

**FIELD SAMPLING PLAN
SITE INSPECTION FOR PETTIBONE CREEK,
BOAT BASIN, AND HARBOR AREAS
GREAT LAKES NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS**

**PREPARED BY
DONOHUE & ASSOCIATES, INC.**

**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN)
PROGRAM**

**CONTRACT NO. N62472-90-D-1298
CONTRACT TASK ORDER 0019**

APRIL 1992



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ENVIRONMENTAL ACTION NAVY (CLEAN) PROGRAM**

**Submitted to:
Department of the Navy
Northern Division
Environmental Branch - Code 18
Naval Facilities Engineering Command
Building 77L, U.S. Naval Base
Philadelphia, Pennsylvania**

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**Submitted by:
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LIST OF ACRONYMS/ABBREVIATIONS

CHSM	Corporate Health and Safety Manager
COD	Chemical Oxygen Demand
FDC	Field Data Coordinator
FSP	Field Sampling Plan
FTL	Field Team Leader
HSP	Health and Safety Plan
HRS	Hazard Ranking System
HSO	Health and Safety Officer
NTC	Naval Training Center
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI/FS	Remedial Investigation/Feasibility Study
SI	Site Inspection
SQCO	Site Quality Control Officer
TAL	Target Analyte List
TCL	Target Compound List
TDS	Total Dissolved Solids
TOC	Total Organic Compound
TSS	Total Suspended Solids
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound

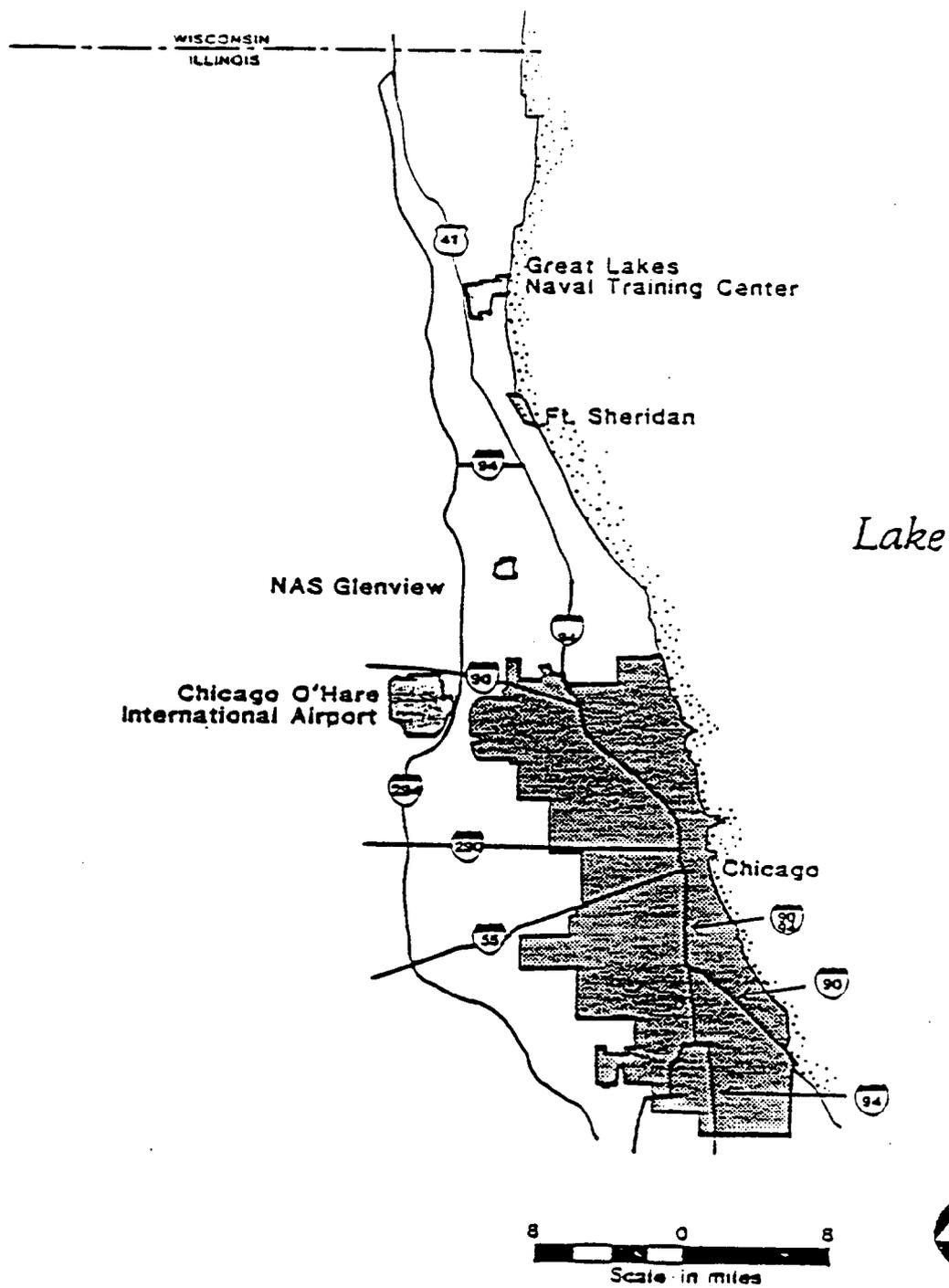
1.0 SITE INSPECTION OBJECTIVES AND APPROACH

The purpose of the Great Lakes Naval Training Center (NTC) (Figure 1-1) Site Inspection (SI) is to satisfy data needs associated with the following objectives:

1. Evaluate the types and levels of contaminants present at the Boat Basin, the Harbor Area and Pettibone Creek.
2. Establish background levels for the contaminants of concern.
3. Evaluate suspected contaminant migration pathways and patterns. Determine, if possible, whether contaminants have migrated via Pettibone Creek or Lake Michigan to the Harbor areas.
4. To collect additional samples for the Navy to evaluate dredging and disposal options for the potentially contaminated sediments in the Boat Basin and the Harbor Areas.

This Field Sampling Plan (FSP) presents procedures for collection, packaging, and shipping of environmental samples. The following chapters describe the approach and standard operating procedures to be used for field team organization and responsibilities; media-specific sampling including sample locations, equipment required, sampling procedures, decontamination, quality control, documentation, and sample identification numbers, chain of custody, and packaging and shipping. A discussion of the field investigation rationale and approach is presented in the SI Work Plan.

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SOURCE:
 INITIAL ASSESSMENT STUDY
 ROGERS, GOLDEN, HALPERN, 1986

GENERAL LOCATION MAP

GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS

FIGURE I-1



ENGINEERS
 ARCHITECTS
 SCIENTISTS

2.0 FIELD TEAM ORGANIZATION AND RESPONSIBILITIES

Donohue & Associates, Inc. (Donohue), and subcontractors will perform field sampling activities under the direction of the Field Team Leader. Field team members and their responsibilities follow.

2.1 FIELD TEAM LEADER

The Field Team Leader (FTL) will have overall responsibility for completion of field activities according to the FSP. The FTL is the overall coordinator of activities at the site and is the communication link between field team members, the Site QC Officer, the Field Data Coordinator (FDC), and the Project Manager. The FTL will assign specific field duties to team members in conjunction with the Project Manager. The FTL will be on-site during all field activities and oversee operations. The FTL will be responsible for mobilization and demobilization of the field team and subcontractor. The FTL will direct the activities of subcontractors on-site. Logistical problems hindering field activities such as equipment malfunctions or availability, personnel conflicts, or weather-dependent working conditions will be relayed to the FTL and resolved by the FTL.

Field team members will report to the FTL and provide daily verbal progress reports of field activities. The FTL is responsible for completing the Site Daily Logbook. The FTL is responsible for informing the Project Manager of daily activities. The FTL is responsible for supplying field team members with appropriate field notebooks and field documentation forms.

2.2 FIELD TEAM

Field team members will report directly to the FTL. Field team members will collect soil samples; perform soil gas sampling; develop, test, and sample wells; and collect sediment and surface water samples. Decontamination of sampling equipment will be accomplished by the field team under the direction of the FTL. Field team members will complete and file personal Daily Time Logs (Appendix A) and complete field documentation forms as indicated in the FSP. Field team members will submit field documentation forms to the Site QC Officer and will relinquish custody of field samples to the FDC. Field team members may assist in sample packaging and shipping. Field team members will comply with the provisions of the Site-Specific Health and Safety Plan (HSP).

2.3 SITE QUALITY CONTROL OFFICER

The Site QC Officer will check the completion of Chain of Custody Forms, packaging and shipment of samples and Sample Logbook entries for accuracy and compliance with sampling plan protocols. The Site QC Officer will be the contact to the laboratories regarding shipment and arrival of samples. The Site QC Officer will check the Daily Time Logs and field data forms for accuracy and compliance with the Quality Assurance Project Plan (QAPP) and FSP. The Site QC Officer is responsible for maintaining Field Instrumental Calibration Logs for field instruments. After review of documentation, the Site QC Officer is responsible for storing and forwarding the documentation to the FDC for filing. The Site QC Officer may be a member of the field team but cannot be the FDC.

2.4 FIELD DATA COORDINATOR

The FDC will be responsible for maintaining an adequate supply of sample containers, preservatives, labels, and shipping materials in the field. The FDC will assign Site-Specific Sample Numbers as described in Section 4.0. The FDC will receive samples from the field team and package them for shipment according to the procedures specified in Section 4.0. The FDC will ensure that custody seals are on shipping containers and that samples are shipped promptly. The FDC will file the shipping air bills. The FDC will maintain sample collection, labeling, and shipment documentation in the Sample Logbook. The Sample Logbook will follow the format shown in Appendix A. The FDC will receive field documentation reviewed by the Site QC officer copy the documentation, forward the copies to the project manager, and file the original documentation. The FDC may also be a member of the field team but cannot be the Site QC Officer.

2.5 SITE HEALTH AND SAFETY OFFICER

The Health and Safety Officer (HSO) will be present on-site during field operations and will be responsible for health and safety activities and delegation of duties to the health and safety staff in the field. Because the Great Lakes Site is identified as low-hazard, Level C or Level D, the HSO may direct site health and safety efforts through an Assistant HSO approved by the Corporate Health and Safety Manager (CHSM). The Assistant HSO will be responsible for implementing the HSP. The HSO may direct or participate in downrange activities as appropriate when this does not interfere with primary HSO responsibilities. The HSO has stop-work authorization which can be executed upon his/her determination of an imminent safety hazard, emergency condition, or other potentially dangerous situations, such as detrimental weather conditions. Authorization to proceed with work will be issued by the CHSM in conjunction with the Project Manager after such action. The HSO will initiate and execute contact with support facilities and personnel when this action is appropriate.

2.6 ASSISTANT HEALTH AND SAFETY OFFICER

On low-hazard Level C or Level D sites, the Assistant HSO may have collateral duties but must be qualified for the health and safety responsibility by the CHSM. At Level A, B, or specific Level C sites, the Assistant HSO will be the downrange person who accompanies field sampling teams and will report to the HSO. Additionally, the Assistant HSO will be required to support the HSO when multiple operations are conducted that require monitoring and HSO surveillance. The Assistant HSO's primary responsibility is to provide appropriate monitoring to ensure the safe conduct of field operations. The Assistant HSO will have access to continuous communications with the Command Post. The number of Assistant HSOs will depend upon the number of downrange operations occurring simultaneously, designated levels of protection, and individual assignments made by the HSO. The Assistant HSO will also share responsibility with the FTL and the HSO for ensuring that safety practices are followed by downrange teams.

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3.0 SURFACE WATER AND SEDIMENT SAMPLING PLANS

3.1 INTRODUCTION

Surface water and sediment sampling will be conducted at the sites discussed under this FSP. These sites include Pettibone Creek and select tributaries, Boat Basin, Inner Harbor, Outer Harbor, and Lake Michigan. The sample collection procedures for Pettibone Creek and the Harbor Area are discussed separately in the following sections.

The state of contamination is presently not known. Therefore, surface water and sediment sample analyses will include the Target Compound List (TCL) and Target Analyte List (TAL) parameters. TCL parameters include VOC, BNA, and pesticide/PCB. TAL parameters include metals and cyanide. In addition, Pettibone Creek surface water will be analyzed for water quality parameters. Water quality parameters will be measured to determine water quality changes along the length of Pettibone Creek for three reasons: 1) to help support contamination findings from the TCL and TAL analyses, 2) to determine possible impacts on aquatic life, and 3) to assess potential impacts of Pettibone Creek water quality on Lake Michigan. Water quality parameters include chemical oxygen demand (COD), total organic carbon (TOC), total suspended solids (TSS), total dissolved solids (TDS), alkalinity, chloride, sulfate, and nitrate plus nitrite. Filtered and unfiltered surface water samples will also be collected from the Pettibone Creek and the Harbor Area and compared qualitatively to assess if suspended material has an impact on contamination levels. This information will also be used to assess data in reference to total suspended solids (TSS) measured in creek samples. The above information may be important in terms of contaminant impacts on harbor sediments. If contamination is associated with TSS in creek surface water samples, then harbor sediments may be the primary receptor of contamination from the creek.

In addition, the following tests will be conducted on sediment samples from select locations (sampled during a previous investigation) within the Boat Basin and northern half of the Outer Harbor Area: Toxicity Characteristic Leaching Procedure (TCLP), reactive CN and reactive sulfate, particle size analysis, supernatant and elutriate test on arsenic, copper, mercury, total organic carbon (Method 9060), and % solids (Vol/Vol). These tests will be run in order to aid in the evaluation of land disposal alternatives for potentially contaminated sediments removed during dredging activities. Exact locations where sediment for these tests will be collected is provided in Table 3-5.

A summary of sampling and analysis to be performed for all media is shown on Table 3-1. Sample containers, preservatives, volumes, and holding times required are shown on Table 3-2. A summary of sample locations and sampling rationale for Pettibone Creek and the Harbor Area is provided in Table 3-3.

TABLE 3-1

**SAMPLING AND ANALYSIS SUMMARY
 SITE INSPECTION FOR PETTIBONE CREEK, BOAT BASIN, AND HARBOR AREAS
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992**

<u>Location/Matrix</u>	<u>Field Parameters</u>	<u>Laboratory Parameters</u>	<u>DQO Level</u>	<u>Field Samples</u>	<u>Field QC(A)</u>			<u>Laboratory QC</u>			<u>Total No. of Samples</u>
					<u>FB</u>	<u>RB</u>	<u>FD</u>	<u>LD</u>	<u>MS</u>	<u>MSD</u>	
PETTIBONE CREEK											
Surface Water	Temp., pH, Conductivity, Turbidity		I	11	--	--	1	--	--	--	12
		TCL	IV	11	1	1	1	--	1	1	14
		TAL (Dis.)	IV	11	1	1	1	1	1	--	14
		TAL (Total)	IV	11	1	1	1	1	1	--	14
		WQ	IV	11	1	1	1	1	1	--	14
Sediment		TCL	IV	11	--	1	1	--	1	1	13
		TAL	IV	11	--	1	1	1	1	--	13
BOAT BASIN											
Sediment 0-3',3-6'		TCL	IV	8	--	1	1	--	--	--	10
		TAL	IV	8	--	1	1	--	--	--	10
		TCLP	IV	4	--	--	--	--	--	--	4
		Reactive CN and reactive sulfate	IV	4	--	--	--	--	--	--	4
		Particle size analysis	IV	8	--	--	--	--	--	--	8
		% Solids	IV	8	--	--	--	--	--	--	8
		TOC	IV	8	--	--	--	--	--	--	8
		Supernatant Elutriate	IV	8	--	--	--	--	--	--	8
			IV	8	--	--	--	--	--	--	8
			IV	8	--	--	--	--	--	--	8
Surface Water	Temp., pH, Conductivity, Turbidity		I	2	--	--	1	--	--	--	3
		TCL	IV	2	1	1	1	--	--	--	5
		TAL (Dis.)	IV	2	1	1	1	--	--	--	5
		TAL (Total)	IV	2	1	1	1	--	--	--	5
			IV	2	1	1	1	--	--	--	5

TABLE 3-1 (Continued)

**SAMPLING AND ANALYSIS SUMMARY
SITE INSPECTION FOR PETTIBONE CREEK, BOAT BASIN, AND HARBOR AREAS
GREAT LAKES NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS
APRIL 1992**

<u>Location/Matrix</u>	<u>Field Parameters</u>	<u>Laboratory Parameters</u>	<u>DQO Level</u>	<u>Field Samples</u>	<u>Field QC(A)</u>			<u>Laboratory QC</u>			<u>Total No. of Samples</u>	
					<u>FB</u>	<u>RB</u>	<u>FD</u>	<u>LD</u>	<u>MS</u>	<u>MSD</u>		
INNER HARBOR												
Sediment 0-3',3-6'		TCL	IV	8	--	--	1	--	1	1	9	
		TAL	IV	8	--	--	1	1	1	--	9	
Surface Water	Temp., pH, Conductivity, Turbidity		I	2	--	--	--	--	--	--	2	
			TCL	IV	2	--	--	--	--	--	--	2
			TAL (Dis.)	IV	2	--	--	--	--	--	--	2
			TAL (Total)	IV	2	--	--	--	--	--	--	2
OUTER HARBOR												
Sediment 0-3',3-6'		TCL	IV	8	--	1	1	--	--	--	10	
		TAL	IV	8	--	1	1	--	--	--	10	
		TCLP	IV	4	--	--	--	--	--	--	4	
		Reactive CN and reactive sulfate	IV	4	--	--	--	--	--	--	4	
		Particle size analysis	IV	8	--	--	--	--	--	--	8	
		% Solids	IV	8	--	--	--	--	--	--	8	
		TOC	IV	8	--	--	--	--	--	--	8	
		Supernatant	IV	8	--	--	--	--	--	--	8	
		Elutriate	IV	8	--	--	--	--	--	--	8	
	Surface Water	Temp., pH, Conductivity, Turbidity		I	2	--	--	--	--	--	--	2
			TCL	IV	2	--	1	--	--	--	--	3
			TAL (Dis.)	IV	2	--	1	--	--	--	--	3
			TAL (Total)	IV	2	--	1	--	--	--	--	3

TABLE 3-1 (Continued)

**SAMPLING AND ANALYSIS SUMMARY
SITE INSPECTION FOR PETTIBONE CREEK, BOAT BASIN, AND HARBOR AREAS
GREAT LAKES NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS
APRIL 1992**

<u>Location/Matrix</u>	<u>Field Parameters</u>	<u>Laboratory Parameters</u>	<u>DQO Level</u>	<u>Field Samples</u>	<u>Field QC(A)</u>			<u>Laboratory QC</u>			<u>Total No. of Samples</u>
					<u>FB</u>	<u>RB</u>	<u>FD</u>	<u>LD</u>	<u>MS</u>	<u>MSD</u>	
LAKE MICHIGAN (DOWN CURRENT)											
Sediment 0-3'		TCL	IV	2	--	--	1	--	1	1	3
		TAL	IV	2	--	--	1	1	1	--	3
Surface Water	Temp., pH, Conductivity, Turbidity		I	TBD	--	--	1	--	--	--	3
		TCL	IV	1	1	--	1	--	1	1	3
		TAL (Dis.)	IV	1	1	--	1	1	1	--	3
		TAL (Total)	IV	1	1	--	1	1	1	--	3
LAKE MICHIGAN (BACKGROUND)											
Sediment 0-3'		TCL	IV	4	--	1	1	--	1	1	6
		TAL	IV	4	--	1	1	1	1	--	6
Surface Water	Temp., pH, Conductivity, Turbidity		I	TBD	--	--	--	--	--	--	TBD
		TCL	IV	4	1	1	1	--	1	1	7
		TAL (Dis.)	IV	4	1	1	1	1	1	--	7
		TAL (Total)	IV	4	1	1	1	--	1	1	7

TCL - Target Compound List parameters as found in Tables 3-1, 3-2, and 3-3.

TAL (Dis.) - Target Analyte List parameters in Table 3-4, after filtering through a 45- μ filter.

TAL (Total) - Target Analyte List parameters in Table 3-4, without filtering.

WQ - Water Quality parameters in Table 3-5.

FB - Field Blank

MS - Matrix Spike

FD - Field Duplicate

MSD - Matrix Spike Duplicate

LD - Laboratory Duplicate

RB - Rinsate Blank

TBD - To be determined. Temp., pH, conductivity, and turbidity will be measured at two foot intervals from the lake surface to the lake bottom. The number of intervals will be determined in the field.

- (A) Trip blanks will be provided at a frequency of one per cooler of aqueous samples for TCL volatiles analysis. Total samples do not include trip blanks. Trip blanks will originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic (VOA) samples (NEESA 20.2-047B). One field blank will be provided for each different source of water per event. Rinsate blank samples will be collected at a frequency of one sample per day. Field duplicates will be collected at a frequency of one per 10 samples collected.

