (QAPP).

1.3 The frequency of equipment use dictates that most decontamination be accomplished at each sampling site between collection points. All cleaning materials and wastes should be stored in a central location so as to maintain control over the quantity of materials used or produced throughout the study. Decontamination waste products such as liquids, solids, rags, gloves, etc., will be collected and disposed of as specified in the QAPP.

1.4 Health and Safety Considerations

Decontamination procedures may involve;

- chemical exposure hazards associated with the medium being explored or solvents employed and may also involve:
- physical hazards associated with decontamination equipment.

When decontamination is performed on equipment which has been in contact with hazardous materials or when the quality assurance objectives of the project require decontamination with chemical solvents, the measures necessary to protect personnel must be addressed in the Health and Safety Plan.

The Health and Safety Plan must be approved by the project Health and Safety Officer before work commences, must be distributed to all personnel performing equipment decontamination and must be adhered to as field activities are performed.

1.5 Quality Assurance Planning Considerations

The following topics must be considered and addressed during the formulation of a decontamination strategy and should be outlined in the Quality Assurance Project Plan (QAPP). Each are dependent on site logistics, site-specific chemistry, the nature of the contaminated media and the objectives of the study.

- decontamination method
- solvent
- frequency
- location on site
- the method of containment and disposal of decontamination wash solids and solutions and

- state and local agency specific requirements for the selection of solvents and decontamination procedures.

1.5.1 The ideal situation would be to have all sampling equipment such as bailers, trowels and shovels laboratory decontaminated and dedicated to one sampling location for each day of sampling.

1.5.2 Laboratory decontamination may not be a practical option, however, depending on the scope of the project. It may be to expensive to obtain laboratory decontaminated sampling devices for short-term projects or projects which have numerous sampling locations. Sampling equipment such as split-spoon samplers or hand augers are too large to have laboratory cleaned. Finally, it may be difficult to schedule the necessary laboratory procedures.

1.5.3 There are several factors which need to be considered when deciding upon a decontamination solvent:

- the solvent should not be an analyte of interest;
- the solvent must be relatively stable so that it can be handled and stored in the field without special handling requirements;
- all sampling equipment must be resistant to the solvent:
- the solvent must be evaporative or water soluble or preferably both;
- state or local agencies may have specific requirements regarding decontamination solvents; and
- the analytical objectives of the study.

1.5.4 Methanol is the solvent of choice for general organic analyses. It is relatively safe and effective. A 10% nitric acid in deionized water solution is the solvent of choice for general metals analyses. Nitric acid use is restricted to use on Teflon, plastic or glass equipment.

1.5.5 If used on metal equipment, nitric acid will eventually corrode the metal and lead to the introduction of metals to the collected samples. If it is necessary to use metal sampling equipment for metals sampling, the procedure for decontamination will be:

- a non-phosphate detergent wash
- a tap water rinse
- a double distilled/deionized water rinse

State or local agencies may take exception to this procedure and require an acid wash. If this is the case, it must be recognized that the use of nitric acid on metal sampling equipment may lead to analytical interferences.

1.5.6 Decontamination should be performed far enough away from the source of contamination so as not to be affected by the source but close enough to the sampling site to keep handling to a minimum.

1.5.7 If heavy equipment such as drill rigs or backhoes are to be decontaminated, then a central decontamination station should be considered. Power may be required to run steam generators or high pressure water pumps. A water source may also be necessary. The construction of a sealed concrete pad with drains and walls, or other suitable temporary structure, to contain sprays and splashes may be necessary. Rinse and wash solutions should be collected and contained in 55 gallon metal or plastic drums.

1.5.8 Depending on the nature of the contaminated media or the decontamination solvents utilized, it may be necessary to collect and dispose of all particulate matter and wash solutions. If containment is necessary it may be achieved by performing the decontamination in large galvanized tubs or over plastic sheeting.

1.5.9 Upon review of the analytical data generated from the sampling program, the proper disposal method of these waste products will be determined.

2.0 RESPONSIBILITIES

2.1 It is the responsibility of the project manager to ensure that the proper decontamination procedures are followed and that all waste products of decontamination are properly stored and disposed.

2.2 It is the responsibility of the project safety officer to design and effect safety measures which provide the best protection for all persons involved directly with sampling and/or decontamination.

2.3 It is the responsibility of any subcontractors (i.e., drilling contractors) to follow the proper, designated decontamination procedures that are stated in their contracts and outlined in the project QA and/or Health and Safety Plan.

2.4 It is the responsibility of all personnel involved with sample collection or decontamination to adhere to the decontamination requirements and procedures in this SOP and in project specific Health and Safety Plans and QA plans, to maintain a clean working environment and to reasonably assure that contaminants are not negligently introduced to the environment.

3.0 REQUIRED MATERIALS

Decontamination agents may include: LIQUI-NOX or other phosphate-free biodegradable detergent solutions, tap water, distilled/deionized water, nitric acid, methanol, isopropanol, acetone or other appropriate solvent as specified in the QAPP.