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TABLE 3-2

SAMPLE CONTAINERS, PRESERVATIVES AND HOLDING TIMES
 SITE INSPECTION FOR PETTIBONE CREEK, BOAT BASIN,
 AND HARBOR AREAS
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

<u>Parameter</u>	<u>Container(a)</u>	<u>Preservative</u>	<u>Holding Time(b)</u>
Sediment, Soil			
TCL VOC	Two 120-ml glass vials with teflon septa	4° C	14 days
TCL SVOC	One 8-oz wide mouth glass jar with teflon-lined lid	4° C	(c)
TCL PEST/PCB	One 8-oz wide mouth glass jar with teflon-lined lid	4° C	(c)
TAL INORGANIC Metals Mercury	One 8-oz wide mouth glass jar with teflon-lined lid	4° C	6 months 30 days
Cyanide			14 days
TCLP Reactive CN and reactive sulfate Particle size analysis % Solids TOC Supernatant Elutriate	Two 1-quart wide mouth glass jar with teflon-lined lid	None	None
Surface Water			
TCL VOC	Two 40-ml glass vials with teflon septa	4° C, HCl to pH 2	14 days
TCL SVOC	Two 1-liter amber glass with teflon-lined lids	4° C	(c)
TCL PEST/PCB	Two 1-liter amber glass with teflon-lined lids	4° C	(c)

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TABLE 3-2 (Continued)

**SAMPLE CONTAINERS, PRESERVATIVES AND HOLDING TIMES
SITE INSPECTION FOR PETTIBONE CREEK, BOAT BASIN,
AND HARBOR AREAS
GREAT LAKES NAVAL TRAINING CENTER
GREAT LAKES, ILLINOIS
APRIL 1992**

<u>Parameter</u>	<u>Container(a)</u>	<u>Preservative</u>	<u>Holding Time(b)</u>
TAL INORGANIC Metals Mercury	One 1-liter HDPE with teflon-lined lid	4° C, HNO ₃ to pH <2	6 months 28 days
Cyanide	One 1-liter HDPE with teflon-lined lid	4° C, NaOH to pH >12	14 days
Sulfate, Alkalinity, Chloride	One 1-liter HDPE with teflon-lined lid	4° C	Sulfate-28 days Alkalinity-14 days Chloride-28 days
Nitrate-Nitrite Nitrogen	One 1-liter HDPE with teflon-lined lid	1 ml 1:1 H ₂ SO ₄ , pH <2, 4° C	28 days
COD, TOC	One 1-liter HDPE with teflon-lined lid	1 ml 1:1 H ₂ SO ₄ , pH <2, 4° C	28 days
TDS, TSS	One 1-liter HDPE with teflon-lined lid	4° C	7 days

(a) Sample containers will be certified clean by the supplier according to USEPA standards and protocols.

(b) From time of collection.

(c) Fourteen days until extraction and analyze within 40 days for sediment and soil, seven days until extraction and analyze within 40 days for surface water and groundwater.

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TABLE 3-3

SURFACE WATER AND SEDIMENT SAMPLING PLAN RATIONALE
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

SAMPLE ID	MATRIX	LOCATION	RATIONALE
SW/SD-PC-01	Surface Water/ Sediment	Pettibone Creek; near creek outlet. Approximately 50 feet upstream from Boat Basin.	- Assess contamination near the creek outlet. Comparisons will be made to contamination upstream and in the Boat Basin which may potentially be impacted by contamination from the creek.
SW/SD-PC-02	Surface Water/ Sediment	Pettibone Creek; approximately 300 feet upstream from Boat Basin.	- Assess contamination just downstream of main creek juncture. - Assess contaminant contributions to main creek from the north and south branches.
SW/SD-PC-03	Surface Water/ Sediment	Pettibone Creek; near base of south branch, approximately 100 feet upstream from main juncture.	- Assess contamination in south branch just before entering main creek branch. Information will be used to assess contributions of contamination to main creek branch from south branch.
SW/SD-PC-04	Surface Water/ Sediment	Pettibone Creek; near base of subbase along south branch, approximately 500 feet upstream from main juncture.	- Assess contamination in subbranch just before entering south branch. Information will be used to assess contributions of contamination to south branch from the subbranch.

TABLE 3-3 (CONTINUED)

SURFACE WATER AND SEDIMENT SAMPLING PLAN RATIONALE
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

SAMPLE ID	MATRIX	LOCATION	RATIONALE
SW/SD-PC-05	Surface Water/ Sediment	Pettibone Creek; south branch, approximately 50 feet upstream from Navy property.	- Background sample to be compared to downstream sample locations and to assess contaminants contributed by the golf course and the west end of NTC.
SW/SD-PC-06	Surface Water/ Sediment	Pettibone Creek; south branch, approximately 500 feet upstream from Navy property.	- Background sample to be compared to downstream sample locations.
SW/SD-PC-07	Surface Water/ Sediment	Pettibone Creek; near base of north branch, approximately 200 feet upstream from main juncture.	- Assess contamination in north branch just before entering main creek branch. Information will be used to assess contributions of contamination to main creek branch from north branch.
SW/SD-PC-08	Surface Water/ Sediment	Pettibone Creek; near base of subbranch along north branch, approximately 700 feet upstream of main juncture.	- Assess contamination in subbranch just before entering north branch. Information will be used to assess contributions of contamination to south branch from the subbranch.
SW/SD-PC-09	Surface Water/ Sediment	Pettibone Creek; north branch, approximately 1,000 feet upstream from the main juncture.	- Assess contaminant contributions to the north branch between sample locations 09 and 06.

TABLE 3-3 (CONTINUED)

SURFACE WATER AND SEDIMENT SAMPLING PLAN RATIONALE
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

SAMPLE ID	MATRIX	LOCATION	RATIONALE
SW/SD-PC-10	Surface Water/ Sediment	Pettibone Creek; north branch, approximately 50 feet upstream from Sheridan Road.	- Background sample to be compared to downstream sample locations.
SW/SD-PC-11	Surface Water/ Sediment	Pettibone Creek; north branch, approximately 500 feet upstream from Sheridan Road.	- Background sample to be compared to downstream sample locations.
SW/SD-BB-01	Surface Water/ Sediment	Boat Basin; near Pettibone Creek outlet.	- Characterize the nature and extent of contamination in the Boat Basin/ Pettibone Creek transition area. - Evaluate land disposal alternative for potentially contaminated sediment.
SW/SD-BB-02	Surface Water/ Sediment	Boat Basin; near mid-section.	- Characterize the nature and extent of contamination in the Boat Basin. - Evaluate land disposal alternative for potentially contaminated sediment.
SW/SD-BB-03	Surface Water/ Sediment	Boat Basin; near mid-section.	- Characterize the nature and extent of contamination in the Boat Basin. - Evaluate land disposal alternative for potentially contaminated sediment.

TABLE 3-3 (CONTINUED)

SURFACE WATER AND SEDIMENT SAMPLING PLAN RATIONALE
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

SAMPLE ID	MATRIX	LOCATION	RATIONALE
SW/SD-BB-04	Surface Water/ Sediment	Boat Basin Channel leading to Inner Harbor.	- Characterize contamination in Boat Basin/Inner Harbor transitional area.
SW/SD-IN-05	Surface Water/ Sediment	Inner Harbor; near Boat Basin exit channel.	- Characterize the nature and extent of contamination in Inner Harbor/Boat Basin transitional area.
SD-IN-06	Sediment	Inner Harbor; near north central section.	- Characterize the nature and extent of contamination in the Inner Harbor.
SW/SD-IN-07	Surface Water/ Sediment	Inner Harbor; near southeast section.	- Characterize the nature and extent of contamination in the Inner Harbor.
SD-IN-08	Sediment	Inner Harbor; near outlet to Main Harbor.	- Characterize the nature and extent of contamination in Inner Harbor/Outer Harbor transitional area.
SD-OH-09	Sediment	Outer Harbor, near boat ramp, northeast section	- Evaluate land disposal alternative for potentially contaminated sediment.
SD-OH-10	Sediment	Outer Harbor; northern section.	- Evaluate land disposal alternative for potentially contaminated sediment.

TABLE 3-3 (CONTINUED)

SURFACE WATER AND SEDIMENT SAMPLING PLAN RATIONALE
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

SAMPLE ID	MATRIX	LOCATION	RATIONALE
SW/SD-OH-11	Surface Water/ Sediment	Outer Harbor; northern section.	<ul style="list-style-type: none"> - Characterize the nature and extent of contamination in the Outer Harbor area. - Evaluate land disposal alternative for potentially contaminated sediment.
SD-OH-12	Sediment	Outer Harbor; northern section.	<ul style="list-style-type: none"> - Characterize the nature and extent of contamination in the Outer Harbor area. - Evaluate land disposal alternative for potentially contaminated sediment.
SW/SD-OH-13	Surface Water/ Sediment	Outer Harbor; southern section.	<ul style="list-style-type: none"> - Characterize the nature and extent of contamination in Outer Harbor Area.
SD-LM-14	Sediment	Outer Harbor; southern section.	<ul style="list-style-type: none"> - Characterize the nature and extent of contamination in Outer Harbor Area.
SD-LM-15	Sediment	Lake Michigan; near Outer Harbor outlet.	<ul style="list-style-type: none"> - Characterize the nature and extent of contamination in Lake Michigan/Harbor transition area.
SW/SD-LM-16	Surface Water/ Sediment	Lake Michigan; south side of Outer Harbor.	<ul style="list-style-type: none"> - Characterize the nature and extent of contamination in Lake Michigan down current of Harbor Area.

TABLE 3-3 (CONTINUED)

SURFACE WATER AND SEDIMENT SAMPLING PLAN RATIONALE
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

SAMPLE ID	MATRIX	LOCATION	RATIONALE
SW/SD-LM-17	Surface Water/ Sediment	Lake Michigan; approximately 500 feet north of Harbor Area.	- Background sample to be compared to downcurrent sample locations.
SW/SD-LM-18	Surface Water/ Sediment	Lake Michigan; approximately 1,000 feet north of Harbor Area.	- Background sample to be compared to downcurrent sample locations.
SW/SD-LM-19	Surface Water/ Sediment	Lake Michigan; approximately 2,000 feet north of Harbor Area.	- Background sample to be compared to downcurrent sample locations.
SW-SD-LM-20	Surface Water/ Sediment	Lake Michigan; approximately 3,000 feet north of Harbor Area.	- Background sample to be compared to downcurrent sample locations.

RP/19FSPBF/AA4

3.2 PETTIBONE CREEK SAMPLE COLLECTION PROCEDURES

3.2.1 Introduction

A minimum of 11 locations along Pettibone Creek will be sampled for surface water and sediment. Approximate surface water and sediment sampling locations are shown in Figure 3-1. Sample locations will be selected to represent stream conditions in the different branches of the stream. Two or more samples will be collected from longer branches to represent different sections of the stream branch. In addition, four samples will be collected upstream and off-site to represent background conditions. Four background samples are necessary for a statistical comparison to on-site samples. The statistical methodology is described in the work plan. Two background samples will be collected from the north branch off-site and two will be collected from the south branch off-site.

On-site sample locations selected will be used to evaluate whether contaminants have originated from off-site or on-site sources. In addition, this is a preliminary evaluation which may lead to a more focused investigation. This data will also be used to provide information for site scoring according to the HRS.

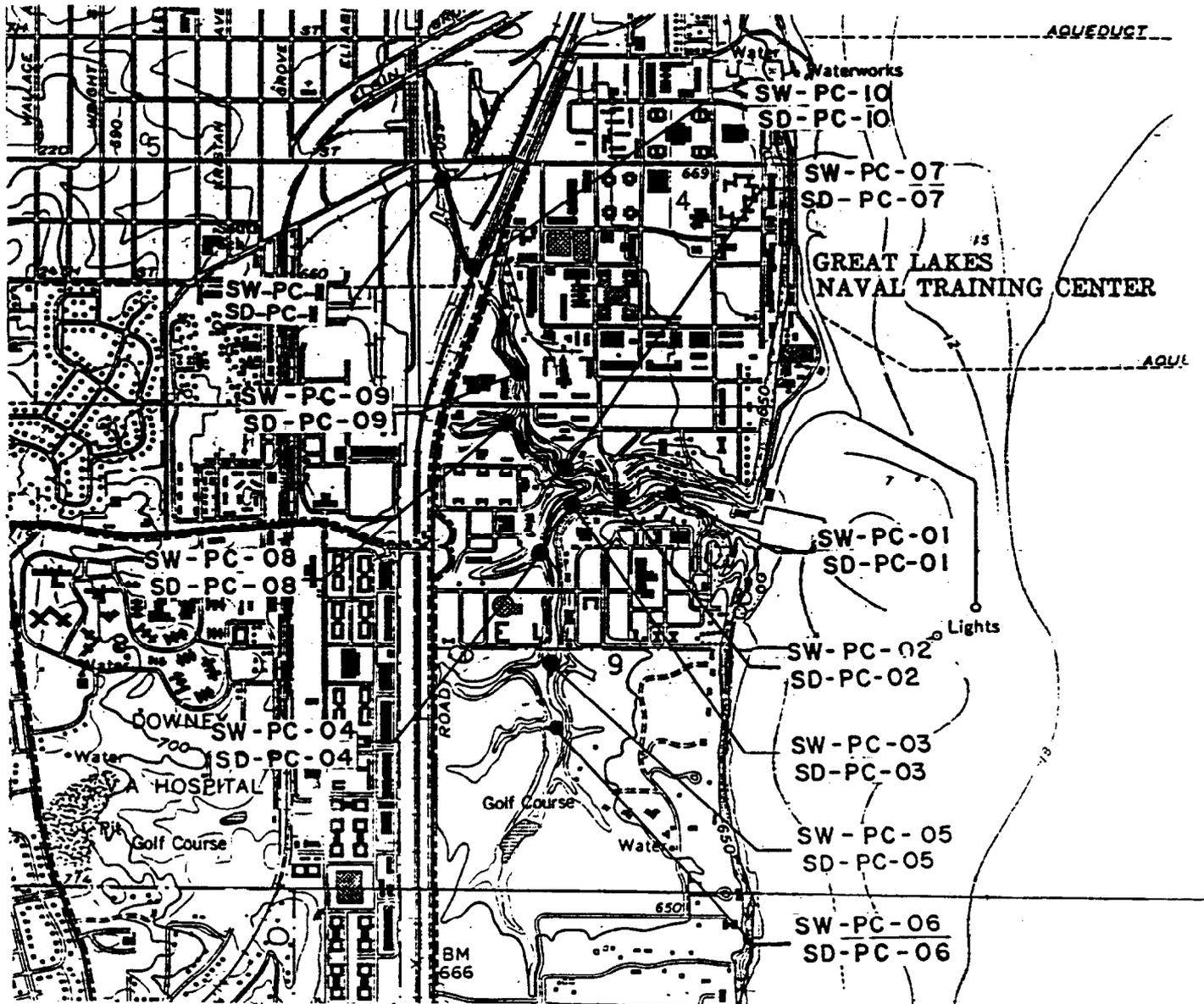
The following sections detail the equipment and procedures to be followed for sample collection along Pettibone Creek.

Sample integrity will be maintained by decontaminating field equipment between each sample location and adhering to sample preservation, packaging, and chain of custody protocols developed for this investigation.

3.2.2 Equipment

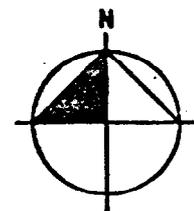
The following equipment and materials will be used during surface water and sediment sampling:

- Sample containers and preservatives as indicated in Table 3-2; pH paper.
- HDPE filtration jugs.
- Millipore field filtration apparatus.
- Field filtration apparatus filters, 0.45-microns.
- Nitrogen gas cylinder and regulator.
- Portable turbidity meter.
- Conductivity meter.
- pH meter and pH 7 and 10 calibration buffer solution.
- Thermometer.
- Water, distilled (ASTM Type II) and tap.
- Isopropanol (A.C.S.).



LEGEND

● SAMPLE LOCATION



0 1000 2000

SCALE: FEET

SCALE IS APPROXIMATE

SOURCE:
 USGS 7.5 MINUTE QUADRANGLE
 WAUKEGAN, ILLINOIS, 1960
 PHOTOREVISED 1972 AND 1980

**PETTIBONE CREEK
 SAMPLE LOCATIONS**

GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS

FIGURE 3-1

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 ARCHITECTS
 SCIENTISTS

- Five-gallon pail with cover to contain isopropanol rinses.
- Alconox soap.
- Powderless surgical gloves.
- Brushes.
- Stainless steel bowls and spoons.
- Sample tags and Chain of Custody Forms.
- Munsell Soil Color Chart.
- Stainless steel auger.
- Field notebook with appropriate forms.
- Camera and film.
- Chest waders.
- Measuring tape.
- Clean plastic bags.
- Coolers with ice packs, "blue" ice, or equivalent.

3.2.3 Sample Collection Procedures

Each sample location will be identified by marking an appropriate site base map. In addition, sampling locations along Pettibone Creek will be marked with numbered stakes and flagging. Surface water and sediment samples will be stored in a cooler iced to 4°C immediately following collection. Sample container and preservative requirements are listed in Table 3-2. The sample locations and sediment composites will be photographed, and a description will be recorded in the field notebook at sampling locations.

Surface Water

Surface water samples will be collected concurrently with and just prior to sediment sample collection. Sample locations will be approached from a downstream direction. Sample bottles will be filled directly from the stream by pointing the bottle upstream and hand dipping it upside down below the stream surface then turning the bottle right side up when submerged to allow the water to displace the air in the bottle. Powderless surgical gloves will be worn during sampling and changed between sample locations to avoid the introduction of contamination from the sampler's hands. In addition, the containers will be rinsed several times with surface water to minimize the introduction of contamination from the containers. Temperature, pH, conductivity, and turbidity measurements will be performed on the samples and recorded on the Surface Water Data Forms (Appendix A) in order to detect water quality changes along the stream length. Filtered samples will also be collected and compared qualitatively in order to assess if suspended material has an impact on contaminant levels.

Temperature, pH, and conductivity measurements will be taken according to the SOPs in Appendix B. Calibration procedures for these measurements are also included in Appendix B.

Samples for metals analysis will be collected in a HDPE filtration jug and filtered immediately. The details of the filtering process are included in Appendix B. Following field filtering, the sample will be preserved. The pH of the preserved sample will be checked to ensure that adequate preservative was added. Performance of field-filtering will not be indicated on paper work accompanying samples to the lab because these samples will be digested in order to analyze the "total dissolved" fraction of metals.

Sediment

Stream sediment samples will be collected by wading into the stream in a manner which will minimize stirring up of stream bed sediments by approaching the sampling location from the downstream direction. Downstream sampling locations will be sampled first followed by progressively further upstream locations. Surface water samples will be collected before sediment samples at each location.

Stream sediment samples will be collected from 0- to 1-foot using a stainless steel hand auger. The contents of the auger will be emptied into a decontaminated stainless steel compositing bowl and visually described on the Sediment Grab Data Form (Appendix A). Sample jars for volatile organic compound (VOC) analysis will be filled from representative portions of the sample in the compositing bowl immediately after recording the soil description. Samples for VOC analysis will not be composited. Water will then be decanted and a sample of sediment will be taken for mixing. Each stream sediment sample will be mixed in the stainless steel compositing bowl with a decontaminated stainless steel mixing spoon. The sediment will be mixed until a visually homogeneous sample is obtained. The resultant mixed sediment composite will be spread evenly in the bottom of the bowl. The sediment will be divided into four quadrants. A sample will be taken from each quadrant using a stainless steel spoon and loaded directly into sample jars. Excess sediment remaining in the bowl will be returned to the stream a few yards downstream of the sampling location. At one location, a sediment duplicate sample will be prepared by filling two sample jars from the same mixed and quartered sediment composite.

3.2.4 Decontamination

Before sampling and between sampling location, sampling equipment, such as stainless steel augers, spoons and bowls will be decontaminated with: 1) Alconox soap and tap water wash, 2) a tap water rinse, 3) an isopropanol rinse, and 4) two distilled water (ASTM Type II rinses). Clean sampling equipment will be wrapped and stored before use in clean plastic bags.

The Millipore field filtration unit will be decontaminated using the following steps:

1. Water remaining in the pressure vessel will be discarded and the vessel will be rinsed twice with distilled water (ASTM Type II).
2. A minimum of 500 ml of distilled water (ASTM Type II) will be flushed through the entire system.

Soap and isopropanol rinses will be retained in a closed container for discharge to the municipal wastewater treatment system.

3.2.5 Quality Control

In order to verify the quality of the sampling process, field duplicates, rinsate blanks, and field blanks will be collected for both surface water and sediment samples. The number of QC samples to be collected is listed in Table 3-1.

Field duplicates will be taken at a rate of 10 percent of field samples collected from the sediment stainless steel mixing bowl and surface water at the same time and in the same manner as the original samples. Surface water samples selected for matrix spike analysis will require triple the volume listed in Table 3-2.

Rinsate blank samples will be collected at a frequency of one sample per day after decontamination procedures in Section 3.2.4. This will be done by running distilled water (ASTM Type II) across the sampler (stainless steel auger) and allowing the runoff to fill the appropriate sample containers listed in Table 3-2. Rinsate blanks and field blanks, for dissolved metals, will be field filtered using the procedure in Appendix B. Field blank samples will be collected from each source of water used for decontamination by pouring the source water directly into appropriate sample containers listed in Table 3-2.