- Personal protective equipment (defined in project Health and Safety Plan)
- Chemical-free paper towels
- Disposable gloves
- Waste storage containers: drums, boxes, plastic bags
- Cleaning containers: plastic buckets, galvanized steel pans, plastic (nalgene or equivalent) upright cylinder
- Cleaning brushes

- High pressure water or steam generator (if necessary)
- Plastic sheeting
- Plastic water storage containers

4.0 METHOD

4.1 General Procedures

4.1.1 The purpose of decontamination is three-fold.

- The first is to ensure that any compounds or contaminants which have been determined through chemical analyses to be present in a sample are in fact native to the sample.

  All sampling equipment such as bailers, trowels, shovels, tape measures, split-spoon samplers, dredges, sample containers, sample shipment coolers, etc., must be decontaminated before use to ensure that contaminants have not been introduced to the sample during the sampling process.

- The second purpose of decontamination is to minimize the exposure of sampling personnel to hazardous materials.

- The third purpose of decontamination is to prevent the introduction of new contaminants to a sampling site or prevent the transportation of compounds or contaminants from the site.

  Heavy equipment such as trucks, drilling rigs and backhoes should be decontaminated upon arrival at the site to prevent the introduction of road chemicals or contaminants from a previous site. Monitoring well riser pipes, screens and drilling augers must also be decontaminated to prevent the introduction of contaminants.

It should be assumed that all sampling equipment, including gloves, are contaminated until the proper decontamination procedures have been performed on them and that contaminated equipment can lead to invalid analytical results.

4.1.2 Unless the decontaminated equipment or construction materials are to be used immediately, they should be wrapped in aluminum foil, shiny side out, and stored in a designated "clean" area. Field equipment can also be stored in plastic bags to eliminate the potential for contamination.

Field equipment should be inspected and decontaminated prior to use if the equipment has been stored for long periods of time.

If customized procedures are not stated in the QAPP the standard procedures specified below shall be followed.

4.2 Decontamination for Organic Analyses

4.2.1 Determine from the QAPP the method of containment for the particulate and wash solution products of decontamination. Typically, smaller equipment will be decontaminated in a plastic or galvanized tub. The brush and container used for the decontamination process should be treated in the same manner as sampling equipment in steps 4.2.2 through 4.2.10.

4.2.2 Decontamination is to be performed before sampling events and between sampling points.

4.2.3 Remove all solid particles from the equipment or material by brushing and then rinsing with available tap water. This initial step is performed to remove gross contamination.

Depending on the size of the equipment being decontaminated, this may be preceded by a steam or high pressure water rinse to remove solids and/or residual oil or grease.

See Section 4.5 for decontamination of heavy equipment.

4.2.4 Wash the equipment or sampler with LIQUI-NOX or other phosphate-free detergent solution.

4.2.5 Rinse with tap water or distilled/deionized water until all detergent and other residue is washed away. Rerinse if necessary or repeat previous steps as necessary.

4.2.6 Rinse with methanol or other appropriate solvent. The solvent to be used should be specified in the QAPP.

4.2.7 Rinse with deionized water to remove any residual solvent.

4.2.8 Allow the equipment or material to air-dry in a clean area or wipe with chemical-free paper towels before use.

4.2.9 Dispose of soiled materials and wash solutions in the designated disposal containers.

4.3 Decontamination for Metals Analyses

4.3.1 For Teflon, plastic and glass, follow the procedures outlined in 4.2, however, use a 10% nitric acid solution as the solvent rinse in step 4.2.7.

4.3.2 For metal equipment, follow steps 4.2.1 through 4.2.6 and allow the equipment or material to air dry in a clean area or wipe with chemical-free paper towels before use.

4.4 Decontamination of Submersible Pumps

4.4.1 This procedure will be used to decontaminate submersible pumps before and between ground-water sample collection points as well as the end of each day of use. If different pumps are used, consult the QAPP for specific decontamination procedures.

4.4.2 During decontamination the submersible pump will be placed on a decontaminated surface, such as a plastic sheet.

4.4.3 When removing the submersible pump from each well the power cord and discharge line will be wiped dry using chemical-free disposable towels. Should the pump be fitted with a disposable discharge line, disconnect the line and dispose of it.

4.4.4 Clean an upright plastic-nalgene cylinder first with a methanol. 10% nitric acid or other specified solvent and then a distilled/deionized water rinse, wiping the free liquids after each.

4.4.5 For reversible pumps, reverse the pump to backwash all removable residual water present in the pump tubing. The pump should be shut off as soon as intermittent flow is observed from the reverse discharge.

4.4.6 Rinse the stainless steel submersible down hole pump section with a detergent solution followed by a water rinse and a liberal application of the specified solvent.

4.4.7 Place the submersible pump section upright in the cylinder and fill the cylinder with tap water, adding 50-100 ml of specified solvent for every one liter of water.