3.2.6 Documentation

Surface water and sediment sampling information and other observations made by the on-site samplers during sampling activities will be recorded on the appropriate field forms shown in Appendix A. This will include:

- Daily Time Log
- Sediment Grab Data Form
- Surface Water Sampling Form
- Photo Log Labels
- Sample Labels

3.3 HARBOR AREA AND LAKE SAMPLE COLLECTION PROCEDURES

3.3.1 Introduction

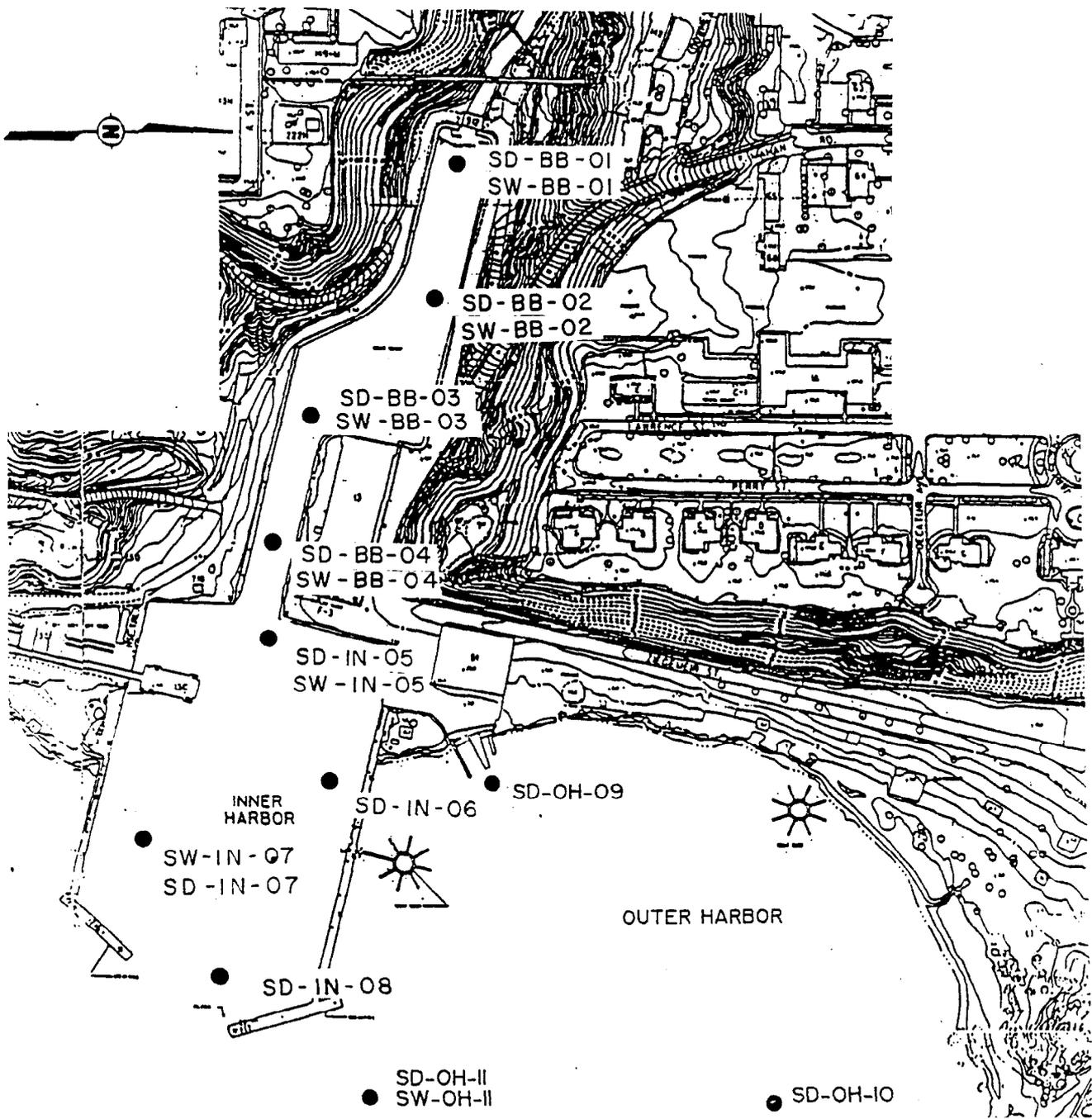
A minimum of 34 sediment and 11 surface water samples will be collected from 20 locations in the Harbor Area and Lake Michigan in close proximity to the Harbor Area to assess the nature and extent of contamination. Specific areas for sampling include: Boat Basin, Inner Harbor, Outer Harbor, and Lake Michigan. Four surface water and four sediment samples from Lake Michigan, up current from the Harbor Area, will be collected to represent background conditions. Four background samples are necessary for a statistical comparison to on-site samples. The statistical methodology is described in the Work Plan. Approximate surface water and sediment sampling locations are shown in Figures 3-2 and 3-3. A summary of the number of sample locations, the number of surface water and sediment samples, and associated analysis for each specific area are listed in Tables 3-4 and 3-5.

Sediment samples will be collected from 0- to 3-foot and 3- to 6-foot depth intervals in the Boat Basin, Inner Harbor, and Outer Harbor. Previous investigation samples were composited from 0 to 5 feet and there were indications that sediment had accumulated to a depth of 5 feet. Therefore, sampling is based on that information. In addition, to get an idea about the vertical distribution of contamination in sediments, samples will be collected at the above two intervals. Lake Michigan sediment samples will be collected from the 0- to 3-foot depth interval. It is anticipated that only the top interval will be sampled because of the elevation differences between Lake Michigan sample locations and Harbor Area sample locations.

Surface water samples in the Boat Basin and Harbor Areas were listed to 50 percent of the sample locations in each harbor area section. This should provide adequate information on surface water contamination in each harbor section due to the turbulent mixing of surface water in these environments.

The following sections detail the equipment and procedures to be followed for sample collection in the Harbor Area and Lake Michigan.

Sample integrity will be maintained by decontaminating field equipment between sample locations and adhering to sample preservation, packaging, and chain of custody protocols developed for this investigation.



LEGEND

- -BB- BOAT BASIN SAMPLING LOCATION
- -IN- INNER HARBOR SAMPLING LOCATION
- -OH- OUTER HARBOR SAMPLING LOCATION

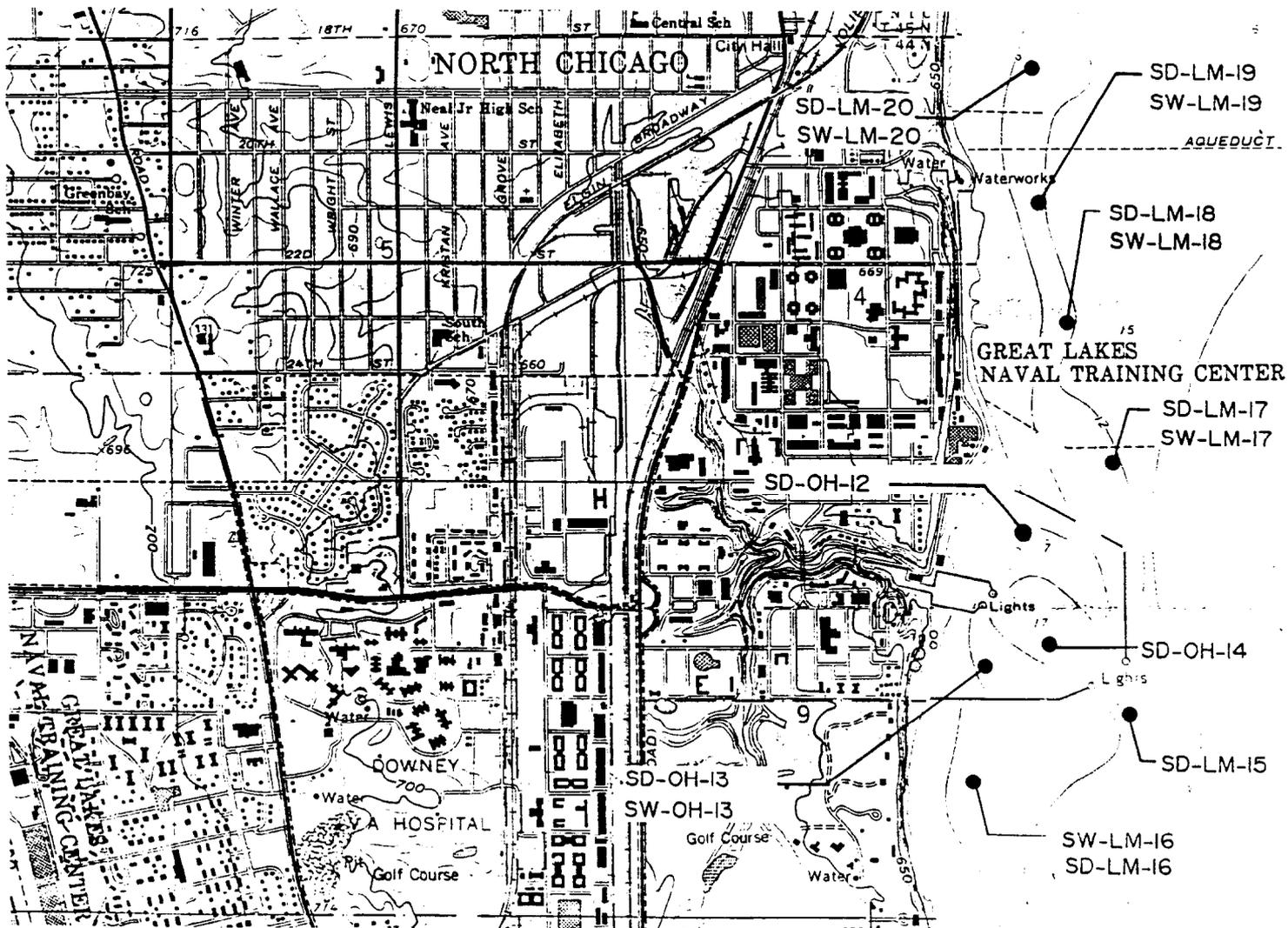
0 200 400
 SCALE : FEET
 SCALE IS APPROXIMATE

**INNER HARBOR, BOAT BASIN, AND OUTER HARBOR
 SAMPLE LOCATIONS**

FIGURE 3-2

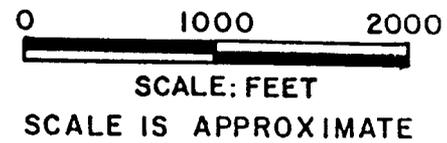
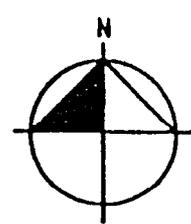
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LEGEND

- -LM- LAKE SAMPLE LOCATION
- -OH- OUTER HARBOR SAMPLE LOCATION



SOURCE:
 USGS 7.5 MINUTE QUADRANGLE
 WAUKEGAN, ILLINOIS, 1960
 PHOTOREVISED 1972 AND 1980

**OUTER HARBOR AND LAKE
 SAMPLE LOCATIONS**

**GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS**

FIGURE 3-3

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TABLE 3-4

SUMMARY OF SURFACE WATER AND SEDIMENT SAMPLES AND LOCATIONS
 PROPOSED FOR THE HARBOR AREA AND LAKE MICHIGAN
 GREAT LAKE NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

<u>Specific Area</u>	<u>Number of Sample Locations</u>	<u>Number of Surface Water Samples</u>	<u>Number of Sediment Samples</u>	<u>Sediment Sampling Intervals (ft)</u>
Boat Basin	4	2	8	0-3, 3-6
Inner Harbor	4	2	8	0-3, 3-6
Outer Harbor	6	2	12	0-3, 3-6
Lake Michigan (Downcurrent)	2	1	2	0-3
Lake Michigan (Background)	4	4	4	0-3

RP/19FSPBF/AA2

TABLE 3-5

SUMMARY OF SURFACE WATER AND SEDIMENT SAMPLE ANALYSIS
 BY LOCATION
 SITE INSPECTION FOR PETTIBONE CREEK, BOAT BASIN, AND HARBOR AREAS
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

<u>Sample Location</u>	<u>TCL/TAL</u>	<u>TCLP, Reactive CN and Reactive Sulfate</u>	<u>Total Organic Carbon and % Solids</u>	<u>Particle Size Analysis</u>	<u>Supernatant and Elutriate Test</u>
BOAT BASIN					
SW-BB-01	X				
SD-BB-01	X	X	X	X	X
SW-BB-02	X				
SD-BB-02	X		X	X	X
SW-BB-03	X				
SD-BB-03	X	X	X	X	X
SW-BB-04	X				
SD-BB-04	X		X	X	X
INNER HARBOR					
SW-IN-05	X				
SD-IN-05	X				
SW-IN-06	X				
SW-IN-07	X				
SD-IN-07	X				
SD-IN-08	X				

TABLE 3-5 (Continued)

SUMMARY OF SURFACE WATER AND SEDIMENT SAMPLE ANALYSIS
 BY LOCATION
 SITE INSPECTION FOR PETTIBONE CREEK, BOAT BASIN, AND HARBOR AREAS
 GREAT LAKES NAVAL TRAINING CENTER
 GREAT LAKES, ILLINOIS
 APRIL 1992

<u>Sample Location</u>	<u>TCL/TAL</u>	<u>TCLP, Reactive CN and Reactive Sulfate</u>	<u>Total Organic Carbon and % Solids</u>	<u>Particle Size Analysis</u>	<u>Supernatant and Elutriate Test</u>
OUTER HARBOR					
SD-OH-09			X	X	X
SD-OH-10			X	X	X
SD-OH-11	X	X	X	X	X
SW-OH-12	X				
SD-OH-12	X	X	X	X	X
SW-OH-13	X				
SD-OH-13	X				
SD-OH-14	X				
LAKE MICHIGAN					
SD-LM-15	X				
SW-LM-16	X				
SD-LM-16	X				
SW-LM-17	X				
SD-LM-17	X				
SW-LM-18	X				
SD-LM-18	X				
SW-LM-19	X				
SD-LM-19	X				
SW-LM-20	X				
SD-LM-20	X				

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3.3.2 Equipment

The following equipment will be used during surface water and sediment sampling:

Surface Water

- Keck pump.
- Millipore field filtration apparatus.
- Field filtration apparatus filters, 0.45 micron.
- Nitrogen gas cylinder and regulator.
- Yellow Springs Instrument (YSI) Model 3500 Water Quality Monitoring System for pH, temperature, and conductivity measurements.
- Portable turbidity meter.
- Tap water and distilled water (ASTM Type II) for decontamination of sampling equipment.
- Isopropanol (A.C.S.) for decontamination of sampling equipment.
- Five-gallon pail with cover, for collecting and storing isopropanol rinses.
- Sample containers and preservatives listed in Table 3-2.
- Sample tags and Chain of Custody Forms.
- Alconox detergent.
- Powderless surgical gloves.
- Sampling platform (barge listed in sediment sampling equipment).

Sediment Sampling

- Boat of sufficient size to shuttle three people.
- Sample tags and Chain of Custody Forms.
- Barge-mounted drill rig with the following capabilities:
 - Ability to sample through 12 feet of water, six feet into the bottom sediments.
 - Stainless steel Osterberg tube, Shelby tube, and split spoon samplers.
 - Appropriate hammers.
 - Appropriate anchors.
- Clean 8-ounce glass jars with teflon lids.
- Fiber glass tape of adequate length (20 feet).
- Field notebook.
- Small and large brushes.
- Munsell color chart.

- Camera and film.
- Alconox detergent.
- Tap and distilled (ASTM Type II) water for decontaminating sampling equipment.
- Isopropanol (A.C.S.) for decontamination of sampling equipment.
- Coolers.
- Five-gallon pail with cover for collecting and storing methanol rinsate.

Each sample location will be identified by marking an appropriate site base map. All surface water and sediment samples will be stored in a cooler iced to 4°C immediately following collection. Sample container and preservative requirements are listed in Table 3-2.

The following discusses surface water and sediment sampling procedures separately.

3.3.3 Sample Collection Procedures

Surface Water

Surface water sample locations will coincide with sediment sample locations. Surface water sampling will be conducted from the barge-mounted drill rig after it has been securely anchored and prior to sediment sampling.

Prior to surface water sampling, a water quality profile will be conducted at each location to determine water quality changes with depth. The Yellow Springs Instrument (YSI) Model 3500 Water Quality System or similar water quality system will measure pH, temperature, conductivity, and depth of measurement at 2-foot intervals from lake surface to lake bottom. A portable turbidity meter will measure turbidity at the same intervals. Lake water from each two-foot interval will be supplied to the YSI and turbidity meter by a Keck pump. At each interval the Keck pump will be allowed to run for approximately three minutes in order to obtain a representative water sample. Water quality parameters will be recorded on the Surface Water Data Form (Appendix A). Instrument calibration procedures and standard operating procedures are outlined in Appendix B and will be recorded on the Field Meter Calibration Log (Appendix A).

Surface water samples will be collected at the mid-point between water surface and bottom, as determined during the water quality profile measurements. Surface water samples will be collected using a Keck pump.

Samples for metals analysis will be collected in a HDPE filtration jug and filtered immediately. The details of the filtering process are included in Appendix B. Following field filtering, the sample will be preserved. The pH of the preserved sample will be checked to ensure that adequate preservative was added. Performance of field-filtering will not be indicated on paper work accompanying samples to the lab because these samples will be digested in order to analyze the "total dissolved" fraction of metals.

Sediment

Sediment cores will be obtained from a barge-mounted drill rig, as close as possible to the designated sample location. Sample locations will be approached from the down-current direction if a current direction can be identified. The sediment will then be sampled using, in order of preference, stainless steel Osterberg tube, Shelby tube, or 3-inch split spoon sampler. Choice of sampler will depend on the physical characteristics of the sediments. In fine-grained materials an Osterberg tube or Shelby tube will be used. In coarse grained material, sampling may have to be done with a 3-inch split spoon. If a split spoon sampler is used, casing will be driven to the bottom of each sample interval and flushed using rotary wash drilling methods. Lake water will be used as the drilling fluid, and return water will be discharged to the lake. In the event bentonite drilling fluid is used during drilling, bentonite fluids will be containerized on the barge and discharged on the land surface. Sampling will continue through 6 feet into the lake bottom sediment. Samples will be logged by an on-site geologist and classified according to United Soil Classification System (USCS). Unused portions of samples will be returned to the lake.

Sample volumes will need to be sufficient enough to fill the following containers: two 120 ml vials, three 8 oz jars and one 1-quart jar. If sufficient volume cannot be obtained from the first sampling attempt, a second sample will be collected from the same sample interval as close as possible to the original sample location.

Two composite samples will be taken from the 0- to 3-foot and 3- to 6-foot depth intervals for chemical analysis at the Boat Basin, Inner Harbor, and Outer Harbor locations. One composite sample will be taken from the 0- to 3-foot depth interval for chemical analysis at Lake Michigan locations. However, drilling will be conducted down to 6 feet and if the 3- to 3-foot depth interval appears to be visually different from the 0- to 3-foot depth interval, an additional sample will be collected from the 0- to 3-foot interval. Sample jars for VOCs will be filled immediately after samples are retrieved. Each sediment sample will then be mixed in a stainless steel composting bowl with a decontaminated stainless steel mixing spoon and loaded into appropriate sample jars.

The sediment will be mixed until a visually homogeneous sample is obtained. The resultant mixed sediment composite will be spread evenly in the bottom of the bowl. The sediment will be divided into four quadrants. A sample will be taken from each quadrant and loaded in the appropriate jars. Sediment duplicate samples will be prepared by filling a second set of jars at the same time in the same manner as the original sample.

3.3.4 Decontamination

Surface Water

The outer parts of the Keck pump which come into contact with the surface water will be cleaned between sample locations by: 1) Alconox and water wash, 2) tap water rinse, 3) isopropanol rinse, and 4) two distilled water (ASTM Type II) rinses. The inner parts of the Keck pump will be cleaned by pumping one gallon of distilled water (ASTM Type II) through the pump and tubing system.

The Millipore field filtration unit will be decontaminated using the following steps:

1. Water remaining in the pressure vessel will be discarded and the vessel will be rinsed twice with distilled water (ASTM Type II).
2. A minimum of 500 ml of distilled water (ASTM Type II) will be flushed through the entire system.

Sediment

Sediment drilling and sampling equipment will be decontaminated prior to use and between sediment cores to avoid cross contamination between sample locations. The drill rigs, drilling tools, and sampling devices will be steam-cleaned before mobilization onto the site and between drilling locations. The decontamination procedure will be as follows:

1. Drilling equipment will be steam-cleaned with lake water.
2. Sampling equipment will be washed with soap and water solution and rinsed with lake water and distilled water.
3. Sampling equipment will be rinsed with isopropanol.
4. Sampling equipment will be rinsed twice with distilled water.

3.3.5 Quality Control

In order to verify the quality of sampling process, field duplicates, rinsate blanks, and source blanks will be collected for both surface water and sediment samples. The number of QC samples to be collected is listed in Table 3-1.

Field duplicates will be taken from the sediment stainless steel mixing bowl and surface water at the same time and in the same manner as the original samples. Surface water samples selected for matrix spike analysis will require triple the volume listed in Table 3-2.

Rinsate blank samples for surface water samples will be collected at a frequency of one sample per day after decontamination of the Keck pump. This will be done by pumping distilled water (ASTM Type II) through the Keck pump after decontamination procedures in Section 3.3.4 and collecting the water in the appropriate bottles listed in Table 3-2. Rinsate blanks and field blanks for dissolved metals will be field-filtered using the procedure in Appendix B.

Rinsate blank samples for sediment samples will be collected after decontamination procedure in Section 3.3.4 by running distilled water (ASTM Type II) across the sampler and allowing the runoff to fill the appropriate sample containers listed in Table 3-2. Field blank samples will be collected from each source of water used for decontamination by pouring the source water directly into appropriate sample containers listed in Table 3-2.

3.3.6 Documentation

Surface water and sediment sampling information and other observations made by the on-site samplers during sampling activities will be recorded on the appropriate field forms shown in Appendix A. These will include:

- Daily Time Log
- Sediment Grab Data Form
- Surface Water Sampling Form
- Photo Log Labels
- Sample Labels

RP/19FSPBF/AA1

4.0 SAMPLE IDENTIFICATION AND HANDLING

Samples will be identified using the identification system described below. These numbers will be used to complete sample documentation including sample labels, Chain of Custody Forms, and sample logbooks. Examples of this documentation are included in Appendix A.

4.1 FIELD SAMPLE IDENTIFICATION NUMBER

Field sample numbers are specified in Section 3.0, on sample locations maps, and tables. Field sample numbers are comprised of a two-place alpha-code denoting sample matrix followed by a one-digit sample location code.

4.2 SAMPLE LOCATION IDENTIFIER

Sample Location Identifiers will be used on sample labels, chain of custody forms, and sample logbooks. Sample location identifiers consist of the following components:

Project Identification Code

A two-letter designation will be used to identify the property where the sample was collected. The two-letter designation for the Great Lakes NTC, Great Lakes, Illinois, will be "GL."

Sample Matrix and Location Codes

Each sample will be identified by an alpha-code corresponding to the sample matrix (or sample type), followed by an alpha-code corresponding to a specific sampling area. The alpha-codes are as follows:

RB	-	Rinsate Blank
FB	-	Field Blank
FD	-	Field Duplicate
TB	-	Trip Blank
MS	-	Matrix Spike
MSD	-	Matrix Spike Duplicate
SD	-	Sediment Sample
SW	-	Surface Water Sample
PC	-	Pettibone Creek
BB	-	Boat Basin
IH	-	Inner Harbor
OH	-	Outer Harbor
LM	-	Lake Michigan

Rinsate blank samples will have an identification code of RB followed by the appropriate alpha-codes for the type of sample and location (for example, a sediment rinsate blank from the Boat Basin will be identified as "RB-SD-BB"). Similarly, field duplicate samples, matrix spike samples, and trip blanks will be FD, MS, and TB followed by the appropriate alpha-codes.

Samples will have a two-digit number as the last component of the Sample Location Identifier.

Examples of site-specific sample numbers are as follows:

- | | |
|---------------|---|
| GL-SW-PC-02 | Great Lakes Environmental Investigation, Surface Water Sample Number 2 from Pettibone Creek |
| GL-SW-OH-11 | Great Lakes Environmental Investigation, Surface Water Sample Number 11 from the Outer Harbor |
| GL-FDSW-LM-14 | Great Lakes Environmental Investigation, Surface Water Sample Number 14 from Lake Michigan |

In addition, sediment core samples from the Harbor Area and Lake Michigan will have an alpha-code attached to the last component of the Sample Location Identifier. These alpha-codes will indicate sample depth.

The alpha-codes are as follows:

- A - 0 to 3 feet
- B - 3 to 6 feet

Examples of Sample Location Identifiers with sample depth alpha-codes are as follows:

- | | |
|----------------|--|
| GL-SD-IN-08B | Great Lakes Environmental Investigation, Sediment Core Sample Number 8 taken at depth interval 3 to 6 feet from the Inner Harbor |
| GL-SD-BB-02A | Great Lakes Environmental Investigation, Sediment Core Sample Number 2 taken at depth interval 0 to 3 feet from the Boat Basin |
| GL-FDSD-LM-17A | Great Lakes Environmental Investigation, Field Duplicate Sediment Core Sample Number 17 taken at depth interval 0 to 3 feet from Lake Michigan |

4.3 SAMPLE LABELS AND CHAIN OF CUSTODY

Samples, other than those collected for in-situ field measurements or analyses, are identified by using a standard sample label which is attached to the sample container. A copy of a standard sample label is included in Appendix A. The sample labels are sequentially numbered and are accountable. The following information shall be included on the sample label:

- Site name.
- Field identification or sample station number.
- Date and time of sample collection.
- Designation of the sample as a grab or composite.
- Type of sample (matrix) and a brief description of the sampling location.
- The signature of the sampler.
- Sample preservation and preservative used.
- The general types of analyses to be conducted.

The Chain of Custody record is used to record the custody of samples and shall accompany samples at all times. A copy of a chain of custody form is included in Appendix A. The following information will be supplied to complete the Chain of Custody record:

- Project name.
- Signature of samplers.
- Sampling station number or sample number, date and time of collection, grab or composite sample designation, and a brief description of the type of sample and sampling location.
- Signatures of individuals involved in sample transfer (i.e., relinquishing and accepting samples). Individuals receiving the samples shall sign, date, and note the time that they received the samples on the form.
- Matrix.

Sample analysis request sheets serve as official communication to laboratories of the analyses required for each sample and provide further evidence that the chain of custody is complete.

Chain of custody records initiated in the field will be placed in plastic covers and taped to the inside of shipping containers used for sample transport from the field to the laboratory.

4.4 SAMPLING PACKAGING AND SHIPPING

Shipping containers will be secured using nylon strapping tape and custody seals to ensure that samples have not been disturbed during transport. Packing of samples will be accomplished as follows.

An adhesive sample label will be attached to each sample container. Sample labels will be covered with 3-inch wide clear tape. Each container will be placed in an appropriately sized ziploc or polyethylene bag and sealed. Bagged samples will be placed in foam shipping sleeves or wrapped with bubble wrap.

Samples which must be kept at 4°C will be shipped in insulated containers with either freezer forms or ice. If ice is used, it will be placed in a container so that water will not fill the cooler as the ice melts. The samples will be shipped within 24 hours of collection to allow the laboratory to meet holding times. The Department of Transportation regulations will be followed for packaging, quantities of shipment, and the way samples are sent.

Copies of the signed Chain of Custody forms will be delivered with the data packages. The originals will remain on file with the contractor or with the laboratory.

An appropriately sized metal or plastic cooler will be selected, and drain plugs will be taped on the inside and outside with duct tape. The cooler will be lined with a large polyethylene garbage bag. Samples (in sleeves or bubble wrap) will be placed in the large polyethylene garbage bag. Absorbent packaging material (vermiculite) will be placed under and around samples (in sleeves or bubble wrap) to minimize the possibility of breakage.

The large polyethylene garbage bag will be sealed, and blue ice or ice packs will be placed on top of the sealed bag. Ice will be enclosed in sealed plastic bags (double bagged) to prevent soaking of packing materials.

The closed cooler will be taped with nylon stripping tape in at least two locations. Chain of Custody Seals, with air bill numbers previously recorded on the Chain of Custody Form in the cooler, will be placed over cooler latches or at the cooler left back and right front corners, so that seals will break if the cooler is opened. Seals will be covered with clear tape. Seals will be signed and dated.

A label marked "Environmental Samples" will be placed on top of the cooler and covered with clear tape. Appropriate sides of the cooler will be marked "This End Up" and arrows will be added accordingly.

Coolers will be weighed and air bills filled out. All samples will be shipped through a reliable commercial carrier such as Federal Express, Emery, Purolator, or equivalent.

APPENDIX A

FIELD DOCUMENTATION FORMS



Chain of Custody Record

Check delivery method:	
<input type="checkbox"/> Samples delivered in person	Custody Seal #
<input type="checkbox"/> Donohue courier	
<input type="checkbox"/> Common carrier	
<input type="checkbox"/> Mail	

Project Number		Project Name/Client				Lab Sample Number	Con-tainer Number	Analysis Required										Matrix		
Samplers: (Signature)								<div style="display: flex; justify-content: space-between;"> <div style="width: 45%; border: 1px solid black; transform: rotate(-45deg); padding: 2px;">X-Field Filtered</div> <div style="width: 45%; border: 1px solid black; transform: rotate(-45deg); padding: 2px;">I-Susp. Hazard Mat.</div> </div>												Sample Type (Water, Soil) etc.
Item No.	Sample Description (Field ID Number)	Date	Time	Grab	Comp.															
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
Relinquished by: (Signature)		Date/Time	Received by: (Signature)				Disposed of by: (Signature)				Items:	Date/Time								
Relinquished by: (Signature)		Date/Time	Received by: (Signature) [Laboratory]				Disposed of by: (Signature)				Items:	Date/Time								
Send Lab Results To:		Remarks:						Laboratory Receiving Notes:												
								Custody Seal Intact?												
								Temp. of Shipping Container:												
								Sample Condition:												

Donohue Analytical
 4738 North 40th Street
 Sheboygan, WI 53083

(414)458-8711

From _____

Date _____ Site _____

Collected By _____

Analysis Needed:

Project	Sample No.	Month/Day/Year	Time	Sample Type		
				Comp	Grab	
Tag No. 3497	Sample Matrix	Samplers (Signatures)				Preservative: HNO ₃ H ₂ SO ₄ HCl NaOH
	Remarks	Geotechnical	TCL Volatiles	TCL BNA	TCL Pesticides/PCBs	
Lab Sample No.	TP, COD, TKN, NH ₃	BOD, TSS, TDS, hard	NO ₂ + NO ₃	Total Diss. Metals	Total Rec. Metals	Analysis
				Total Metals		
				Cl, SO ₄ , alkalinity		

01-82-2

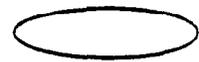
Donohue Custody Seal #

Donohue Custody Seal #

Donohue

SEDIMENT GRAB DATA FORM

SAMPLE LOCATION NUMBER



Engineers & Architects & Scientists Site: _____ Project No.: _____

DATE _____

TIME _____

COLLECTOR _____

Sample No. _____

Water Depth _____

Loran-C Coordinates: _____ Lat. _____ Long.

Sample Equipment: _____

PHYSICAL DESCRIPTION OF SEDIMENT GRAB SAMPLE : _____

Weather: Wind Direction: _____

Cloud Cover: _____

Wind Speed: _____

Precipitation: _____

Temp.: _____

Lake Conditions: _____

ANY OTHER CHARACTERISTICS OF NOTE: _____

Donohue

Surface Water Data Form

Sample Location Number



Engineers & Architects & Scientists

Site _____ Project No. _____

Date _____

Sample No. _____

Time _____

Water Depth _____

Collector _____

Loran-C Coordinates: _____ Lat.

_____ Long.

Shallow Sample

Deep Sample

pH: _____

Dissolved Oxygen: _____

Temperature: _____

Conductivity: _____

Odor: _____

Clarity: _____

Comments: _____

Weather: Wind Direction: _____

Cloud Cover: _____

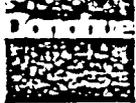
Wind Speed: _____

Precipitation: _____

Temperature: _____

Lake Conditions: _____

Any other characteristics of note _____



500 YEARS
ARCHITECTS
SCIENTISTS

DAILY TIME LOG

Circle: Sun Mon Tue Wed Thu Fri

Site: _____ Project No.: _____

Weather: _____

Task/Equipment: _____

Firm/Contractor's Personnel: _____ Hrs On-Site: _____

Donohue's Personnel: _____ Hrs On-Site: _____

-Site Visitors: _____

Time Log indicating work in progress, remarks:

0600 - 0630 _____

0630 - 0700 _____

0700 - 0730 _____

0730 - 0800 _____

0800 - 0830 _____

0830 - 0900 _____

0900 - 0930 _____

0930 - 1000 _____

1000 - 1030 _____

1030 - 1100 _____

1100 - 1130 _____

1130 - 1200 _____

1200 - 1230 _____

1230 - 1300 _____

1300 - 1330 _____

1330 - 1400 _____

1400 - 1430 _____

1430 - 1500 _____

1500 - 1530 _____

1530 - 1600 _____

1600 - 1630 _____

1630 - 1700 _____

1700 - 1730 _____

1730 - 1800 _____

Items requiring follow-up: _____

Donohue Record of Respiratory Wear

Employee Name: _____

Project Site: _____

Project Number: _____

Site Safety Officer: _____

 Date

 Time in Respirator

 Instrument Reading¹
 (HINU or OVA)

 Type of Respirator²

Comments: _____

Notes:

¹ If worn because of dusty conditions - Note "Dusty Conditions"

² Level C or B

Return to Corporate Health & Safety Manager

APPENDIX B

**CALIBRATION AND OPERATING PROCEDURES FOR
FIELD INSTRUMENTS AND FILTRATION UNIT**

FIELD CALIBRATION PROCEDURES

HNu Model PI 101 Calibration

The calibration of the HNu is to be checked daily before field use by using a cylinder of isobutylene (HNu pn 101-350) with a regulator (HNu pn 101-351).

The ppm isobutylene reading, along with the span setting, is recorded in the calibration report contained in the HNu case (35 ppm, span 9.8).

In the field, the calibration must be checked daily before use and readjusted, if necessary, by using this cylinder and regulator as follows:

1. Connect the analyzer to the regulator and cylinder with a short piece of clean tygon tubing.
2. With the SPAN setting at 9.8 and the function switch at the same positions as listed on the Isobutylene Calibration Report, open the valve on the cylinder until a steady reading is obtained.
3. If the reading is 35 ppm, the analyzer calibration for the original species of interest is still correct.
4. If the reading has changed, adjust the SPAN setting until the reading is 35 ppm.
5. Shut off the cylinder as soon as the reading is established.
6. Record and maintain this new SPAN setting.

Notes:

- A. The regulator sets and controls the flow rate of gas at a value preset at the factory. This will be about 100 to 200 cc/min.; no adjustment to the regulator is necessary in the field.
- B. Do not use the cylinder below about 30 psig as readings below that level can deviate up to 10 percent from the rated value.
- C. Safely discard the disposable cylinder when empty and do not refill. It is against the law to transport refilled cylinders.

Fisher Accumet Model 955 Calibration

To measure the pH values of samples that vary over a range wider than two pH units, a two-point calibration will be done daily before field use to compensate for less than 100 percent electrode efficiency. The STANDARDIZE control provides the first set-point. The slope control sets the second set-point.

At pH 7, this "slope" adjustment has no effect on the readings. As readings increasingly differ from pH 7, the adjustment's effect becomes more pronounced - always in the opposite direction from one side of pH 7 to the other. Therefore, both calibration set points should be on the same side of pH 7.

Choose two buffer solutions with values that bracket the desired measuring range, usually pH 7 and pH 10 for groundwater and surface water. The buffer closest to pH 7 in value should always be used for the first set-point (with the STANDARDIZE control), and the buffer furthest from pH 7 in value should always be used for the second set-point (with the SLOPE control).

pH 7 Buffer Calibration:

1. Observe that electrode lead is securely connected to INPUT jack on instrument top panel. Also be sure to remove protective cot from tip of supplied combination electrode.
2. Observe that plug of ATC Probe is securely connected to °C jack on instrument right-side panel.
3. Obtain pH 7 buffer and ensure that buffer temperature is within 10° C of sample temperature.
4. Immerse electrode system and ATC Probe into buffer solution.
5. Set FUNCTION selector to °C position and place ON-OFF switch to ON position. Set the slope control full counter clockwise.
6. Allow electrode system and buffer solution to reach thermal equilibrium (°C reading steady), then determine exact pH of buffer solution from the table of buffer pH versus temperature found on the bottle label.
7. Set FUNCTION selector pH position, then adjust STANDARDIZE control until digital display indicates the pH value of buffer solution.
8. Remove electrode system and ATC Probe from buffer solution and rinse them with distilled water.

pH 10 (or 4) Buffer Calibration:

1. Immerse the electrode system and ATC probe into the pH 10 buffer.
2. Set the FUNCTION selector to C position. Allow the electrode system and buffer solution to reach thermal equilibrium ($^{\circ}\text{C}$ reading steady), then determine the exact pH of the buffer solution from the table of buffer pH versus temperature found on the bottle label.
3. Set the FUNCTION selector to the pH position, then adjust the SLOPE control until the digital display indicates the pH value of the buffer solution.
4. Remove the electrode system and ATC probe from the buffer solution and rinse with distilled water.
5. The pH meter is now ready for sample measurements.

Notes:

Thermal equilibrium normally requires about one minute, but will vary depending upon temperature difference between electrode system and buffers.

Cole Parmer Model 4070 Conductivity Meter

Two options for calibration of the Model 4070 are available in the field, depending on instrument accessory availability. If the pre-calibrated probe is available, this is the easiest calibration procedure to do in the field. However, if the probe is not available, calibration will have to be done daily before field use with a standard solution (commercially prepared):

Calibration with Pre-Calibrated Probe:

1. Connect a standard pre-calibrated probe to the unit.
2. Select the "Set K" position on the function switch.
3. Adjust the "Set K" control until the display indicates the value of the cell constant as marked on the probe being used.
4. The standard X 1.0 probe has a cell constant range from 0.80 to 1.20 and is calibrated to 2 decimal places. The display should be set to indicate this figure exactly.

The standard X 10 probe has a cell constant range from 8.0 to 12.0 and is calibrated to 1 decimal place. The display should be set to indicate this figure shifted one place to the right.

The standard X 0.1 probe has a cell constant range from 0.08 to 0.12 and is calibrated to 2 decimal places. The display should be set to indicate this figure shifted one place to the left.

5. Before using the 20 uS range, the probe should be thoroughly rinsed in deionized water, excess water shaken off and the outside of the probe body wiped dry. The display should then be set to zero, with the probe in free air, by using the "Zero 20 uS" control.

Calibration with a Standard Solution:

1. Select the "COND" range.
2. Immerse the conductivity cell and A.T.C. probe (if separate probe is being used) into the prepared standard.
3. Select the 2000 uS range if using a 1000 uS or 1413 uS standard or other suitable range if an alternative standard is being used.
4. Adjust the "Set K" control to give the exact readout of the standard solution selected on the display.
5. After carrying out the calibration with standard solutions as detailed above and with the probe still in the standard solution and the display set to the value of the standard solution, switch to the "Set K" range to give a direct readout of the cell constant.

6. If the readout cannot be set to the value of the standard solution with the "Set K" control, then the cell constant lies outside the "Set K" range of 0.80 to 1.20. In such cases, the display should be set to read 1.00 on the "Set K" position, the display reading on the range giving the best resolution should be noted and the cell constant calculated from the following formula:

$$K = \frac{\text{Conductivity of Standard Solution}}{\text{Display Reading}}$$

This figure should be noted and (with the cell constant set to 1.00 on the "Set K" position) the display reading should be multiplied by this figure to obtain the correct conductivity.

Note:

Ensure that the conductivity standard has not reached or gone over the expiration date marked on the container.

Operation and Description - Turbidity Meter

The EPA recommends that cuvettes used for instrument calibration or sample measurement be matched or indexed.

For accurate measurements in the low range rotate the cuvettes in the well to obtain the minimal reading. Mark the cuvette with one of the adhesive dots provided with the instrument so that orientation of the cuvette will be identical each time it is placed in the instrument.

To operate the turbidimeter, switch to the "20" range and place the Reference Standard (0.02 NTU) in the optical well.

With the light shield in place over the well, adjust the Reference Adjust knob to cause the meter to read the reference standard value on the scale. The unit is now ready for use in either range.

To make a measurement of a sample, clean one of the cuvettes and fill to within approximately 1/2 inch of top with the sample. Place the top of the cuvette and carefully clean the outside surface of the cuvette with a lint free wiper such as Kimwipes. Place the sample in the well and place the light shield over the well. Select the appropriate range for best readability.

If the instrument has been subjected to cold (below 10 degrees Celsius) and then brought indoors, it should be allowed to warm up before use, since condensation may form on the various lenses. This can be aided by leaving the case open and the instrument on for approximately a half hour.

Recorder Output:

The DRT-15C is shipped complete with a 0-1 mA Recorder Output. The jack is located on right side of the chassis (refer to J1 on Figure 2). To use, connect the 1/8 inch miniplug provided to your recorder. Adjust R11 to obtain a full scale output compatible to a full scale reading on the DRT-15C. Once this adjustment is made, the DRT-15C will always be set up for this recorder.

Critical Measuring Area

The critical measuring area of the sample containers is the 3/4 inch wide band starting 5/8 inch above the bottom. Keep this area clean and free of scratches or abrasion. Handle by the top party only. (See Figure 1).

GLASS SAMPLE
CONTAINER
28 MM O.D.

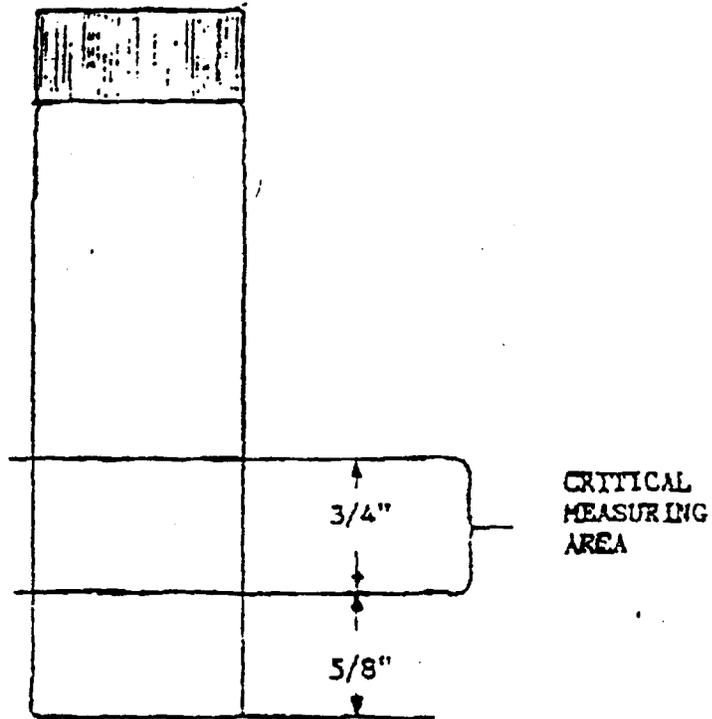


Figure 1

OPERATING PROCEDURES FOR FIELD INSTRUMENTS AND FILTRATION UNIT

THERMOMETER

Measurement Techniques for Water Temperature

Temperature measurements should be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

If a thermometer is used on a collected water sample:

1. Rinse the thermometer with a portion of the collected sample.
2. Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of contamination, the thermometer should not be inserted into samples which will undergo subsequent chemical analysis.
3. Record values on field forms.

If a temperature meter or probe is to be used, the instrument should be calibrated according to the manufacturer's recommendations and a National Bureau of Standards (NBS) certified thermometer or one that is traceable to NBS certification before field use. Cross-checks and duplicate field analyses should agree within ± 0.5 degrees C. A cross-check with a calibrated NBS certified thermometer shall be made at least semi-annually and within one week before use in the field.