4.4.8 Activate the pump in the forward mode, withdrawing water from the cylinder.

4.4.9 Continue pumping until the water in the cylinder is pumped down and air is drawn through the pump. At this time air pockets will be observed in the discharge line. Shut off the pump immediately.

4.4.10 Remove the pump from the cylinder and place the pump in the reverse mode to discharge all removable water into a disposal container.

4.4.11 Using the water remaining in the cylinder, rinse the sealed portion of the power cord and discharge tube by pouring the water carefully over the coiled lines.

4.4.12 On reaching the next monitoring well, place the pump in the well casing and wipe dry both the power and discharge lines with a chemical-free paper towel as the pump is lowered.

4.5 Decontamination of Heavy Equipment

4.5.1 Upon arrival and prior to leaving a sampling site, all heavy equipment such as drill rigs, trucks, and backhoes should be thoroughly cleaned. This can be accomplished in two ways, steam cleaning or high pressure water wash and manual scrubbing.

4.5.2 Consult the QAPP for instruction on the location of the decontamination station and the method of containment of the wash solutions. Depending on the scope of the project it may be necessary to construct a sealed cement pad with draining capabilities and walls, or other suitable temporary structure, to contain splashes and sprays. A water supply and power source would also be required.

4.5.3 Following the initial cleaning, only those parts of the equipment which come in close proximity to sampling activity should be decontaminated in between sampling events. This would include items such as the backhoe bucket and extension arm.

5.0 QUALITY CONTROL

Necessary quality control checks and acceptance criteria are dependent on site specific chemistry, the nature of the media sampled and the objectives of the study. These checks shall be determined on a project specific basis and shall be outlined in the QAPP or project work plan.

5.1 General guidelines for the quality control checks for decontamination of field equipment are as follows:

- the collection of at least one field blank from the decontaminated equipment per day.

- For the sampling of soils and other solids, a solid field blank is not collected. Instead, decontamination rinsate samples should be collected as field blanks. Although the matrices differ, this water decontamination rinsate sample will provide an indication of the potential contamination due to inadequate decontamination procedures or ambient conditions.

- one shipping blank should accompany each shipment of aqueous samples destined for volatile organic analyses.

In this manner, a qualitative, and in the case of field blanks, quantitative assessment of potential contamination, and of effectiveness of the decontamination process is obtained.

5.2 Field Blanks

5.2.1 Field blanks are prepared for water sampling by pouring laboratory supplied deionized water into or over the freshly decontaminated sampling equipment (bailer, water level measurement tape, etc.) and then transferring this water into a sample container.

- Field blanks should be collected in the same location that samples are collected to determine if ambient VOCs are impacting the samples.

- Sample containers should be filled to the same levels as the samples the blanks are intended to represent.

- Field blanks should be labeled as a sample and submitted to the laboratory to be analyzed for the same parameters as the associated sample.

- Field blank sample numbers, as well as collection method, time and location should be recorded in the field notebook.

5.2.2 Field blanks should also be collected following the decontamination of submersible pumps.

- The pump should be used to withdraw laboratory supplied deionized water from the container and fill a sample container.

- The pump field blank should then be treated as in 4.2.1.

5.2.3 For soil and other solid samples, a solid field blank is not collected. Instead decontamination rinsate samples should be collected. Immediately following the decontamination of the soil sampling equipment (trowel, shovel, split-spoon samplers, dredge, etc.), laboratory supplied deionized water shall be applied to the entire sampler with a squirt bottle and then collected in a sample container.

- Sample containers should be filled to the same levels as the samples the rinsates are intended to represent.

- Decontamination rinsates should then be labeled as a sample and submitted to the laboratory to be analyzed for the same parameters as the associated samples.

- Decontamination rinsate sample numbers, as well as collection method, time and location should be recorded in the field notebook.

5.3 Shipping Blanks

5.3.1 Shipping blanks are used to identify errors introduced by cross-contamination of samples during shipping, sample bottle preparation and blank water quality.

- Analysis of shipping blanks is restricted to volatile compounds because these compounds demonstrate the greatest capacity for migration.

- Shipping blanks are sample containers which are filled with deionized water in the laboratory and placed in the sample shipping coolers when the sampling kits are assembled.

- They remain in the coolers in the field and are not opened.

- They are returned to the laboratory with the collected samples and analyzed for the same parameters as the associated samples.

- The volume of each shipping blank should be the same as the volume of the samples with which it is shipped and it should be in the same type of container as the samples.

6.0 DOCUMENTATION

Comprehensive documentation of decontamination is accomplished by completion of the following:

6.1 Field Notebook Entries

- Date, time and location of each decontamination event
- Equipment decontaminated
- Solvents
- Notable circumstances
- Identification of field blanks and decontamination rinsates
- Method of blank and rinsate collection
- Date, time and location of blank and rinsate collection

6.2 Field Blank and Decontamination Rinsate Sample Labels

- Blanks and rinsates should be labeled as samples

6.3 Chain-of-Custody Forms

- Instructions for lab analyses of blanks and rinsates

7.0 REFERENCES

Not applicable.