Thermometers should also be checked against the NBS reference thermometer. Results of all calibration should be recorded on the Field Meter Log Sheet.

Source: Ebasco Rem III Program Guidelines No. FT-7.10.

FILTRATION UNIT

Samples collected for dissolved metals analysis will be filtered in the field immediately after collecting the sample. The filtering process is designed to remove suspended sediment from the sample. Such suspended material can react with the sample and may change the concentration of certain dissolved constituents. Following the filtering process, samples will be preserved using appropriate chemical preservatives.

Field filtering procedures are as follows:

1. The filtering apparatus will be set up according to the manufacturer's directions.
2. A 0.45-micron membrane filter will be used. If the sample is highly turbid, a pre-filter may be needed to prevent clogging.
3. A minimum of 500 ml of reagent grade water will be flushed through the filtering apparatus before filtering the sample in order to reduce the risk of altering the composition of the sample by the filtering operation.
4. The sample will be pumped through the filter and the first 100 to 200 ml discarded.
5. The remaining volume of sample will be collected in the RAS metal sample containers.
6. The filter membrane (and the pre-filter if used) will be removed after the sample is collected and discarded.
7. The filtering apparatus and tubing will be flushed with 500 ml reagent grade water.
8. The filter apparatus will then be reassembled for the next sample.
9. The sample label, traffic reports, and chain of custody forms will indicate that the sample was field filtered.

SPECIFIC CONDUCTANCE

It is important to obtain a specific conductance measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance.

Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are listed below:

1. Check batteries and calibrate instrument before going into the field. Potassium chloride standard solutions with a specific conductance closest to the values expected in the field should be used. The table below may be used for guidance:

SPECIFIC CONDUCTANCE OF KCl SOLUTIONS AT 25 DEGREES CENTIGRADE

<u>Concentration</u>	<u>Specific Conductance</u>	
mol/l	mg/l	umhos/cm
0.0001	7.456	14.94
0.0005	37.28	73.90
0.001	74.56	147.0
0.005	372.8	717.8
0.00702	523.4	1000
0.01	745.6	1413
0.02	1591.2	2767

NOTE: This table has been modified from **Standard Methods for the Examination of Water and Wastewater (1980)**.

2. Record the true and actual meter readings on the Field Meter Calibration Form.
3. Rinse the cell with one or more portions of the sample to be tested.
4. Immerse the electrode in the sample and measure the conductivity.
5. Read and record the results in a field log book. Adjust the temperature setting to the sample temperature.

6. Repeat the procedure with fresh sample until reproducible (+/-10%) results are obtained.

If the specific conductance measurements become erratic, or inspection shows that any platinum black has flaked off the electrode, replatinization of the electrode is necessary. See the manufacturer's instructions for details.

Source: Ebasco Rem III Program Guidelines No. FT-7.10.

6. Safety Precautions.

Common sense is the best safeguard against any potential hazards. Obviously, one must never pipette samples or standard solutions by mouth. Handle the probes carefully to avoid breakage. Since the meter will be measuring potentially hazardous material, the probes must never be placed in the mouth.

7. Sample Size, Collection, Preservation, and Handling.

Samples should be collected in clean glass or plastic containers. The volume should be such that the cell plates of the probe are completely immersed in the sample. Samples may be filtered through a 4.5 m filter before analysis if necessary. Specific conductance should be measured as soon after sampling as possible, however, if readings cannot be taken immediately, samples should be stored at 4° C and measured as soon as possible.

8. Apparatus and Material.

- 8.1 Cole Parmer Conductivity Meter, Model 4070
- 8.2 Conductivity probe
- 8.3 Automatic Temperature Compensation (ATC) probe
- 8.4 Clean sample containers
- 8.5 Squeeze-type wash bottle, 125 ml or larger
- 8.6 Deionized water
- 8.7 Calibration standard solution
- 8.8 Laboratory wipes - KimWipe or equivalent
- 8.9 Replacement batteries, types PP3, 6F12, or MN1640

9. Routine Preventative Maintenance.

It is necessary to keep the external surfaces clean and free from dust.

All conductivity probes should be thoroughly rinsed after use and stored in deionized water. Particular care should be taken to ensure that the electrical connections are free from dirt and debris. It is recommended that the instrument be checked and calibrated before going into the field. The symbol "BAT" will appear on the display if the batteries need replacing.

10. Reagents and Calibration Standards.

Potassium chloride standard solutions with a specific conductance closest to the values expected in the field should be used. The table below may be used for guidance:

SPECIFIC CONDUCTANCE OF KC1 SOLUTIONS AT 25 DEGREES CENTIGRADE

<u>Concentration</u> mol/l	<u>Specific Conductance</u>	
	mg/l	umhos/cm
0.0001	7.456	14.94
0.0005	37.28	73.90
0.001	74.56	147.0
0.005	372.8	717.8
0.00702	523.4	1000
0.01	745.6	1413
0.02	1591.2	2767

NOTE: This table has been modified from Standard Methods for the Examination of Water and Wastewater (1980).

Standard solutions may be stored at 4° C for up to one week. Date of preparation can be noted on the container and on the Field Meter Instrument Calibration Log.

11. Sample Preparation.

If the sample contains a great deal of particulate matter which may interfere with readings, they may be filtered through a 4.5 m filter.

12. Analytical Measurement.

12.1 Calibrate the instrument.

12.2 Rinse the conductivity probe and the ATC probe thoroughly with deionized water, shake to remove internal droplets, and the outside should be wiped before immersing into sample.

12.3 Allow the readout on the instrument to settle (usually about one minute). Multiply the instrument readout by the correction factor determined during calibration. Record the corrected conductivity on the Well Purging and Sample Collection form.

12.4 Step 12.2 should be repeated after every sample to prevent cross-contamination.

12.5 On completion of sample measurement, the probes should be thoroughly rinsed in deionized water and for short term storage should be kept immersed in deionized water so that the plates remain wetted. For longer term storage, the probes should be thoroughly rinsed in deionized water, the outside of the probes wiped dry, and the probes stored dry. It should be noted that it may take some time for stability to be achieved when a dry probe is first used while the plate becomes re-wetted.

13. Data Deliverables.

Initial calibration of the instrument and continuing calibration check results will be recorded on the Field Meter Instrument Calibration Log form. Summary of sample analysis will be recorded on the Well Purging and Sample Collection form, including sample duplicates.

14. Quality Control Requirements.

The meter will be read to the nearest 10 umhos/cm within a range of 0 to 20,000 umhos/cm. Accuracy of measurements shall be ± 5 percent of a standard. The meter will be calibrated at least once daily and after every 10 field samples. Field duplicates will be measured at a frequency of every 10 samples by thoroughly rinsing the probes in deionized water, waiting one full minute, and then immersing probes in the duplicate sample. Precision shall be a standard deviation of ± 10 percent.

15. References.

Material for this SOP was obtained from the Instruction Manual for the Cole Parmer Model 4070 Conductivity Meter.

16. Method Validation Data.

The parameter of specific conductance is being measured for field screening to select sampling locations, and method validation data is, therefore, not required.

pH METER

Two field methods are available for pH measurement: the pH meter and pH indicator paper. Indicator paper is used only when a rough estimate of the pH is required, for example to check proper acid/base preservation of samples. The pH meter is used when a more accurate measurement is needed. The response of a pH meter can be affected by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

Equipment

The following equipment is needed for taking pH measurements:

1. Orion portable pH meter, or equivalent.
2. Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs).
3. pH indicator paper, such as Hydrion or Alkacid, to cover the pH range 2 through 12.
4. Buffer solutions of pH 4,7 and 10, or other buffers which bracket the expected pH range.

Because of the diversity of pH meters currently available on the market, the investigator has the option of selecting the unit that best meets specific investigative needs and field limitations. Digital meters are preferred, as opposed to deflection meter outputs, because of the relative ease in reading response for in-situ measurements.

Measurement Techniques for Field Determination of pH

1. pH Meter

The following procedure is used for measuring pH with a pH meter:

- a. The instrument and batteries should be checked and calibrated in the laboratory before the field effort begins.

- b. The accuracy of the buffer solutions used for field and laboratory calibration should be checked. Buffer solutions need to be changed due to degradation upon exposure to the atmosphere. (The date of preparation of each buffer should be included on the bottle label.) Record source of buffer and date opened on Field Meter Log Sheet.
- c. Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes, as some must be stored dry.
- d. Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
- e. Immerse the electrode(s) in a pH-7 buffer solution.
- f. Adjust the temperature compensator to the proper temperature (on modes with automatic temperature adjustment, immerse the temperature probe into the buffer solution). Alternately, the buffer solution may be immersed in the sample and allowed to reach temperature equilibrium before equipment calibration. It is best to maintain buffer solution at or near expected sample temperature before calibration.
- g. Adjust the pH meter to read 7.0.
- h. Remove the electrodes(s) from the buffer and rinse well with demineralized water. Immerse the electrode(s) in pH-4 or 10 buffer solution (depending on the expected pH of the sample) and adjust the slope control to read the appropriate pH. At least three successive readings during calibration, one minute apart, should be within ± 0.1 pH unit. For best results, the standardization and slope adjustments should be repeated at least once daily before use.
- i. Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the log book.

- j. Read and record the pH of the solution, after adjusting the temperature compensator to the sample temperature. pH should be recorded to the nearest 0.1 pH unit on the Field Meter Calibration Log.
- k. Rinse the electrode(s) with demineralized water.
- l. Keep the electrode(s) immersed in water when not in use.

The sample used for pH measurement should never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions which may interfere with pH measurement, such as oily materials or turbidity, should be noted on the Field Meter Calibration Log.

Source: Ebasco Rem III Program Guidelines No. FT-7.10.

Standard Operating Procedure
for the
Measurement of pH in the Field
Using the Fisher Accumet Model 955 Portable
pH/mV Temperature Meter

1. Parameter to be measured: pH.
2. Range of Measurement: 0.00 to 14.00 pH units.
3. Sample Matrix.

This method is applicable to drinking, surface, saline, and groundwater samples; chemical domestic and industrial wastes; leachates.

4. Principle, Scope, and Application.

The pH of a sample is determined electrometrically, using a combination sample-reference pH electrode.

5. Interferences and Corrective Action.

- 5.1 Any sample constituent which coats the electrode can cause sluggish response. This can be eliminated by cleaning the electrode according to manufacturer's instructions.
- 5.2 Temperature effects on the electrometric measurement of pH arise from two sources. The first source is caused by change in electrode output at various temperatures. This is avoided by using the Automatic Temperature Compensation (ATC) probe. The second source is the change of pH inherent in the sample at various temperatures. Therefore, the sample temperature should be reported with the pH.

6. Safety Precautions.

Common sense will eliminate the possibility of any hazards while the portable pH meter is being used. Obviously, buffers and field samples must never be pipetted by mouth. Handle the electrode carefully to avoid breakage. Since the electrode will be measuring potentially hazardous material and all pH electrodes leak small quantities of electrolytes, they must never be placed in the mouth.

7. Sample Size, Collection, Preservation, and Handling.

Collect approximately 50 ml or more of the sample to be measured. To avoid the possibility of cross contamination from sample to sample and contamination of leaking electrolyte, the samples will be discarded after pH measurement and not used for any other parameters. If for any reason the pH cannot be taken immediately in the field, samples must be stored at 4° C and measured within a 24-hour period.

8. Apparatus and Materials.

- 8.1 Fisher Accumet Model 955 Portable pH/mV Temperature Meter
- 8.2 Three or more 50 ml plastic beakers
- 8.3 Commercially prepared pH 4.01, 7.00, 10.00 buffers
- 8.4 Squeeze type wash bottle, 125 ml or larger
- 8.5 Distilled water
- 8.6 Electrode; extra electrolyte for filling if necessary
- 8.7 Automatic Temperature Compensation (ATC) Probe
- 8.8 One or two 9-volt transistor batteries

9. Routine Preventive Maintenance.

- 9.1 The instrument and batteries should be checked and calibrated in the laboratory before the field effort begins.
- 9.2 The accuracy of the buffer solutions used for field and laboratory calibration should be checked. Buffer solutions need to be changed due to degradation upon exposure to the atmosphere. (The date of preparation of each buffer should be included on the bottle label.) Record source of buffer and date opened on Field Meter Log Sheet.
- 9.3 Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes, as some must be stored dry.
- 9.4 Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
- 9.5 Distilled water pH and conductivity should be monitored periodically.
- 9.6 The electrode should be stored and cleaned according to manufacturer's instructions.

10. Reagents and Calibration Standards.

Commercially prepared standardized buffers of pH 4.01, 7.00, and 10.00 are used to calibrate the instrument. The source and date opened will be recorded on the Field Meter Log Sheet.

11. Sample Preparation.

There is no sample preparation for this procedure other than allowing the electrode system and sample solution to reach thermal equilibrium (steady thermometer reading).

12. Analytical Measurement.

12.1 Calibrate the instrument.

12.2 Remove electrode system and ATC Probe from buffer solution and rinse them with distilled water.

12.3 Immerse the electrode system and ATC Probe into the sample solution and allow sufficient time for the electrode system and sample solution to reach thermal equilibrium.

Notes: Thermal equilibrium normally requires about 1 minute, but will vary depending upon temperature difference between electrode system and sample.

12.4 Read the pH value of sample from the digital display and record on the Well Purging and Sample Collection form. Remove electrode system and ATC probe from sample and rinse with distilled water. Repeat step 12.3 and 12.4 for remaining samples.

12.5 ON-OFF switch to OFF after last measurement.

13. Data Deliverables.

The pH accuracy will be assessed by performing two measurements on three standard buffer solutions. Each measurement will be within $\pm 0.05\%$ standard unit of the certified value for the buffer solutions. Precision will be assessed through replicate measurements on field samples. The standard deviation of four replicate measurements must be less than or equal to 0.1 standard unit. The electrode will be withdrawn, rinsed with dionized water, and re-immersed between each replicate. Calibration and verification will be done in the field before the first replicate and after the last. The instrument used will be capable of providing measurements of 0.01 standard unit. The instrument will be calibrated at least once daily and every 10 samples and results recorded on the Field Meter Instrument Calibration Log. Field replicates will be done at a frequency of every 10 samples. This will be done in quadruplicate. All field sample measurements will be recorded on the Well Purging and Sample Collection form.

14. Quality Control Requirements.

Quadruplicate samples will be done every 10 samples by rinsing the electrode after the initial reading, waiting 1 full minute, and then measuring the next sample. The standard deviation of four replicate measurements must be less than or equal to 0.1 standard unit.

15. References.

Material for this SOP was obtained from the Instruction Manual for the Fisher Accumet Model 955 Portable pH/mV Temperature Meter, Catalog No. 69348.

16. Method Validation Data.

The parameter of pH is being measured for field screening to select sampling locations and method validation data is, therefore, not required.

FIELD MEASUREMENT OF VOLATILE ORGANICS BY HNu

I. PARAMETER(S)

Volatile organics with ionization potentials of less than 10.2 eV.

II. RANGE OF MEASUREMENT

The linear range is 0.1-400 ppm, the useful range is 0.1-2000 ppm.

III. LIMIT OF DETECTION

The detection limit of 0.1 ppm was determined by the manufacturer based on the response of benzene at a span setting of 9.8 and a 10.2 eV probe.

IV. SAMPLE MATRICES

Headspace above soil samples collected in split spoon samplers or with trowels.

V. PRINCIPLE, SCOPE AND APPLICATION

The analyzer measures the concentration of trace gases present in the atmosphere by photoionization. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and become a positive ion. This will occur when the ionization potential of the molecule in electron volts (eV) is less than the energy of the photon. The source of photons is an ultraviolet lamp with an energy of 10.2 eV.

Sample gases enter through the inlet into the ion chamber and are exposed to photons emanating from the ultraviolet lamp. Ionization occurs for those molecules having ionization potentials near to or less than that of the lamp. A positive-biased polarizing electrode causes these positive ions to travel to a collector electrode in the chamber. Thus the ions create an electrical current which is amplified and displayed on the meter. This is proportional to the concentration of trace gas present in the ion chamber and to the sensitivity of that gas to photoionization.

In service, the analyzer is first calibrated with a gas of known composition equal, close to, or representative of that to be measured. Gases with ionization potentials near to or less than 10.2 eV will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials higher than 10.2 eV will not be detected.

Ionization potentials for various atoms, molecules and compounds are given in the Instruction Manual Appendix. The ionization potential of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to about 15.6 eV and are not ionized by any of the three lamps. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, with low sensitivity.

VI. INTERFERENCES AND CORRECTIVE ACTIONS

Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings. Soil, dust, or debris drawn into the probe will result in low readings and/or negative deflection of the meter. High ambient humidity and high percent moisture samples will cause negative deflection of the meter.

To obtain stable, reproducible readings, corrective actions such as shielding the probe from drafts or currents and rain should be done. Sample moisture content is not controllable as representativeness dictates that no special handling of the sample occurs that might bias chemical results. Any drying of the sample would result in loss of volatiles. The field records should indicate which samples were wet and note any negative meter deflection.

VII. SAFETY PRECAUTIONS

Do not look at the light source closer than 6 inches with unprotected eyes. Observe only if necessary, then only briefly. Continued exposure to ultraviolet energy generated by the light source can be harmful to eyesight.

The instrument measures gases in the vicinity of the operator and a high reading when measuring toxic or explosive gases should be cause for action for operator safety.

Use HNu only in an emergency with a low battery when on battery charge.

Turn the function switch on the control panel to the OFF position before any disassembly. Otherwise, high voltage of 1200 vdc will be present. Use great care when operating the analyzer with the readout assembly outside its case due to the presence of 1200 vdc.

Do not interchange lamps of different eV ratings in a probe. Amplifier and components are selected for a specific eV lamp. A probe with the wrong lamp will not operate properly.

VIII. SAMPLE SIZE, COLLECTION, PRESERVATION AND HANDLING

Soil

Measurement is done on the soil contained in the split spoon sampler or trowel placed in a clean 8-ounce jar with a teflon-lined lid. Measurement should be made within 5 minutes of collection in the field. The jar should be half full.

IX. APPARATUS

- Clean 8-ounce clear glass jars with teflon-lined lid, hole the diameter of the HNu probe drilled in top.
- Duct tape.
- HNu Model PI 101.
- Isobutylene calibration gas cylinder and regulator.
- Spare 10.2 eV lamps.
- Battery charger.

X. ROUTINE PREVENTIVE MAINTENANCE

1. Battery

Check the battery charge during each period of operation, at least once daily. If the battery is low as indicated by the meter reading or the warning indicator, it is necessary to recharge the battery.

2. Lamp

During periods of operation of the analyzer, dust or other foreign matter could be drawn into the probe forming deposits on the surface of the UV lamp or in the ion chamber. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, or drifting, or show apparent moisture sensitivity. These deposits interfere with the ionization process and cause erroneous readings. Check for this condition daily. Cleaning can be accomplished as follows:

- a. Disassemble the probe and remove the lamp and ion chamber. Exercise great care in doing so to prevent inadvertent damage to these components.
- b. First check the lamp window for fouling by looking at the surface at an incident angle. Any deposits, films or discoloration may interfere with the ionization process. Clean the window as follows:

- 1) First clean by rubbing gently with lens tissue dipped in a detergent solution.
- 2) If this does not remove deposit, apply a small amount of HNu cleaning compound (PA101534) directly onto the lens of the lamp and spread evenly over surface with a non-abrasive tissue (e.g. Kim-Wipe) or a lens tissue.
- 3) Wipe off compound with a new tissue.
- 4) Rinse with a warm water (about 80° F) or damp tissue to remove all traces of grit or oils and any static charge that may have built up on the lens. Dry with new tissue.
- 5) Reinstall lamp in detector and check analyzer operation.
- 6) If performance is still not satisfactory, replace the lamp.

3. Ion Chamber

- a. Inspect the ion chamber for dust or particulate deposits. If such matter is present, the chamber can be cleaned by removing the outer Teflon ring, and the four screws holding the retaining ring. Carefully move the retaining ring aside (NOTE: this is soldered) and remove the screen. A tissue or cotton swab, dry or wetted with methanol, can be used to clean off any stubborn deposits. The assembly can also be gently swirled in methanol and dried gently at 50-60° C for approximately a half hour. No liquid must be present at reassembly as this would affect the performance. Do not clean the ion chamber with the HNu cleaning compound.
- b. Reassemble the probe and check analyzer operation.
- c. If performance is still not satisfactory, replace the lamp.

XI. REAGENTS AND CALIBRATION STANDARDS

The calibration gas cylinder containing a certified value of isobutylene is the only reagent/standard. Replace when empty, no shelf life is applicable.

XII. CALIBRATION PROCEDURES - TURBIDITY METER

1. Standard Formazin Solutions

Calibration of this instrument is based on Formazin, a material which can be made by synthesis and reproduced repeatedly within one percent. When properly mixed, it is uniform in the number, size, and shape of its particles, thus making it an ideal turbidity standard. The unit of measure, and thus the calibration of this instrument is in Nephelometric Turbidity Units (NTU) based on Formazin.

Calibration samples may be obtained by diluting Formazin stock suspension using "Turbidity Free" water. Formazin stock suspension may be prepared by the user (Reference A.W.W.A. "Standard Methods", 14th Edition) or it may be purchased in kit form, HF scientific part number 50040.

Each kit contains:

- 1 liter of 4000 NTU Stock Suspension
- 1 gallon (3.79 liters) turbidity-free water
- 7 sample cuvettes (28 mm), with screw caps
- Instructions for dilution
- One 200 ul Pipette

The following table gives the recommended dilutions of the stock suspension. Be sure to adequately mix the stock suspension prior to removing a portion for dilution.

PROCEDURE

<u>Value</u>	<u>Pipettes Requires</u>	<u>Pipette into a 200 ml Volumetric Flank</u>
198 NTU	10 ml graduated in tenths of a ml	9.9 ml of 4000 NTU stock. Add low turbidity water to 200 ml mark.
19.8 NTU	20 ml volumetric	Pipette 20 ml of the 198 dilution above into another 200 ml volumetric flask. Add low turbidity water to the 200 ml mark.
2.0 NTU	2.0 ml volumetric	Pipette 2.0 ml of the 198 dilution into a 200 ml volumetric flask. Add low turbidity water to the 200 ml mark. NOTE: Value includes 0.02 NTU added by the water.

NOTE: 1. When the prepared samples start to flocculate, they are unreliable and fresh ones must be made. This will occur rapidly for the lower value diluted suspensions.

2. Electronic Calibration Using Freshly Prepared Formazin Solutions

The DRT Turbidimeters have been carefully calibrated by the factory. However, should the Electronic P.C. Board, the Photo Detectors, or the Light Source be replaced or if very carefully prepared Formazin suspensions indicate a need for recalibration, this may be easily accomplished in your facility.

To carry out a complete calibration the following Formazin suspension values are required:

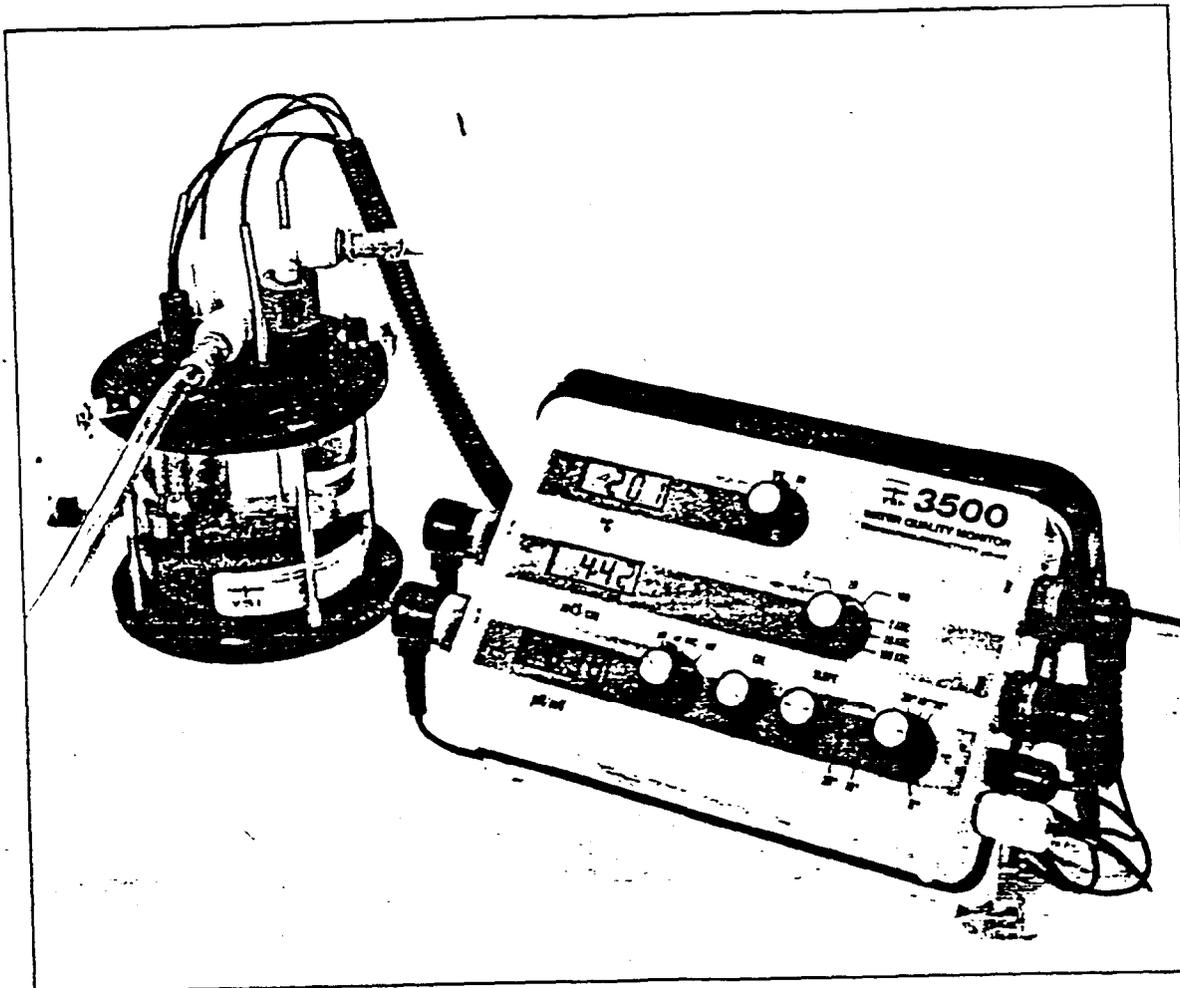
- 198 NTU - Fill cap and label a separate
- 19.8 NTU - cuvette with a sample of each.
- & 2.0 NTU -
- Always mix the contents of each cuvette by inverting several times before placing in the Optical Well for a reading.
- Keep the outside surface of cuvettes clean.
- When placing any standards in the well, always use the Light Shield to cover the well in order to keep out ambient light.

To gain access to the trim pots, remove the accessories from the foam holder. Refer to Figure 2 for trim pot identification during the next few steps.

- 1) Center the reference adjust control on top of the instrument.
- 2) Insert the reference standard and turn the range control on the DRT-15C to the 20 range. Adjust the "Course Zero" trim pot (R2) until a reading of 0.02 NTU is obtained.
- 3) Replace the reference standard with the 19.8 formazin standard and adjust the "20 Range Adjust" trim pot (R7) to obtain a reading of 19.8 NTU \pm 0.1 NTU.
- 4) Replace the 19.8 NTU formazin standard with the reference standard and adjust the reference adjust control to obtain a reading of 0.02 NTU.
- 5) Repeat steps 3 and 4 until no further adjustments are required.
- 6) The 2.0 NTU Formazin Standard may be used to check calibration for low readings.
- 7) Turn the range control on the DRT-15C to the 200 range. Insert the 198 NTU formazin standard and adjust the "200 Range Adjust" trim pot to obtain a reading of 198 \pm 1 NTU.

This completes the calibration of the DRT-15C.

YSI MODEL 3560 WATER QUALITY MONITORING SYSTEM INSTRUCTIONS



85 24 44
47 00 14
17 00 58



YSI Incorporated

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GENERAL DESCRIPTION

The YSI 3560 Water Quality Monitoring System

The rugged YSI 3560 Water Quality Monitoring System is primarily designed to be used in the field with a well or surface water pump, but use with a bailer, in the laboratory, or the like, is also possible. The 3560 system consists of a YSI 3500 Water Quality Monitor, a YSI 3510 Temperature Probe, a YSI 3520 Flow-Through Conductivity Cell, a YSI 3530 pH Electrode, a YSI 3550 Sample Chamber Assembly, a YSI 3565 Sample Cup Pack and assorted fittings. Other components, described below, are available as optional accessories.

As water is pumped through the system, temperature, conductivity, temperature compensated conductivity, pH, temperature compensated pH, and millivolts can all be measured. It is possible to make stable readings of the fluids running through the sample chamber in as little as two minutes. The constant monitoring of these values will help determine when a representative sample of the aquifer has been obtained. The system is designed for simple assembly and disassembly to facilitate frequent sensor calibration and easy cleaning.

The YSI Model 3500 Water Quality Monitor

The YSI 3500 Water Quality Monitor is an integral part of the 3560 system. This instrument allows the user to visually monitor three parameters simultaneously by means of three 1/2" LCD displays. The recorder output allows simultaneous recording of four parameters. The monitor is housed in a yellow molded ABS plastic case which has been tested to military specifications for shock and vibration. The 3500 uses 6 alkaline D cells which will power it for a minimum of 1400 hours. When BAT is shown on any of the displays, it is time for battery replacement.

An on/off switch controls power to the instrument. A second function switch controls each of the three ranges of conductivity and automatically temperature compensated conductivity as indicated on the middle display. The displayed values are read out in millimho/cm (mM/cm). When a temperature probe is attached, temperature is read out constantly in °C on the top display and temperature compensated conductivity can be measured, automatically corrected to 25°C. This correction uses a temperature coefficient recommended in "Official Methods of Analysis of the Association of Official Analytical Chemists", Ed. Sidney Williams, 14th edition, 1984, Arlington, Va. This temperature coefficient of 2%/°C is calculated by the formula:

$$\text{Compensated Conductivity} = \frac{\text{Uncompensated Conductivity}}{[(P/4\%)(0.04T-1)]+1}$$

T = temperature in °C
P = temperature coefficient in %

A third function switch controls the bottom display which shows manually temperature compensated pH, or automatically temperature compensated pH, in either pH units or in millivolts (mV). Both of the temperature compensated pH functions use a temperature coefficient of .335%/°C. The mV function is designed to work with optional electrodes such as the YSI 3540 ORP Electrode. It may be used with most ion specific electrodes that meet the 3500 input specifications.

The YSI Model 3510 Temperature Probe

The YSI 3510 Temperature Probe can be used as either a Temperature/ATC Conductivity Probe or as a pH ATC Probe when attached appropriately to the YSI 3500 Water Quality Monitor. It is usable over a temperature range of -5 to 50°C with an accuracy of ±.2°C. The polyurethane cable is three feet long and is terminated at one end with a watertight MS connector. A YSI Thermilinear[®] thermistor is mounted in a stainless steel sheath.

The YSI Model 3520 Flow-Through Conductivity Cell

The YSI 3520 Flow-Through Conductivity Cell is an integral conductivity cell of rigid and durable chlorinated polyvinyl chloride (CPVC). A three foot polyurethane jacketed cable is attached to the cell body with a bend relief. A watertight MS type connector terminates the cable.

Two electrodes measure conductivity. The cell response time is 10 seconds for 95% reading of conductivity changes. Accurate measurements can be made with a flow rate up to 1.5 gallons per minute. The conductivity cell constant is K = 5.0/cm.

The YSI Model 3530 pH Electrode Assembly

The YSI 3530 pH Electrode Assembly has been designed for YSI for use with the YSI 3560 Water Quality Monitoring System, but it may be used equally well with other pH measuring systems that have similar specification requirements. The 3530 has a rugged 5.5 inch long polymer body designed to withstand demanding field and laboratory use. The silver/silver chloride reference electrode and silver working electrode are sealed in a 4 molar potassium chloride gel to eliminate the need to add filling solution; a porous Teflon[®] junction is used to maximize electrode life. The 3530 comes with a 36 inch long cable, a black BNC cover and a black end cap for easy visual distinction. The unit is shipped in a soaker bottle containing pH 4.0 buffer. It is important that the electrode be immersed in the buffer solution to prevent the electrode from drying out in storage or transport.

The YSI Model 3540 ORP Electrode Assembly

The YSI 3540 ORP Electrode Assembly has been designed for YSI for use with the YSI 3560 Water Quality Monitoring System, but it may be used equally as well with other ORP measuring systems that have similar specification requirements. The 3540 has a rugged 5.5 inch long polymer body designed to withstand demanding field and laboratory use. The silver/silver chloride reference electrode and platinum working electrode are sealed in a 4 molar potassium chloride gel to eliminate the need to add filling solution; a porous Teflon Circle R junction is used to maximize electrode life. The 3540 comes with a 36 inch long black cable, a yellow BNC cover and a yellow end cap for easy visual distinction.

The electrode assembly is shipped in a soaker bottle containing pH 4.0 buffer. It is important that the electrode be immersed in the buffer solution to prevent the electrode from drying out in storage or transport.

The YSI Model 3682 Zobell Solution

This is a reference solution used to verify the performance characteristics of redox potential cells such as the YSI 3540 ORP Electrode Assembly.

The YSI Model 3550 Sample Chamber Assembly

The YSI 3550 Sample Chamber Assembly is an integral part of the YSI 3560 Water Quality Monitoring System. It is designed to be attached to a pump outlet but can be used equally well as a non-flowing sample chamber. It is designed to hold up to five sensors and to provide inlet and outlet ports for fluid movement through the chamber. It provides good mixing of fluids so residual sample will not be a problem. The clear acrylic sides of the chamber permits observation of fluid flow.

Two gaskets keep fluids from leaking around the sensor mounting plate and base assemblies, while two o-rings in each of the sensor ports provide excellent seals. The sensor mounting plate is permanently marked to indicate the location of each sensor. This sample chamber holds approximately one liter. See Figure 1.

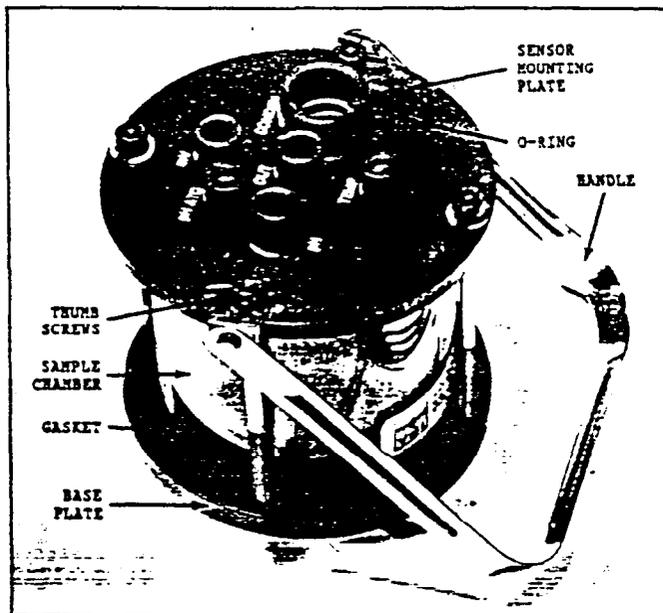


Figure 1. The YSI Model 3550 Sample Chamber Assembly

The YSI Model 3555 Sample Chamber Maintenance Kit

The YSI Model 3555 Sample Chamber Maintenance Kit is designed to provide all the o-rings, gaskets and tools necessary to perform the prescribed annual maintenance on the 3550 Sample Chamber Assembly.

The YSI Model 3565 Sample Cup Pack

The YSI Model 3565 Sample Cup Pack consists of five boxes of 100 each 50 ml polypropylene sample cups. Each box comes with velcro strips for easy installation to most surfaces. The 50 ml size is ideal for use with the 3560 system to minimize the consumption of buffers and standards used in routine calibration procedures.

The YSI Model 3570 Recorder Interface Cable

The YSI 3570 Recorder Interface Cable Assembly has four leads and a common conductor, terminated with a PVC molded connector. The 1/4 inch diameter, 10 foot long polyurethane jacketed cable provides the interface between the YSI Model 3500 Water Quality Monitor and whatever data logging or data recording device is in use. The watertight MS connector is pinned out as follows:

Pin A - Green Conductor	- mV
Pin B - White Conductor	- pH
Pin C - Gray Conductor	- Common
Pin D - Red Conductor	- mS/cm
Pin E - Black Conductor	- °C

The YSI Model 3580 Carrying Case

The YSI Model 3580 Carrying Case is constructed of yellow polyethylene outer shells and has a yellow ABS insert which holds the 3560 system in place for carrying and provides a convenient working platform for the system in use. All metal parts are either plated or anodized to resist corrosion in the harshest environments. Two stays and a continuous hinge give the case rugged strength and durability. Two locks assure that it will stay closed in transit; tie-down straps keep the components secure from movement or damage. Up to four bottles of calibrator solutions can be put into the cavity in the lid for easy access and safe storage away from the instrument. A recess in the lid of the case is provided for convenient mounting of a 3565 Sample Cup Pack box.

The YSI Model 3590 pH Sensor Simulator

The YSI Model 3590 pH Sensor Simulator attaches to either the pH or mV input jack of the Model 3500, and is used to confirm the calibration in both the pH and mV modes. The device simulates pH electrode inputs over the entire pH scale and allows for temperature simulation from -5° to 100°C. These output signals can also be used to simulate mV inputs in the range between -518 mV and +518 mV, as determined by use of a conversion table located on the back of the unit.

The YSI Model 3595 Test Probe Kit

The YSI Model 3595 Test Probe Kit is a probe substitute that simulates both a temperature probe and a conductivity cell. It is used to test Model 3500 function in these parameters by comparing the displayed values on the 3500 (with the test probes connected) with the specifications indicated on the 3595 label.

SYSTEM SPECIFICATIONS

The time needed for the system to come to equilibrium with the sample under test will vary with sample flow characteristics. It could be two minutes or longer.

Temperature Measurement (using YSI 3500 and 3510)
Measurement range: -5.0 to 50.0°C.
Accuracy of temperature measurements: $\pm 0.4^\circ\text{C}$
Resolution: 0.1°C
Response Time: 95% of reading in 10 seconds

Conductivity Measurement (using YSI 3500, 3510 and 3520)
Ranges: 0.0 to 2.000 mS/cm conductivity
0.0 to 20.00 mS/cm conductivity
0.0 to 100.0 mS/cm conductivity
0.0 to 2.000 mS/cm conductivity ATC to 25°C
0.0 to 20.00 mS/cm conductivity ATC to 25°C
0.0 to 100.0 mS/cm conductivity ATC to 25°C

Accuracy of conductivity and ATC conductivity measurements:
at 25°C: $\pm 3\%$ of full scale from 0 to 20.00 mS/cm,
and $\pm 6\%$ of full scale from 20.00 to 50.0 mS/cm,
with cell electrodes not platinized

When the cell is platinized using YSI 3140 Platinizing Solution and YSI 3045 Platinizing Instrument an accuracy of $\pm 6\%$ of full scale from 50.0 to 100.0 mS/cm, can be achieved.

Temperature compensated conductivity is automatically corrected to 25°C with a temperature coefficient of 2%/°C

Resolution: 0.001 mS/cm for 0.0 to 2.000 mS/cm range
0.01 mS/cm for 0.0 to 20.00 mS/cm range
0.1 mS/cm for 0.0 to 100.0 mS/cm range

Response Time: 95% of reading in 10 seconds

pH Measurement (using YSI 3500, 3510 and 3530):
Range: 0 - 14.00 pH units
Accuracy: Subject to calibration using available pH buffer solutions in measurement range
Resolution: 0.01 pH
Response Time: 95% of reading in 10 seconds
Temperature Compensation: Automatic: -5 to 50°C
Manual: $\pm 1^\circ\text{C}$ from 0 to 50°C
Sample Temperature: -5 to 50°C

mV Measurement (using YSI 3500)
Range: -1500 mV to +1500 mV
Accuracy: $\pm 1\%$ of reading, plus 1 count
Resolution: 1 mV

Instrument (YSI 3500)
Monitor Size: 8.3 x 11.8 x 4.1 inches
(21.1 x 30.0 x 10.4 centimeters)
Weight: 5.5 pounds (2.5 kilograms)
Ambient Operating Temperature Range: -20 to 50°C
Humidity: operates in 10 to 90% RH, non-condensing at 25°C
Shock and Vibration: conforms to MIL-T-28800-C,
Class J, Style A
EMI: conforms to FCC (47CFR, Part 15, Subpart J),
Class A & B
Recorder Output: 4 channels simultaneous
(°C, mS/cm, pH, mV)
Sensitivity: 1 mV = 1 count on display
Accuracy: ± 10 counts of display
50 K ohm minimum load impedance
Conductivity ATC output = uncompensated
conductivity output

Calibrated with 50 K ohm load resistor
Power Supply: Batteries: 6 each D cells, Alkaline
Life: 1400 hr. at 3 hr. per day, minimum

Carrying Case (YSI 3580) (not included with system)
Size: 8.5 x 24.0 x 14.9 inches
(21.6 x 61.7 x 37.3 centimeters)
Weight: 11.0 pounds (5.0 kilograms)

ACCESSORIES

3500 Water Quality Monitor
3510 Temperature Probe
(also used for Conductivity ATC, and pH ATC)
3520 Flow-Through Conductivity Cell
3530 pH Electrode Assembly
3540 ORP Electrode Assembly (Redox Potential)
3550 Sample Chamber Assembly
3555 Sample Chamber Maintenance Kit
3565 Sample Cup Pack (500 each)
3570 Recorder Interface Cable Assembly
3580 Carrying Case
3590 pH Sensor Simulator
3595 Test Probe Kit
3632 Zobell Solution (ORP Calibrator Solution)
3167 Conductivity Solution, nom. 1.0 mS/cm, field use
3168 Conductivity Solution, nom. 10.0 mS/cm, field use
3169 Conductivity Solution, nom. 50.0 mS/cm, field use
3045 Platinizing Instrument
3140 Platinizing Solution

Accessories may be purchased through your YSI dealer.

OPERATION

Pump Hook-Up

The YSI 3560 Water Quality Monitoring System is shipped unassembled and must be assembled before use. The system may be connected to the pump outlet at any time during the purging-pumping process as long as the flow rate does not exceed 1.5 gallons per minute. The system is normally connected prior to starting the pump so that constant parameter monitoring may be achieved and the point for logging the representative sample values can be determined. Because of sample chamber construction, it is very important that a 1.5 gallons per minute sample flow not be exceeded; otherwise, leakage may occur.

The outlet from the pump must first be prepared for the sample chamber input. Inlet and outlet lines for the 3550 are cut to the length desired from the ten foot long plastic tubing supplied. Insert a tube-hose stem adapter into each end of the inlet tubing. This section connects the pump outlet to the sample chamber inlet. Insert a third tube-hose stem adapter into one end of the outlet tubing. This goes from the sample chamber to a waste container.

Next, the 3550 is connected to a 1/2" or 3/8" OD pump outlet by using the appropriate straight union connector supplied. For a 1/2" OD pump outlet, use the straight-union connector with two 1/2" ID ports. For a 3/8" OD pump outlet, use the straight-union connector which has one 3/8" ID port and one 1/2" ID port. Hand-tighten the appropriate port of the straight union connector at the pump outlet. Insert one end of the previously constructed sample chamber inlet tubing into the opposite port of the straight union connector and hand tighten it (see Figure 2).

Insert the other end of the constructed inlet tubing into an elbow until it stops. Then insert the elbow into the top of the YSI 3520 Flow-Through Conductivity Cell and push down until it stops. Two internal o-rings in the cell serve as water seals.

The constructed end of the outlet tubing with the inserted tube-hose stem adapter is then pushed into another elbow until it stops. Then the elbow is inserted into the outlet port of the sensor mounting plate and pushed down until it stops. There is a double o-ring seal here too.

Install the sensors that will be used into the sensor mounting plate in their respective ports. The sensor ports not in use must have plugs installed to close off the system. Attach each of the sensors to the 3500. The input jacks are marked for proper placement of each connector. The temperature, conductivity, pH ATC probe inputs, and the recorder output have MS connectors. The pH and ORP electrodes come with BNC connectors which have very low water integrity and so should have their "boots" installed over their connectors. The color coding on the boots also helps identify them when they are in the cable harness. With the sensors attached to the 3500, place all the cables from the sample chamber into the black cable harness provided with the 3560 system. The harness is slotted for easy cable installation. The system is now ready for operation. (See Figure 3.)

With the system connected to the pump, begin pumping according to the pump manufacturer's instructions. Turn on the 3500. Before recording any values, make sure the sample chamber is full, that all air is voided, and that all of the displayed values are stable.

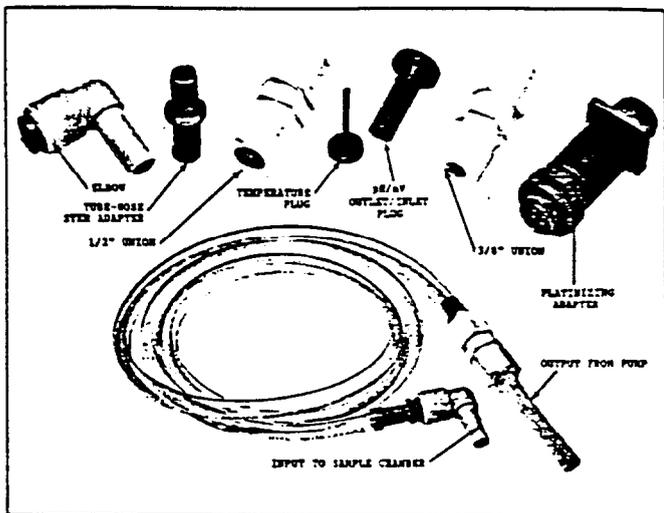


Figure 2. Plumbing Components and Platinizing Adapter

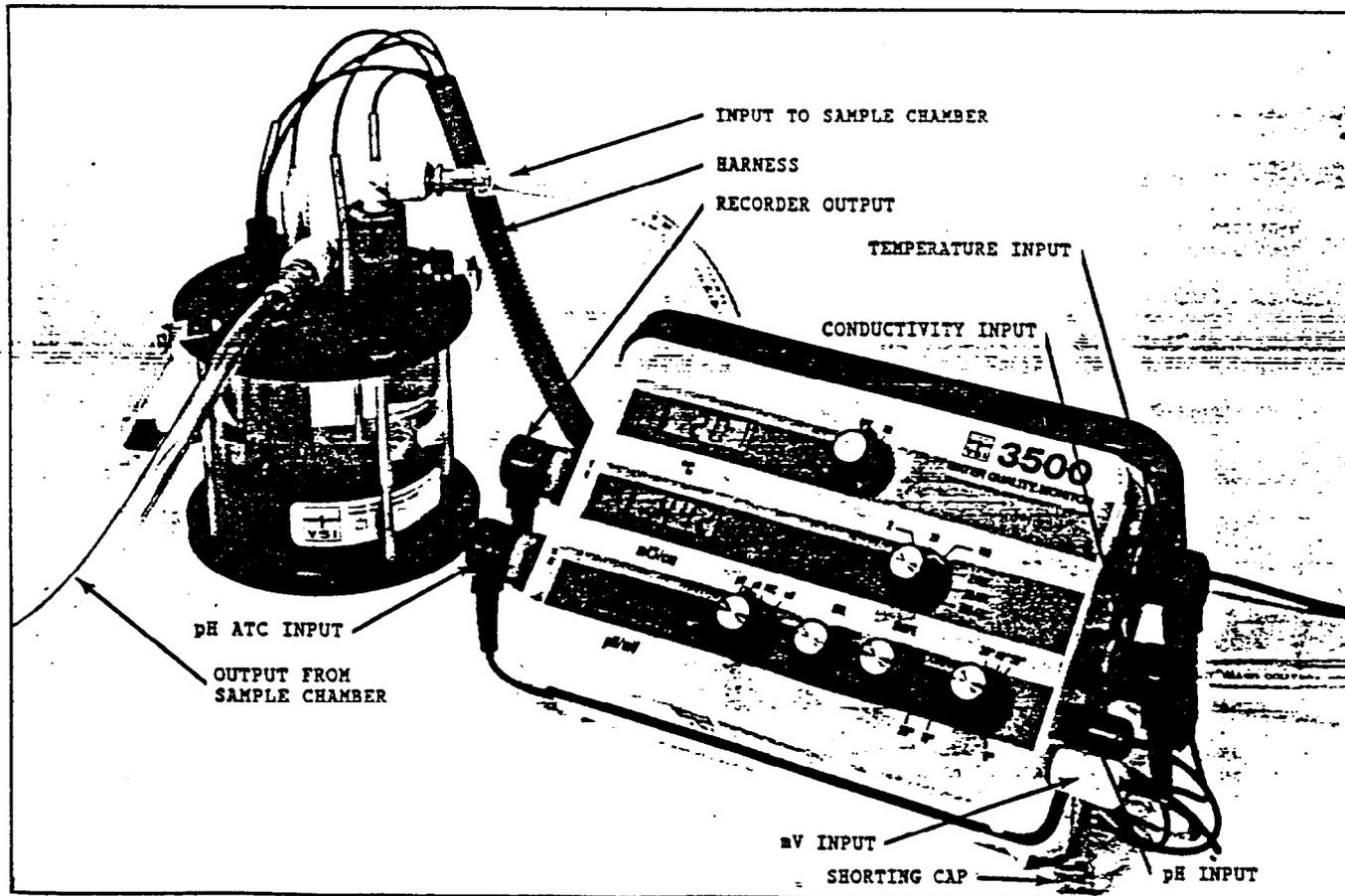
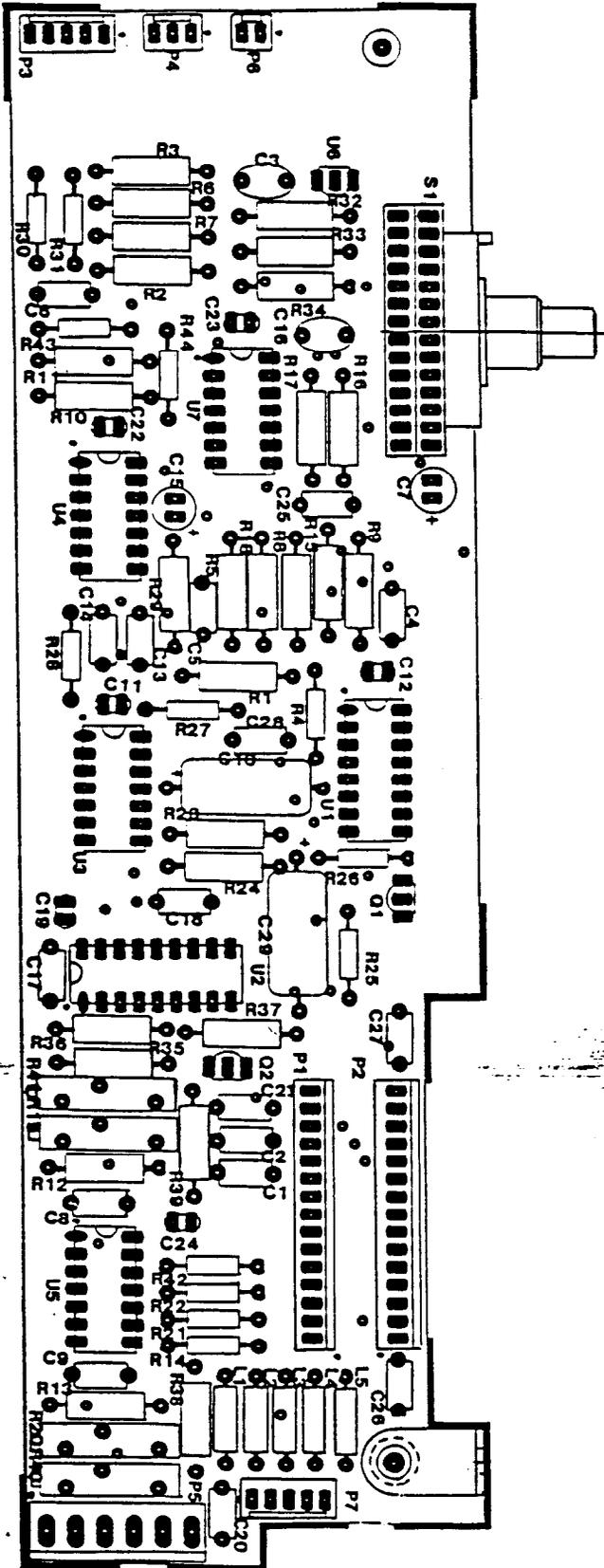


Figure 3. The 3560 System, Assembled

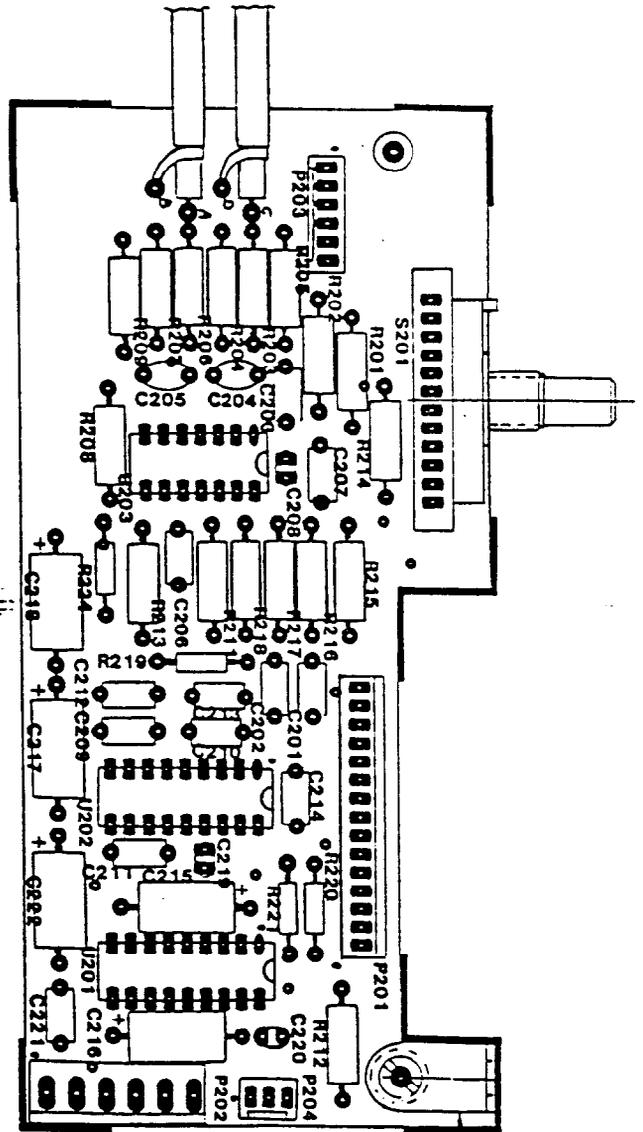
NOTES

(Schematics and board layouts on following pages)

BOARD LAYOUT

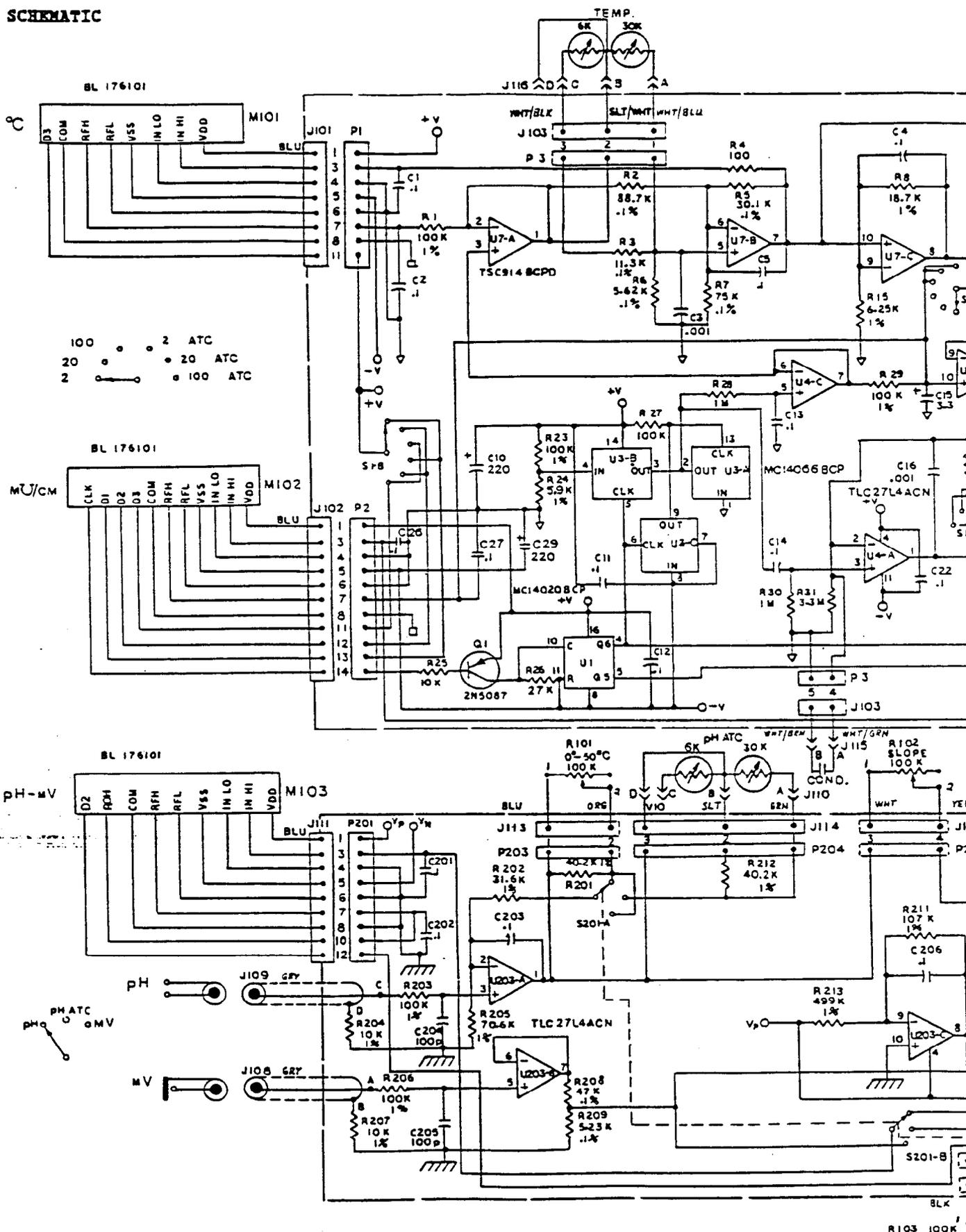


CONDUCTIVITY/TEMPERATURE BOARD



pH/mV BOARD

SCHEMATIC



Temperature Measurement

To measure temperature, connect a 3510 Temperature Probe to the 3500. Temperature is measured in °C and is shown continuously on the top display. With no probe attached, the 3500 display will read $-34.0 \pm 2.0^\circ\text{C}$.

Conductivity Measurements

Before any conductivity cell is used, it should be soaked in distilled or deionized water for at least one hour. To make conductivity measurements, connect a YSI 3520 Flow-Through Conductivity Cell to the 3500. Set the conductivity function switch to 2 and observe the displayed value after the reading is stable. The display reads out in millimhos/centimeter ($\text{m}\Omega/\text{cm}$). If micromhos/centimeter ($\mu\Omega/\text{cm}$) is desired, multiply the displayed value by 1000.

If the overrange signal (1.____) is displayed, the conductivity of the water being assayed is greater than $1.999 \text{ m}\Omega/\text{cm}$. Reset the function switch to 20. If the overrange signal is still displayed, reset to 100. If the overrange signal is still displayed, either the conductivity is greater than $100.0 \text{ m}\Omega/\text{cm}$ and the YSI 3500 Water Quality Monitor can not be used for conductivity determinations, or else there is a system error.

If no cell or a dry cell is attached to the 3500, the display will read 000 (± 002) with the appropriate decimal point.

Automatically Temperature Compensated Conductivity

To measure automatically temperature compensated conductivity, connect a YSI 3510 Temperature Probe and a YSI 3520 Flow-Through Conductivity Cell to the 3500, and set the conductivity function switch to the correct ATC conductivity range. Readings are automatically compensated by $2\%/^\circ\text{C}$ to 25°C . The 3510 must be located in the sample under test for the automatic compensation to work correctly. If no temperature probe is connected to the monitor, the display will show the overrange signal (1.____). See Tables I and II for the correction values.

pH Measurements

To measure pH, connect a YSI 3530 pH Electrode or equivalent to the 3500, and set the pH function switch to pH. Typically, a two point calibration is necessary before actual measurements can be made. See pH Calibration procedure. Once the 3530 is calibrated, install the electrode into its port in the 3550. Though the instrument and electrode have been calibrated at one temperature, they can be used at other temperatures as long as the manual temperature knob is reset to the new sample temperature before final values are determined. Be sure to reset the dial to the temperature indicated by the top display. Though pH is temperature dependent, it is not customarily corrected to 25°C , as conductivity often is. pH changes with temperature at the rate of $.335\%/^\circ\text{C}$ from the calibration point.

When measuring pH with no electrode connected to the mV input, the shorting cap attached to the 3500 should be on the mV input jack.

Automatically Temperature Compensated pH

To measure automatically temperature compensated pH, a YSI 3510 Temperature Probe and a YSI 3530 pH Electrode must be connected to the 3500. As long as the pH ATC mode is being used, the 3510 must remain connected to the pH ATC input jack or else the pH display will show an underrange negative value, or an overrange condition greater than 14.00--which are outside of the pH range of 0.00 to 14.00 and can not be adjusted into the measurable pH range.

Typically, a two point calibration is necessary before actual measurements can be made. See pH Calibration procedure. Once the 3530 is calibrated, install the electrode into the 3550 in its appropriate port, and the 3510 into the pH ATC port. Though the instrument and sensors have been calibrated at one temperature, they can be used at other temperatures, since temperature changes from the calibration point will be automatically corrected to the new value. Though pH is temperature dependent, it is not customarily corrected to 25°C , as conductivity often is. pH changes with temperature at the rate of $.335\%/^\circ\text{C}$ from the calibration point.

When measuring pH with no electrode connected to the mV input, the shorting cap attached to the 3500 should be on the mV input jack.

mV Measurement

The millivolt (mV) function is intended for use with the YSI 3540 ORP Electrode, though other sensors may also be used. Set the pH function switch to the mV mode and read the bottom display. There are no adjustments in this mode, so any sensor that is attached to this input jack should be tested against some known standard as defined by its manufacturer. See Calibration for ORP Electrode. When no electrode is attached to the mV input, the shorting cap attached to the 3500 should be installed on this jack. If the pH input is not in use when an ORP electrode is on the mV input, the shorting cap should be connected to the pH input jack. With the shorting cap installed, the display will read 000 ± 002 .

Bailers

To use the 3560 system with a bailer instead of a pump, use the funnel provided to fill the sample chamber with the solution to be tested. The sample chamber and the conductivity cell must be filled to the very top and all air must be removed to ensure accurate readings.

Recorder Output

The Model 3500 recorder output is capable of driving a data logging device or strip chart recorder. Four outputs are located on the connector designated REC OUT and are defined as Temperature (pin E), Conductivity (pin D), pH (pin B), and mV (pin A); the common for each output is pin C. Each output circuit has a minimum load impedance of 50 K ohms. Each produces 1 mV for every count on the respective displays, and is accurate to ± 10 counts of the display. The outputs have been calibrated with a 50 K ohm load. It should be noted that the conductivity output in the ATC mode is not temperature compensated. Conductivity output is always uncompensated conductivity. Compensated conductivity can be calculated as described elsewhere.

Shut Down

To shut down the system, simply turn the power switch to OFF. Turn the pump off before disconnecting the plumbing. Remove the straight union connector from the pump outlet, then remove the hose and fittings from the sample chamber ports and drain them. Plug the ports with the plastic plugs provided.

To keep the sensors in a suitable environment, the sample chamber can be moved from one site to another with its contained fluid. When the day's measurements are finished, drain the chamber by removing one of the plugs from its port and pouring out the sample. The pH and ORP electrodes should be stored in their soaker bottles to prevent them from drying out. The conductivity cell should be stored moist to minimize its equilibration period.

MAINTENANCE

Instrument

The YSI 3500 Water Quality Monitor requires occasional battery replacement and cleaning. Six alkaline "D" cells in the 3500 provide a minimum of 1400 hours of operation. When BAT appears on any of the three displays, it is time to replace the batteries. It is important to replace all the alkaline batteries at the same time for long life between battery changes. Remove the four rubber feet located on the back of the instrument and take off the back. Replace the batteries in the battery holder tubes, making sure the polarity is correct (red is positive). Reassemble the case, being careful to align the gasket correctly to prevent water infiltration. The rubber feet should be reinstalled finger tight. Do not use a screw driver.

Use a mild soap and water solution to clean the instrument. Wipe the solution on and wipe it off right away; follow this with a clean water wipe. Either a probe or connector cap should be in place over every jack to keep water out. If water gets into the instrument, disassemble it and wipe it dry. Do not dry it with hot air; this could damage the electronic components.

For stubborn stains and other marks, a solution of 50% water and 50% isopropyl alcohol may be used. Do not allow the solution to stand on the instrument case. Rinse by wiping with water, as above.

When storing the 3500 for long periods, remove the batteries to lessen the possibility of leakage.

Sample Chamber

The YSI 3550 Sample Chamber Assembly comes apart easily. The o-ring seals in the ports and the chamber gaskets should be replaced annually. Use the tweezers provided in the YSI 3555 Sample Chamber Maintenance Kit to remove old o-rings and install new ones. Be sure the o-rings are properly seated in their grooves; they fit back in the sides of the ports. When you replace the gaskets located in recesses at the top and bottom of the clear acrylic tube, re-apply the thumbscrews finger-tight only; do not use any tool to tighten them. The gaskets could be cut, which would cause them to leak.

You may clean the parts of the disassembled chamber, as well as the plumbing fittings, with a mild soap solution or with isopropyl alcohol for tough stains. Rinse the cleaned components with water to remove any residual soap or alcohol; residues might cause interference with measurements.

Whenever storing the 3550, remove all the sensors to minimize the possibility of damaging, and store each one as recommended below. The sample chamber should be disassembled and dried before storage to prevent microbial growth.

The tubing and fittings used with the Sample Chamber may be cleaned with a general laboratory detergent. The tubing may be autoclaved. To remove the hose-stem adapter from the elbow, push in the collar on the elbow while pulling out the hose-stem adapter.

Temperature Probe

The 3510 requires very little maintenance in normal use. The durable stainless steel sheath and polyurethane cable may be cleaned with a mild soap and water solution. A solution of 50% isopropyl alcohol and 50% water may be used to remove stains and mineral deposits.

The 3510 should be stored dry in its own shipping box, and kept in a dry location.

Flow-Through Conductivity Cell

The stainless steel electrodes of the 3520 do not require platinization when used between 0.0 and 50.0 $\mu\text{S}/\text{cm}$. When conductivity values from 50.0 to 100.0 $\mu\text{S}/\text{cm}$ are to be measured, the electrodes do require platinization for system accuracy. A platinization adapter has been provided with the system for use in conjunction with the YSI 3045 Platinizing Instrument and YSI 3140 Platinizing Solution. See the 3045 instructions for further information. The cell must always be kept clean to assure proper operation and reproducible accuracy. A dirty cell will contaminate the sample under test and change the conductivity reading. Any of the foaming acid tile cleaners such as Dow Chemical "Bathroom Cleaner" will clean the cell adequately. When a stronger cleaning preparation is required, use a solution of 10 parts distilled water, 10 parts isopropyl alcohol, and one part 10 normal hydrochloric acid.

Dip the cell into the cleaning solution and agitate for two or three minutes. A small test tube brush may be used to gently clean the electrodes and the flow-through port. Be careful to not scratch the electrodes. Rinse the cell in several changes of distilled or deionized water. The cell constant should be checked after each cleaning (see Calibration).

Store the 3520 in deionized water. For short term storage, the cell can be wrapped in a moist towel and placed in a plastic bag. After the 3520 cell has been stored dry, the cell constant will be in error until it has been soaked in deionized water for at least an hour.

Change the two silicone o-rings annually to maintain their sealing integrity. Use the tweezers provided in the 3555 Sample Chamber Maintenance Kit to remove old o-rings and install new ones. Be sure the o-rings are properly seated in their grooves, and be careful not to damage the o-rings or the cell with the tweezers.

pH Electrode

All sealed pH electrodes, including the YSI 3530, will deteriorate with time. The typical electrode will deteriorate after 3 to 6 months of normal use. Age deterioration is characterized by a shortened slope adjustment and slower speed of response. Aging can best be detected by calibrating the electrode. As a rule, if the span for slope adjustment can not be brought into range (that is, a reading of 4.00 can not be set), the electrode should be cleaned and retested or reconditioned (see below). When storing the electrode, keep it in the soaker bottle provided. The solution in the bottle may be replenished with 5 to 10 mL of pH 4 buffer with 1/2 teaspoon of sodium chloride (NaCl). If performance is not restored the electrode should be replaced. The slope control on the YSI 3500 Water Quality Monitor will allow a pH electrode with an 80% to 100% efficiency to be calibrated to the slope adjustment value. If this cannot be set, the electrode is probably below an 80% efficiency value. To clean or recondition a 3530, proceed as follows:

pH Electrode Cleaning: Coating of the bulb can lead to erroneous readings including shortened slope adjustment. Cleaning technique is determined by the type of coating. Soft coatings can be removed by vigorous stirring or by use of a squirt bottle of water. Organic chemicals or hard coatings should be chemically removed. A half-hour soaking in an industrial strength

detergent is recommended. Only in extreme cases should the bulb be mechanically cleaned as abrasion can lead to permanent damage. If cleaning does not restore performance, reconditioning may be attempted.

pH Electrode Reconditioning: When reconditioning is required due to electrode aging or severe fouling, the following chemical treatments can be tried. They are presented in the order of the severity of their attack on the pH electrode glass and may not improve electrode performance, and in some cases they might actually reduce it.

NOTE: USE PROPER PRECAUTIONS WHEN HANDLING THESE HAZARDOUS CHEMICALS.

1. Immerse the electrode tip in 0.1 normal hydrochloric acid for 15 seconds, rinse it in tap water, then immerse the tip in 0.1 normal sodium hydroxide for 15 seconds, and rinse in tap water again. Repeat this sequence three times and then recheck electrode performance. If it has not been restored, try the next step.

2. Immerse the electrode tip in a solution of 20% ammonium bifluoride and 80% water for two to three minutes, rinse in tap water and recheck performance. If performance has not been restored, try the next step.

3. Immerse the electrode tip in a solution of 5% hydrofluoric acid and 95% water for 10 to 15 seconds, rinse well in tap water, quickly rinse in 5 Normal hydrochloric acid, then rinse well in tap water again and recheck performance. If performance has not been restored, replace the electrode.

ORP Electrode

The 3540 should be periodically inspected for coating of the platinum surface, which can cause erroneous readings. The bulb guard of the electrode can be removed to expose the platinum for cleaning. When storing the electrode, keep it in the soaker bottle provided. The solution in the bottle may be replenished with 5 to 10 mL of pH 4 buffer with 1/2 teaspoon of sodium chloride (NaCl). By testing the 3540 with YSI 3682 Zobell Solution, the need for cleaning can be determined (see Calibration). To clean the 3540, proceed as follows:

1. Soft coatings should be removed by use of a squirt bottle of water or by gently wiping with a soft cloth. Remove the bulb guard if necessary. Be careful not to scratch the platinum.

2. Hard coatings or organic chemicals should be removed by an appropriate chemical solvent, by gently scrubbing with a very fine cleansing powder such as "Softscrub," or by gently polishing with 600 grade wet silicon carbide paper. Wet a piece of the paper with water and gently polish the electrode with a circular twisting motion.

NOTE: After cleaning the platinum surface, soak the electrode for 8 to 24 hours in 4.0 pH buffer, then recheck it with YSI 3682 Zobell Solution before further use.

CALIBRATION

Instrument

The Model 3500 has no user serviceable adjustments. If you suspect that the instrument is out of calibration, it may be tested for accuracy using the YSI 3590 pH Sensor Simulator and the 3595 Test Probe Kit. Install the 3595 Test Probe Assembly by connecting the temperature unit (4 pins) to the TEMP input jack on the 3500, and the conductivity unit (2 pins) to the COND input jack. The readings you should see to ascertain correct operation of the temperature, conductivity and ATC conductivity functions of the 3500 are as follows:

$$^{\circ}\text{C} = 15.5 \pm 0.3$$

$$\begin{aligned} 2 \text{ mS/cm} &= 1.563 \pm 0.020 \\ 20 \text{ mS/cm} &= 1.56 \pm 0.10 \\ 100 \text{ mS/cm} &= 1.6 \pm 0.2 \end{aligned}$$

$$\begin{aligned} 2 \text{ mS/cm ATC} &= 1.928 \pm 0.020 \\ 20 \text{ mS/cm ATC} &= 1.93 \pm 0.10 \\ 100 \text{ mS/cm ATC} &= 1.9 \pm 0.2 \end{aligned}$$

Connect the 3590 pH Sensor Simulator to the 3500 as described on the instruction label on the back of the 3590, then follow the steps listed in these instructions. If the displayed values are out of specification, the 3500 should be returned for service. See Warranty and Shipping Information.

Temperature

The 3510 Temperature Probe is assembled with a YSI Thermilinear thermistor and may be tested by customers using an ohmmeter. With the sheath of the probe submerged in a 0.0 \pm 1.0°C ice bath, thermistor resistance can be compared to the following values:

$$\begin{aligned} \text{Across Pins A \& B} &= 94.98 \text{ K} \pm 482 \text{ Ohms} \\ \text{Across Pins B \& C} &= 19.59 \text{ K} \pm 103 \text{ Ohms} \\ \text{Across Pins A \& C} &= 114.6 \text{ K} \pm 585 \text{ Ohms} \\ \text{Across Pins B \& D} &= 0 \quad \pm 1 \text{ Ohm} \end{aligned}$$

If any measurement is out of tolerance, see Warranty and Shipping Information for repair or replacement information.

Conductivity

The designed cell constant of the YSI 3520 Flow-Through Conductivity Cell is $K = 5 / \text{cm}$. Different accuracies in different ranges is a characteristic of the stainless steel electrodes. Though in normal use, re-determination of the cell constant may not be required, the constant can be affected by electrode fouling or mechanical shock. Therefore, it is wise to re-determine the cell constant routinely. When testing the calibration of the system, be sure check the accuracy of the test against System Specifications.

The total accuracy of the system is the sum of all the inaccuracy of its parts. As an example, at 10.00 mS/cm the 3500 and 3520 have an accuracy of $\pm 3\%$ of full scale (20.00), and the 3168 Conductivity Solution has an accuracy of $\pm 1\%$ of solution value. So when the solution is tested in the ATC mode, the displayed value should be 10.00 \pm 0.70 mS/cm.

To check the cell constant, YSI 3167, 3168 or 3169 Conductivity Calibrator Solutions may be used. These solutions are packaged eight to a box in unbreakable plastic one pint bottles designed for field use. The solutions are manufactured to nominal values of 1, 10, or 50 mS/cm at 25°C, with a $\pm 1\%$ accuracy of the stated

value on the label. A chart for uncompensated values at temperatures other than 25°C is included with each box.

In the following example, cell/instrument calibration is confirmed by use of YSI 3167 solution, but these procedures may be followed using any of the YSI solutions with only slight procedural changes.

Connect the 3520 cell and a 3510 Temperature Probe to the 3500, and remove them from the sample chamber. Set the conductivity function switch to 2 ATC. Rinse the inside and outside of the cell and the probe with about 1/3 of the contents of the 3167 bottle. Place both of the sensors into the remainder of the solution in the bottle, and allow them to come to temperature equilibrium. Make sure that the 3520 body is immersed so that the water level is half way up the knurled portion of the cell. See Figure 4. Read the displayed value and determine if the cell/instrument is within specified accuracy. The displayed value is corrected to 25°C automatically and should be 1.000 ± 0.070 mS/cm. If the value is within specification, the measured error can be used to further improve the accuracy of the system by providing a correction factor for further readings. This is done as follows:

$$\text{Corrected Sample Value} = \frac{\text{Calibrator Value}}{\text{Displayed Value}} \times \text{Sample Value}$$

Calibrator Value = 1.000 mS/cm
 Displayed Value = .978 mS/cm
 Sample Value = .634 mS/cm

$$0.648 \text{ mS/cm} = (1.000 \text{ mS/cm}) / (.978 \text{ mS/cm}) \times (.634 \text{ mS/cm})$$

Discard the calibrator solution once the accuracy of the system has been determined. It has been contaminated and should not be reused. If system accuracy is out of specification, see Warranty and Shipping Information for repair instructions.

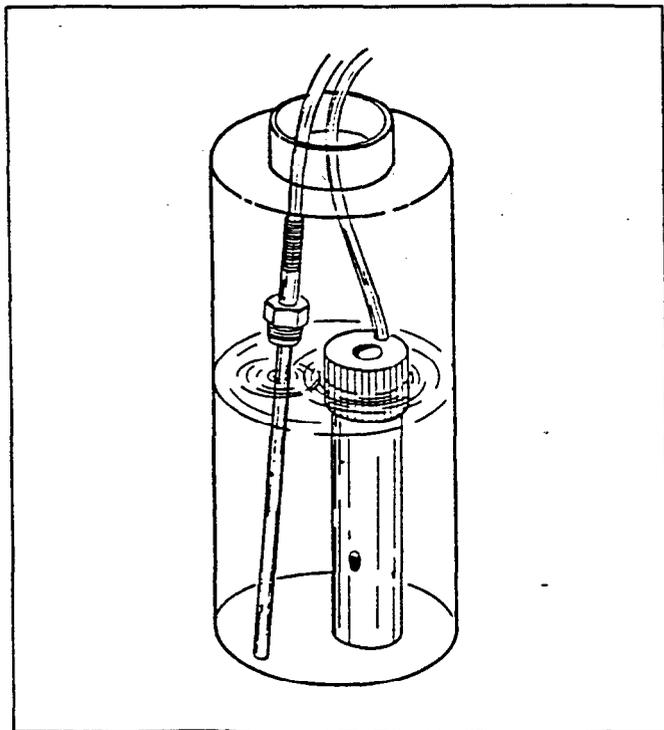


Figure 4. Sensor Level in Conductivity Calibrator Solution

pH

The frequency at which calibration is needed depends on the electrode, the pH monitor and the characteristics of the water to which the electrode is exposed. Since normal life of a pH electrode is only three to six months, it is advisable to calibrate the pH system before sampling at each site. The pH electrode should be tested for background noise and appropriately offset on a weekly basis.

Before connecting the pH electrode, zero the electronics with the shorting cap attached to the 3500. Turn on the 3500 and set the pH function switch to pH. Next, connect the shorting cap to the pH input jack and set the manual temperature compensation knob to 25°C. Then, adjust the CAL control to indicate 7.00 ± 0.01 on the pH-mV display. Disconnect the shorting cap from the pH input and connect it to the mV input jack. The monitor is now zeroed.

Test the 3530 pH Electrode for noise and offset as follows. Rinse the 3530 and a YSI 3510 Temperature Probe with pH 7.00 buffer to remove any contaminants. Connect the 3530 to the pH input jack and the 3510 to the TEMP input jack. Pour pH 7.00 buffer into a 50 ml sample cup, such as one from the YSI 3565 Sample Cup Pack, then immerse both of the sensors into the buffer at 25.0 ± 0.1°C (use the °C display to confirm the temperature). Allow the sensors to equilibrate. A display value other than 7.00 shows electrode background noise and offset. The 3530 background noise and offset at pH 7.00 should not exceed ± 0.2 pH units at 25°C.

Once it has been established that the electrode offset is functioning properly, a two point calibration should be performed. pH buffers of 7.00 and 4.00 or of 7.00 and 10.00, whichever two are closer to the expected sample value, should be used. Proceed as follows to make a two point calibration.

Rinse the 3530 and a YSI 3510 Temperature Probe with pH 7.00 buffer to remove any contaminants. Connect the 3530 to the pH input jack and the 3510 to the TEMP input jack. Pour pH 7.00 buffer into a 50 ml sample cup, such as one from the YSI 3565 Sample Cup Pack, then immerse both of the sensors into the buffer. Allow the sensors to equilibrate in the buffer until a stable reading is obtained. Read the temperature and adjust the pH manual temperature compensation knob to the same value. Adjust the CAL control knob for 7.00 ± 0.01 pH units on the display and discard the buffer. Rinse the sensors with deionized or distilled water, followed by a rinse of the next desired buffer (typically pH 4.00 or 10.00). Half fill another disposable 50 ml sample cup with the next buffer for calibration and immerse the sensors. Allow the sensors to equilibrate until a stable reading is obtained. The temperature of the two buffers should not differ by more than ± 0.1°C. Adjust the SLOPE control until the display is within 0.01 pH units of the buffer's stated value. Discard the buffers. The pH system is now calibrated and ready for use.

Temperature Compensated pH

Follow the pH instructions above, with the following modifications:

Set the pH function switch to pH ATC. Connect the 3510 to the pH ATC input jack. While the 3510 can be used in either location, the pH ATC function will not work unless the 3510 is connected to the pH ATC input. It is recommended that a second YSI 3510 Temperature Probe be used for this operation. Manual temperature compensation is not necessary since temperature compensation is performed automatically in this mode.

mV

The frequency with which the mV function needs to be evaluated depends on the electrode, the monitor and characteristics of the ground water to which the electrode is exposed. It is wise to test the ORP system against a standard on a weekly basis. The YSI 3540 ORP Electrode comes with a bottle of YSI 3682 Zobell Solution which is used as a reference solution. To test the system with this standard, proceed as follows:

First, turn on the YSI 3500 Water Quality Monitor and set the pH function switch to mV. Next, connect the shorting cap attached to the 3500 to the mV input jack. The display should read 000 ±2 mV. This indicates that the 3500 electronics are zeroed. Detach the shorting cap and connect the 3540 to the mV input jack. If a pH electrode is not attached to the pH input jack, connect the shorting cap to it. Attach the 3510 to the TEMP input jack. Rinse the 3540 and 3510 with distilled or deionized water, followed by a rinse with a small amount of reconstituted YSI 3682 Zobell Solution. Half fill a disposable 50 ml sample cup, such as one from the YSI 3565 Sample Cup Pack, with Zobell Solution and fully immerse the bulb of the 3540 and the end of the sheath of the 3510. Allow the sensors to equilibrate, and note the reading. The displayed mV value is not temperature compensated and should be corrected to 25°C at 1.3 mV/°C. The temperature coefficient is in reverse proportion to the temperature. The calculated value for the Zobell Solution should be 231 ±10 mV at 25°C.

Example: Displayed Temperature = 22.1°C
Displayed Value of Zobell Solution = 236 mV

$231 \text{ mV} = \text{Display Value} + [(\text{Display Temp.} - 25^\circ\text{C}) \times (1.3 \text{ mV})]$

$231 \text{ mV} = 236 \text{ mV} + [(22.1^\circ\text{C} - 25^\circ\text{C}) \times (1.3 \text{ mV})]$

$231 \text{ mV} = 236 \text{ mV} + [-3.8 \text{ mV}]$

$231 \text{ mV} = 232.2 \text{ mV, corrected to } 25^\circ\text{C}$

The calculated value of the Zobell solution in this example is within its specified range of 231 ±10 mV. This confirms that the ORP system is functioning properly. Rinse the sensors with deionized or distilled water and discard the used Zobell solution.

NOTE: If a pH sensor such as the 3530 and another potentiometric sensor such as the 3540 are to be installed at the same time into the 3550 Sample Chamber, and if both have their own reference electrodes, both reference electrodes must be immersed in the calibration solution during calibration.

WARRANTY AND SHIPPING INFORMATION

The YSI 3560 is warranted for one year against defects in workmanship and materials exclusive of batteries when used for its intended purposes and maintained according to manufacturer's instructions. The YSI 3530 and 3540 are warranted for three months. Damage due to accidents, misuse, tampering, or failure to perform prescribed maintenance is not covered. The warranty period for chemicals and reagents is determined by the expiration date printed on their labels. This warranty is limited to repair or replacement at YSI's option.

IF SERVICE IS REQUIRED

Contact the YSI dealer from whom you bought the instrument, or the YSI Product Service Department. Report the date purchased, model, serial number, and the nature of the failure.

When shipping any instrument, be sure that it is properly packaged and insured for complete protection. When returning for repair, please note the requirements of the Cleaning Certificate. In communications regarding this instrument or accessories please mention the model and serial number.

Yellow Springs Instrument Co., Inc.
Product Service
1725 Brannum Lane
Yellow Springs, Ohio 45387

YSI Toll Free Number: 1-800-343-HELP

REQUIRED NOTICE

The Federal Communications Commission defines this product as a computing device and requires the following notice:

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class A or Class B computing device in accordance with the specification in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- a) reorient the receiving antenna
- b) relocate the computer with respect to the receiver
- c) move the computer away from the receiver
- d) plug the computer into a different outlet so that the computer and receiver are on different branch circuits

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 0004-000-00345-4.

TROUBLESHOOTING INFORMATION

Five basic assemblies make up the 3500: the conductivity-temperature board assembly, the pH-mV board assembly, the battery assembly, the meter assembly and a front panel assembly. The conductivity-temperature board provides references for the conductivity and temperature circuits as well as signal conditioning, timing, upper display drives and recorder output for all four monitor parameters.

Power is provided by the Battery Assembly and conditioned by the Cond-Temp board. +V is a constant 3.5 V to common and -V varies with the battery level. Power and timing are provided to the pH-mV board via a cable. The pH-mV board in turn provides signal conditioning, lower display drive and circuit isolation for the pH and mV circuits.

The Front Panel Assembly provides interfacing for the sensor inputs, front panel controls and Meter Assemblies.

